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ORGANISATION AND FINANCING OF INTENSIVE CARE SERVICES IN BELGIUM



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LIST OF ABBREVIATIONS

ABBREVIATION	DEFINITION
ABC	Airway, breathing, and circulation
AHRQ	Agency for Healthcare Research and Quality
AI	Artificial intelligence
AMI	Acute myocardial infarction
APACHE	Acute Physiology and Chronic Health Evaluation
APR-DRG	All Patient Refined Diagnosis Related Group
AUC	Area Under the ROC Curve
BFM	Budget of Financial Means
BIC	Bayesian Information Criterion
BIMD	Belgian Index of Multiple Deprivation
BiPAP	Bilevel Positive Airway Pressure
CART	Classification and Regression Trees
CCS	Clinical Classifications Software
CCSR	Clinical Classifications Software Refined
CCU	Coronary care units
CFO	Chief Financial Officer
CI	Confidence interval
CMO	Chief Medical Officer
CNO	Chief Nursing Officer
COPD	Chronic obstructive pulmonary disease
CRRT	Continuous Renal Replacement Therapy
COVID	Coronavirus disease
CZO	*College Zorgopleidingen* (College of education of healthcare professionals – The Netherlands)
DIVI	*Deutsche Interdisziplinäre Vereinigung für Intensiv- und Notfallmedizin* (German Interdisciplinary Association for Intensive Care and Emergency Medicine – Germany)
DNR	Do-Not-Resuscitate
DRG	Diagnosis related group
ECG	Electrocardiogram
ECLS	Extracorporeal life support
ECMO	Extracorporeal membrane oxygenation
ED	Emergency department
EEG	Electroencephalogram
ENT	Ear, nose and throat
ERCP	Endoscopic Retrograde Cholangiopancreatography

EU	European Union
FPS	Federal Public Service (*Federale Overheidsdienst (FOD) / Service Public Fédéral (SPF)*)
FTE	Full-time equivalent
GDPR	General Data Protection Regulation
HAU	High-acuity unit
HB	High-Basic
HDU	High-dependency unit
HR	Hazard ratio
HSPM	Health Systems and Policy Monitor
HSMR	Hospital standardised mortality rate
HT	High-Technical
HTSC	Hospital and Transport Surge Capacity
IABP	Intra-aortic balloon pump
ICD-10-CM	International Classification of Diseases, 10th Version, Clinical Modification
ICU	Intensive care unit
LICHO	Limburgse Intensive Care Hoofdverpleegkundigen Organisatie
IMCU	Intermediate care unit
IQR	Interquartile range
LMB	Low or Medium-Basic
LOC	Level of care
LOS	Length of stay
MARS	Molecular-adsorbent recirculating system
MCU	Medium care unit
MD	Ministerial Decree
MDC	Major Diagnostic Category
Mdiff	Mean difference score
MIC	Maternal intensive care
MICA	Monitoring Intensive Care Activities
MOR	Median odds ratio
MRI	Magnetic resonance imaging
MT	Medium-Technical
MUG – SMUR	Mobile urgency group (*Mobiele Urgentiegroep / Service Mobile d'Urgence et de Réanimation*)
MZG – RHM	Minimal Hospital Data (*Minimale Ziekenhuis Gegevens / Résumé Hospitalier Minimum*)
NAS	Nursing Activities Score

nCPAP	nasal Continuous Positive Airway Pressure
NEMS	Nine equivalents of Nursing Manpower Use Score
NHS	National Health Service
NIC	Nursing Interventions Classification
NICU	Neonatal intensive care unit
NIR	No-information rate
NIRS	Near infrared spectroscopy
NPERCIZ	National percentage of intensive care days
NR	Not reported
NRG	Nursing Related Group
NS	Not significant
NWI	Nursing Work Index
OECD	Organisation for Economic Co-operation and Development
OR	Odds ratio
PACU	Post-Anaesthesia Care Unit
PDX	Principal diagnosis
PICOTS	Participants-Interventions-Comparator-Outcomes-Timing-Study design
PICU	Paediatric intensive care unit
PIT	Paramedical intervention team
POA	Presence on admission
RCT	Randomised controlled trial
RD	Royal Decree
ROC	Receiver operating characteristic
ROM	Risk of mortality
RR	Risk ratio
RSV	Respiratory syncytial virus
SAPS	Simplified Acute Physiology Score
SDU	Step-down unit
SHR	Sub-distribution hazard ratio
SMR	Standardised mortality rate
SOFA	Sequential Organ Failure Assessment
SOI	Severity of illness
TBSA	Total Body Surface Area
TISS	Therapeutic Intervention Scoring System
TPN	Total Parenteral Nutrition
UK	United Kingdom

VG-MZG / DI_RHM	Nursing Minimum Data Set (*Verpleegkundige Gegevens van de Minimale Ziekenhuis Gegevens / Données Infirmières du Résumé Hospitalier Minimum)*
VPC	Variance partition coefficient
VTS	*Vårdtyngdsmätning* (Care load measurement – Sweden)
V&VN	*Beroepsvereniging Verzorgenden Verpleegkundigen* (Professional organisation of nurses and care assistants – The Netherlands)
WFICC	World Federation of Intensive and Critical Care
WFSICCM	World Federation of Societies of Intensive and Critical Care Medicine

SCIENTIFIC REPORT

1 INTRODUCTION

1.1 What is an intensive care unit?

EARLY DEVELOPMENT OF INTENSIVE CARE UNITS

Intensive care units (ICUs) form a cornerstone of hospital-based healthcare systems, offering life-sustaining care to patients facing severe and potentially reversible acute illnesses or injuries. Intensive care expenses constitute a substantial portion of overall hospital costs, accounting for 8% to 30% of total hospital expenditures. Additionally, ICU beds make up roughly 10% to 30% of all hospital beds.[1]

The concept of intensive care began during the 1952 polio epidemic in Copenhagen, Denmark. Many patients suffered from respiratory failure, and positive pressure ventilation via tracheostomy, manually ventilating patients around the clock, was introduced.[2] The most critically ill patients were grouped together for close monitoring, essentially creating the first ICU. Physicians realised that moving critically ill patients between different hospital rooms raised the risk of complications. These early units evolved to provide mechanical ventilation via intubation, managed primarily by anaesthetists who, as a result, initially oversaw ICUs. The success in Copenhagen led to the establishment of dedicated ICUs in hospitals, starting in Europe and then spreading to the United States. The field of critical care medicine began to emerge, with anaesthetists, internists, and surgeons taking leadership roles.

ICUs began treating a wider range of critically ill patients, including those with multi-organ failure, sepsis, trauma, and post-operative complications. By the 1980s, an increasing number of patients, not in need of ventilation (up to an estimated 40%), was admitted to the ICU leading to concerns over rising healthcare costs.[2] Advancements in mechanical ventilation, cardiac monitoring, supportive therapies and resuscitation techniques accelerated ICU growth. To address this, the 1980s saw the introduction of 'step-down' or 'intermediate' critical care units, such as non-invasive respiratory care units, offering a level of care between the general unit and ICU.[3, 4]

DEFINITION OF AN ICU

Since their introduction, ICUs have existed in various forms and the definition of an ICU has differed across regions due to variations in the ability to deliver critical care services.[5] For example, in the United Kingdom, the rationale for ICUs was explained originally in 1989 as follows: 'a service for patients with potentially recoverable disease who can benefit from more detailed observation and treatment that is not generally available in the standard ward and departments. An ICU is a place where special skills and experience from medical and nursing staff are available to provide care to critically ill patients and particularly those in whom there is expectation of failure of one or more organ systems. It also provides a centre for physiological measurements, nursing procedures and therapeutic manoeuvres which are not practicable in the general wards'.[6] Progressively, intensive care medicine became a standalone subspeciality: physicians were required to first complete a general speciality before undertaking specific training in intensive care medicine. The focus of ICUs shifted to the treatment of the critically-ill, dealing with 'instability' (respiratory, haemodynamic) as their main task of care.

In 2014, the World Federation of Societies of Intensive and Critical Care Medicine (WFSICCM)[a] established a multinational task force to develop a unified global definition. In 2017, the task force defined an ICU as '*an organized system for the provision of care to critically ill patients that provides intensive and specialized medical and nursing care, an enhanced capacity for monitoring, and multiple modalities of physiologic organ support to sustain life during a period of life-threatening organ system insufficiency. Although an ICU is based in a defined geographic area of a hospital, its activities often*

[a] Since 2019, called the World Federation of Intensive and Critical Care (WFICC).

extend beyond the walls of the physical space to include the emergency department, hospital ward, and follow-up clinic.'[7]

Both definitions include similar core descriptions of the 'patient', the 'healthcare worker', and the 'capacity'. The WFSICCM definition goes a step further than the UK definition by defining an ICU not as a space but as an organised system of places within a hospital setting.

CLASSIFICATION OF ICUs

The WFSICCM also proposed a three-level classification system for ICUs – primary, secondary, and tertiary – based on factors such as therapeutic capabilities, staffing levels and staff training/expertise, availability of advanced monitoring and organ support, integration within the broader hospital structure, involvement in research and education for quality improvement, and the ability to meet regional and societal healthcare needs.

The structure and classification of ICUs vary significantly across healthcare systems. Some countries adopt a multi-tier system, distinguishing between general intensive care, specialised units based on type of care (such as cardiac, neurological, or neonatal ICUs), and high-dependency or step-down units. The designation and operational standards of these units are typically defined by national or regional regulatory authorities and may depend on factors such as hospital size, catchment area, and case mix.[8]

1.2 Objective and scope of the report

Events such as the COVID-19 pandemic have underscored the critical importance of well-organised and adequately financed intensive care services, revealing both the strengths and vulnerabilities of current systems.

Currently, there is no formal differentiation of ICUs into different levels of care in Belgian hospitals, while this is common practice in many countries. In KCE Report 335 on the 'management of hospital surge capacity in the first wave of the COVID-19 pandemic', it was recommended to study 'how the organisation of the ICU capacity in Belgium (e.g. different expertise levels) is situated in an international context and which model (e.g. in terms of expertise and infrastructure) is indicated to provide the most adequate care context for the treatment and care of critically ill patients in the future'.[9]

This study aims to **explore the key aspects of how intensive care services are organised and financed**. The evaluation of ICU levels involves both a differentiation of ICUs into more specialised units (e.g. for specific patient groups often characterised by multiple organ failure) and a differentiation into less specialised units (also called 'intermediate care' or 'medium care'). The presence of an intermediate level could lower the 'gap' between the intensity of care provision in ICUs and general hospital units (e.g. the mean patient-to-nurse ratio is 2.3 in Belgian ICUs versus 9.4 in general hospital units).[10, 11] This could in turn allow a faster discharge from the ICU (step-down) or a safer care environment compared to the ICU without utilising the high-cost ICU resources (step-up) for patients who are not critically ill but might require additional care (e.g. additional monitoring).

The results and recommendations of this study should help policymakers to optimise the organisation and financing of ICUs in terms of being adapted to the intensity of patients' conditions, deployment of staff and equipment, efficiency, etc. and make it more resilient to future crises.

The general aim of the report can be detailed into the following **research questions**:

- How are intensive care services organised (number of hospitals, beds, etc. at the macro level) and financed in Belgian hospitals?
- What is the activity profile of intensive care services in Belgium?
- What is the staffing structure of Belgian hospitals, what services do they offer, do they include intermediate care units, and how do they collaborate within networks (at the individual hospital level)?

- How does ICU nursing workload, as measured by the Belgian Nursing Minimum Data Set (VG-MZG / DI-RHM), compare to the Nursing Activities Score (NAS)?
- To what extent does in-hospital mortality among ICU patients vary across Belgian hospital sites, and how is this variability associated with hospital characteristics, particularly patient volume?
- How do Belgian stakeholders and experts assess the current organisation and payment system of intensive care services?
- Which useful insights for the Belgian context can be drawn from the organisation of intensive care services in selected countries?
- What is the evidence about the impact of intermediate care units on patient (e.g. mortality) and hospital utilisation (e.g. length of stay, readmission) outcomes?

1.3 Methods

We used a mixed-methods approach to examine the research questions from multiple perspectives. The specific methods and corresponding results are described in detail within each chapter of the report.

- **Organisation of intensive care in Belgium.** Legal documents were analysed to map the legal context in which Belgian hospitals operate when providing intensive care services. The overview of the ICU landscape (number, size and geographical spread of hospital sites with an intensive care unit) is primarily derived from an administrative database, the 2022 Minimal Hospital Data (MZG – RHM) (see Chapter 2).
- **Financing of intensive care services in Belgian hospitals**. The description of the payment system for intensive care services is grounded in legal texts, while the analysis of its various components draws on data provided by the Federal Public Service (FOD – SPF) Public Health (see Chapter 3).
- **Activity profile of stays in intensive care.** The analysis is based on 2019 and 2022 Minimal Hospital Data (MZG – RHM) for the general activity profile and on 2019 Nursing Minimum Data Set (VG-MZG / DI-RHM) for nursing activity (see Chapter 4).
- **Comparison of the nursing activities score (NAS) and the Nursing Minimum Data Set for workload measurement**. The ICU-specific Nursing Activities Score (NAS), used in selected Belgian hospitals, is compared with the Nursing Minimum Data Set (VG-MZG / DI-RHM), which is collected across all Belgian nursing units. The aim is to assess the association between workload measurements from both systems and to explore whether the VG-MZG / DI-RHM could be enhanced for measuring ICU workload by incorporating specific NAS items (see Chapter 5).
- **In-hospital mortality in intensive care**. Variability in in-hospital mortality across Belgian hospital sites is examined as a key indicator of intensive care quality and safety, with a specific focus on the association with hospital characteristics, notably patient volume. The analysis uses Minimal Hospital Data (MZG – RHM) from 2016 to 2019. Subgroup analyses focus on high-comorbidity patients to assess the volume-outcome relationship in more complex cases (see Chapter 6).
- **Organisation of intensive and intermediate care in Belgian hospitals: results from an online survey**. An online survey among Belgian hospitals with an intensive and/or intermediate care unit was carried out in 2023. A questionnaire was developed with questions on: the organisation of intensive care and intermediate care units, staffing levels and models for both medical and nursing personnel, availability and usage of monitoring, diagnostic and therapeutic services, and the degree of integration with other hospital or network services, inter-hospital collaborations and future priorities, such as plans to expand IMCU capacity, ICU tiering, and preparedness for future health crises (see Chapter 7).

- **Analysis of interviews with key informants**. The perceptions of stakeholders and experts on the current and future organisation and payment system of intensive care services were explored through 15 individual in-depth interviews (see Chapter 8).
- **International comparison of the organisation and financing of intensive care**. Legal documents, grey and peer-reviewed literature were reviewed to outline the regulatory framework, organisation and financing of intensive care and intermediate care services in selected countries. A survey was carried out among country experts to collect information on how intensive care is organised and reimbursed. Key informants completed a questionnaire, partially pre-filled by the research team with general organisational details, which experts were asked to verify and complete as needed (see Chapter 9 for a transversal analysis and Appendix to Chapter 9 in the Supplement for the country reports).
- **Intermediate care units: a literature review of the evidence**. A systematic review of the literature was conducted to assess the impact of intermediate care units on patient and hospital utilisation outcomes (see Chapter 10).

Chapter 11 presents a discussion, and Chapter 12 concludes the report.

2 ORGANISATION OF INTENSIVE CARE IN BELGIUM

KEY POINTS

- Intensive care in Belgium is categorised as a hospital function. Paediatric intensive care units (PICUs) lack official licensing, they must adhere to the licensing standards for general intensive care units. Burn care units have their own licensing standards.
- The Royal Decree of 27 April 1998 defines the architectural, functional and organisational standards for a general intensive care unit, including a minimum bed capacity of six beds and medical equipment requirements.
- For the medical staff it is required that the chief physician is a certified specialist in intensive care, and a continuous medical presence is mandated, supported by a roster of specialists.
- The head nurse must hold a special professional title in intensive care and emergency care or be a bachelor or diploma nurse with at least five years of proven experience in this role. The intensive care function must have a dedicated nursing team, ensuring 24-hour availability, with at least two nurses per full set of six beds, one of whom must meet the same qualification standards as the head nurse.
- The patient-to-nurse ratio in the ICU should not exceed 3:1. For every additional set of six beds, the number of nurses must be adjusted proportionally. The team should adapt to the level of activity within the unit, ensuring adequate staffing for patient care, with support from healthcare assistants and other personnel.
- Belgium has a high density of intensive care services, with 98 out of 99 hospitals operating at least one intensive care service, spread across 120 hospital sites. A general intensive care unit is available in 119 hospital sites.
- Of the 2 487 intensive care beds in Belgium, 1 978 are dedicated to general intensive care, while others are assigned to neonatal (380), paediatric (85), and burn care (44) units. Flanders, Wallonia and Brussels, respectively, have a share of 52.4%, 33.6% and 14.0% of general intensive care beds. However, Brussels has a more important relative share of paediatric intensive care beds (35.3%) and neonatal intensive care beds (28.7%).
- Intensive care services are unevenly distributed across Belgium, with significant variation between regions: Brussels has 22.7 general intensive care beds per 100 000 population, Wallonia 18.2, and Flanders 15.5. Important variation exists within regions.
- Approximately 34% of non-university hospital sites with a general intensive care unit are small facilities with fewer than 200 C/D/G/E beds.
- Most hospital sites have only one general intensive care unit, while 29 sites have two or more. Sites with the highest number of units (5, 6, 7 or 8) are often university hospitals, with unit sizes varying significantly across hospital sites.
- 60.5% of general intensive care units have a maximum of twelve beds, with two sites operating below the required minimum of six beds. Larger intensive care services are typically found in hospitals with over 450 licensed beds or university hospitals, which tend to have multiple units.

2.1 The legal framework of intensive care

Hospital care is structured into services, departments, functions and care programmes (see Textbox 1). Intensive care is categorised as a function.[12] While some hospitals have a paediatric intensive care unit (PICU), these units are not officially licensed in Belgium. Additionally, no dedicated care programme has been established for intensive care.

Textbox 1 – Organisation of hospital care activity

- Hospital service: each hospital includes several services of care (maternity, surgery, paediatrics, etc.). Beds in these services are identified by an index (for example, C for surgical beds).
- The notion of hospital department is not properly defined in the law, but in general a department is part of a service. For example, the part of the hospital where maternal intensive care (MIC) is provided, is labelled as a department in the hospital law.
- A hospital function aims to provide transversal care across services and departments.
- A care programme is structured as an organisational framework that facilitates the implementation of clinical pathways.

Source: Crommelynck et al. (2013)[13]

Hospitals, services, departments, functions and care programmes can be subject to programming standards (determined by the federal authorities) and are always subject to licensing standards (since the 6th State reform determined by the federated authorities). In general, programming standards are established as targets based on factors such as population size, age distribution, morbidity of the population and geographical dispersion. Licensing standards concern architectonic, functional and organisational (mainly related to staff) standards that hospitals, services, departments, functions, care programmes, etc. must meet to be licensed.

In the following sections we describe the legislation related to the intensive care function, PICUs and burn care units.

2.1.1 Intensive care function

The intensive care function is designed for patients who are critically threatened in one or more vital functions. These patients require specialised care to support or stabilise these functions through an appropriate medical, nursing, and allied healthcare organisation, continuous monitoring, and tailored diagnostic and therapeutic interventions.[12]

2.1.1.1 Programming standards

No programming standards are defined for the intensive care function.

2.1.1.2 Licensing standards

The Royal Decree (RD) of 27 April 1998 defines architectural, functional and organisational licensing standards.[14] We limit the description here to the standards that are most relevant for this study and refer the interested reader to the RD for more information.

ARCHITECTURAL AND FUNCTIONAL STANDARDS

The intensive care function constitutes an autonomous and architecturally identifiable unit within the hospital. The function has a minimum capacity of six beds.

The function may be divided into multiple units, each with a minimum of six beds, meeting all standards except those outlined in Articles 13 (concerning the chief physician) and 16 (concerning the roster of

specialists – see section on 'medical staff'). If these units are located in different buildings, each unit must independently ensure medical availability as defined in Articles 14 and 15.

Each bed must have the necessary equipment for continuous monitoring and treatment of critically ill patients, including cardiac, respiratory, metabolic, cerebral, and circulatory support, as well as equipment for potential internal patient transport. This equipment must allow for oxygen administration, precisely controlled intravenous infusions, aspiration with varying power levels, mechanical ventilation with parameter regulation, and cerebral and cardiopulmonary resuscitation at each bed.

The intensive care function must have, within the hospital to which the function belongs, access at all times to:

1. a multifunctional operating room, equipped and prepared for emergency surgical interventions;
2. a clinical biology laboratory capable of performing necessary analyses on-site at any time;
3. a medical imaging service with equipment for diagnostic radiological and ultrasound examinations, including a mobile radiography unit and a transverse axial tomography device.

ORGANISATIONAL STANDARDS

Medical staff: A certified medical specialist in surgery, internal medicine, anaesthesiology-reanimation, or one of their subspecialties, or in specific cases, paediatrics, holding the special professional title in intensive care, serves as the chief physician of the function. The chief physician must work full-time at the hospital, with the primary activities within the function.

The medical team consists of certified specialists in surgery, internal medicine, anaesthesiology-reanimation, or their subspecialties, or in specific cases, paediatrics, all holding the special professional title in intensive care. The aim should be to ensure representation of all these disciplines within the medical team.

The function must ensure continuous medical presence, with at least one physician exclusively affiliated with the hospital and possessing one of the following qualifications (Article 14):

1. a specialist in internal medicine or its subspecialties, holding the special title in intensive care;
2. a specialist in surgery or its subspecialties, holding the special title in intensive care;
3. a specialist in anaesthesiology-reanimation or its subspecialties, holding the special title in intensive care;
4. in specific cases, a specialist in paediatrics, holding the special title in intensive care;
5. a specialist in internal medicine, surgery, anaesthesiology-reanimation, or one of their subspecialties;
6. a medical specialist trainee with at least two years of training in one of these specialisations. A certified intensive care specialist must always be available on call and able to reach the function as soon as possible.

Medical presence must be adapted to the intensity of the function's activities and must meet the same competency requirements as defined in Article 14.

Physicians participating in medical presence may not be on duty for more than 24 consecutive hours. The physician on duty must have access to a roster of specialists in internal medicine, surgery, anaesthesiology-reanimation, and other necessary specialties to ensure comprehensive care for critically ill patients. These specialists must be able to reach the hospital as quickly as possible upon request.

Nursing staff: The head nurse must hold a special professional title in intensive care and emergency care or a bachelor or diploma nurse with a least five years proven experience in this function.

The function must have a dedicated nursing team ensuring 24-hour presence, with at least two nurses per full set of six beds, and at least one of whom holds the special professional title in intensive care

and emergency care or is a bachelor or diploma nurse with at least five years of relevant experience. In the 'Requirement framework' of the Flemish government it is stipulated that each intensive care unit must have a minimum of two nurses on duty at all times (= basic presence).[15] For each additional set of six beds that are opened, the number of nurses must be adjusted proportionally to the number of beds.

The nursing team must be adapted to the level of activity within the unit. The intensive care patient-to-nurse ratio should not exceed 3:1. This means that for seven patients, two nurses are sufficient. For eight patients, three nurses must be deployed, and so on. The same competency requirements apply as for basic staffing. Additional support can be provided by healthcare assistants, administrative, or logistical staff. If the head nurse is partially scheduled for direct care, those hours can also be counted towards care hours.[15]

The staffing framework specific to the intensive care function consists of at least twelve FTE nurses per full set of six licensed intensive care beds, of which at least six FTEs must hold the special professional title in intensive care and emergency care, or are a bachelor or diploma nurse with a least five years proven experience in this function. This fixed/core team can be supplemented with staff from the float pool, temporary workers, etc.

The chief physician, middle nursing management, and head nurse are collectively responsible for the ongoing training of personnel.

Other staff: The intensive care function must have access to a physiotherapist.

2.1.2 PICU

Critically ill children can be admitted in both adult (or mixed) and paediatric intensive care units (PICUs). PICUs, however, are not officially licensed in Belgium. Instead, they have to comply with RD of 27 April 1998 defining the standards of an intensive care function to be licensed.

According to the current care programme for children, a hospital with a paediatric service is not obliged to also have an intensive care function. However, a hospital without this function is obliged to conclude a cooperation agreement with at least one hospital with such function (art. 22 of the RD of 13 July 2006[16]).

2.1.3 Burn care unit

There are six burn care centres in Belgium. They must all meet the licensing standards defined in the RD of 19 March 2007.[17] However, in the analysis in section 2.2, only five centres were taken into account since the Minimal Hospital Data (MZH – RHM) do not contain information on the burn care centre in the Queen Astrid Military Hospital in Neder-over-Heembeek. This centre is particular as it falls under the Ministry of Defence.

We refer to KCE Report 209 ('Organisation of aftercare for patients with severe burn injuries'), published in 2013, for a detailed description of the legal framework for burn care units.[18] In this section, we highlight the elements most relevant to this study.

Burn care units may accommodate intensive care patients if capacity is available (see Chapter 4).

ARCHITECTURAL AND FUNCTIONAL STANDARDS

A burn care unit is a hospital service that provides general and multidisciplinary treatment for a specific group of patients (as defined in Article 2 of the RD of 19 March 2007). These patients include second- and third-degree burns covering more than 20% of the total body surface area; third-degree burns covering more than 5% of the total body surface area; burns complicated by significant traumatic injuries or severe local complications; etc.

The service must be an architecturally identifiable unit within a general hospital that has a licensed C- and D-service and additionally meets several other requirements, including a licensed function for specialised emergency care and a licensed function for intensive care. The service must have at least

six beds, including at least three individual isolation rooms equipped for intensive care and designated for patients with severe burns.

ORGANISATIONAL STANDARDS

Medical staff: The service operates within a multidisciplinary context. Its daily operations are jointly managed by a medical specialist in surgery and a specialist with a specific professional title in intensive care. One of these physicians serves as the head of the service and is exclusively and full-time affiliated with the hospital, dedicating more than half of working time to managing the service.

The medical service must always have access to a multidisciplinary team encompassing all medical and surgical specialties necessary for burn treatment. Additionally, the service must have continuous access to a specialist in plastic, reconstructive, and aesthetic surgery, as well as a physician specialising in infectious diseases. If the service treats children, a paediatrician must also be available.

The medical on-call service must be staffed by at least one physician holding one of the qualifications listed in Article 14 of the Royal Decree of 27 April 1998 (see section 2.1.1.2). If this physician does not possess a specialised qualification in intensive care, a specialist with this expertise must always be accessible and able to reach the medical service.

Nursing staff: The service must have a dedicated nursing team, comprising at least three full-time equivalent nurses per bed, including a head nurse. At least half of these nurses must hold a special professional title in intensive and emergency care.

Other staff: The team must include three full-time equivalent positions for physiotherapists, psychologists, and/or occupational therapists, with at least one full-time physiotherapist and one full-time psychologist.

2.2 Current landscape of intensive care in Belgian hospitals

A HIGH DENSITY OF INTENSIVE CARE SERVICES WITH LARGE DIFFERENCES BETWEEN PROVINCES

In December 2022[b], 98 out of 99 hospitals had a licensed intensive care function (see Table 1). These were organised in 120 locations (hospital sites): 59 in Flanders, 45 in Wallonia and 16 in Brussels. Of these 120 hospital sites, 119[c] had a general intensive care unit, 19 operated a neonatal intensive care unit (NICU)[d], 9 had a PICU[e] and 5 included a burn care unit[f].

Total capacity was 2 487 beds, with 1 978 beds allocated to general intensive care, making up nearly 80%.

Table 2 illustrates the distribution of beds across various types of intensive care units, categorised by bed index. All burn care units exclusively have beds with a BR bed index, and similarly, neonatal intensive care units only have beds with a NI bed index. PICUs, on the other hand, have some surgical (CI) and mixed (surgical and medical, HI) beds, but the large majority are paediatric beds (EI). Finally, general intensive care units mainly have surgical (CI), medical (DI) and mixed (HI) beds, but also some

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[b] Although more recent data are available, the decision was made to present the data for December 2022, as the chapter on intensive care activity (Chapter 4) is based on data for 2022, which are the most recent data available for the Minimal Hospital Data (MZG – RHM).

[c] One hospital, exclusively dedicated to children, only has a NICU and a PICU.

[d] Units with more than 50% of their patient population being neonates were classified as neonatal intensive care units (NICUs). NICUs are out of scope for the remainder of the report.

[e] Units with more than 50% of their patient population being children aged 15 or younger (excluding neonates) were classified as paediatric intensive care units (see Chapter 4).

[f] The burn care centre of the military hospital Queen Astrid is not included in this chapter.

other bed types such as paediatric intensive beds (EI) and non-intensive surgical (C), medical (D) and mixed (C/D) beds.

Table 1 – Hospitals and hospital sites with intensive care beds in Belgium, December 2022

	Belgium	Brussels	Flanders	Wallonia
Hospitals with licensed intensive care function (total number of hospitals)***	98 (99)	12 (12)	51 (51)	36 (37)
Hospital sites with licensed intensive care function (total number of sites)*	120 (135)	16 (16)	59 (69)	45 (50)
Hospital sites with neonatal intensive care	19	6	7	6
Hospital sites with paediatric intensive care	9	3	4	2
Hospital sites with burn care	5	0***	3	2
Hospital sites with general intensive care	119	15	59	45
Hospital beds for neonatal intensive care	380	109	148	123
Hospital beds for paediatric intensive care	85	30	42	13
Hospital beds for burn care	44	0	28	16
Hospital beds for intensive care	1 978	277	1 036	665

** With at least one licensed C, D, CD, E or M-bed.*
*** Centre Hospitalier Interrégional Edith Cavell is counted once in the Belgium column but has one licensed intensive care function in Brussels (site 1470 Ste. Anne – St. Remi) and another in Wallonia (site 1760 Braine-l'Alleud).*
**** The MZG – RHM do not contain information on the burn care centre in the Queen Astrid Military Hospital in Neder-over-Heembeek.*
Source: Minimal Hospital Data (MZG – RHM) for the number of beds and FOD – SPF for the number of hospitals/sites.

Table 2 – Bedindices in intensive care services in Belgium, December 2022

	Intensive care unit	Paediatric intensive care unit	Neonatal intensive care unit	Burn care unit
Bedindex CI	666	13	-	-
Bedindex DI	590	-	-	-
Bedindex HI	704	6	-	-
Bedindex EI	2	66	-	-
Bedindex NI	-	-	380	-
Bedindex BR	-	-	-	44
Bedindex C	4	-	-	-
Bedindex CD	2	-	-	-
Bedindex D	10	-	-	-

Source: Minimal Hospital Data (MZG – RHM).

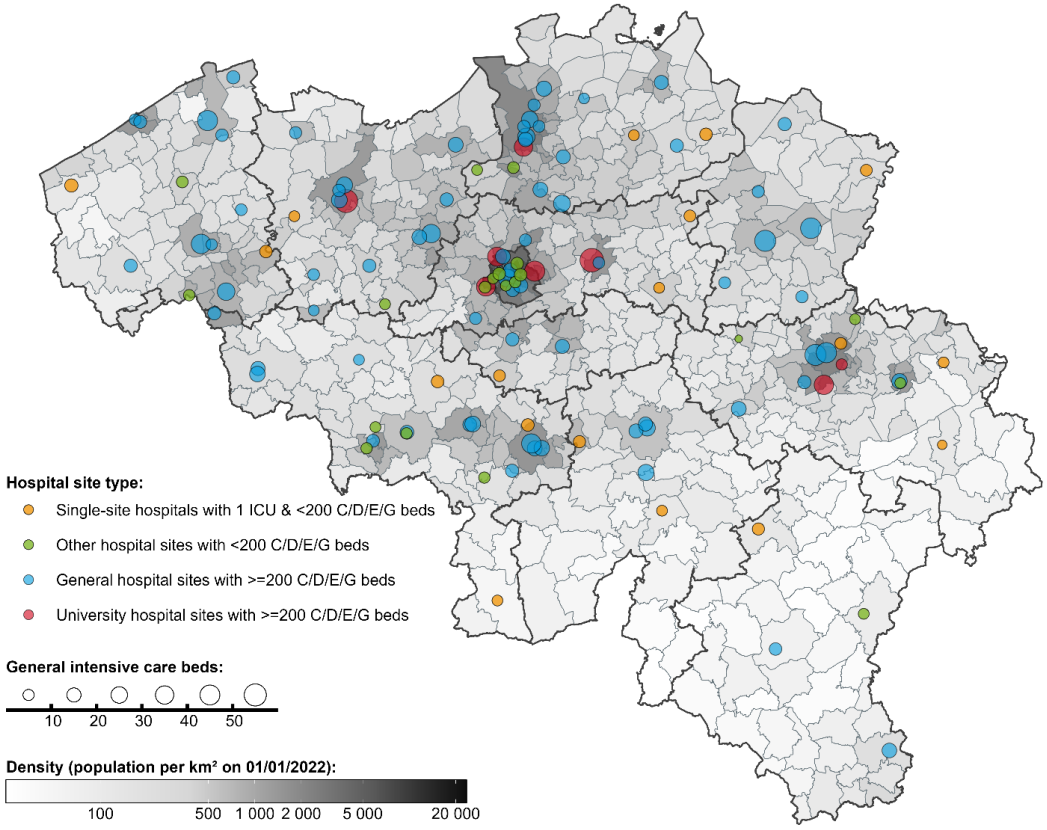
Figure 1 depicts the geographical distribution of general intensive care units in Belgium in December 2022. Larger services (in terms of number of beds) are represented by a larger circle. Hospital sites with a general intensive care unit (119 in December 2022, see Table 1) are classified into four categories: single site hospitals with less than 200 C/D/G/E beds and with one intensive care unit (18 sites); other hospital sites with less than 200 C/D/G/E beds (20 sites); hospital sites with at least 200 C/D/G/E beds (73 sites); and sites belonging to a university hospital (8 sites). Hence, about 34%

of non-university hospital sites with a general intensive care unit are small sites with less than 200 C/D/G/E beds.

Intensive care services are unevenly distributed across the country, and this distribution only partially correlates with population density. Single site hospitals with less than 200 C/D/G/E beds and with one intensive care unit (depicted in orange in Figure 1) are mostly located in sparsely populated areas, while other small hospital sites (depicted in green) are more concentrated in Brussels (see also Figure 2).

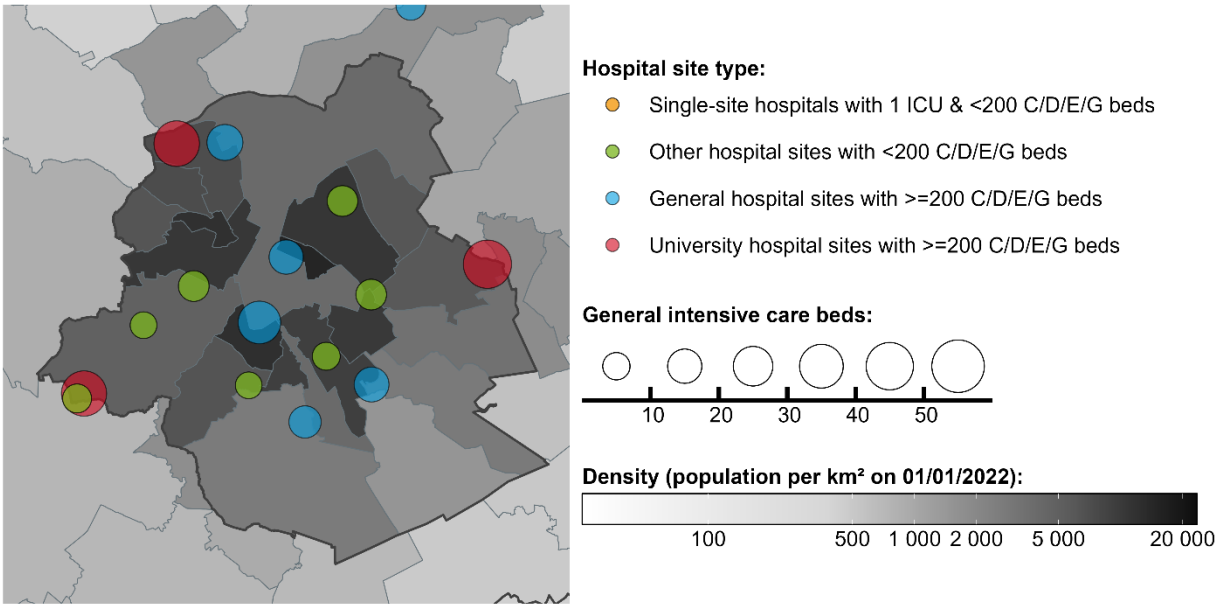
Figure 3 shows the location and size of paediatric intensive care and burn care units in Belgium.

Figure 1 – Geographical distribution of beds in general intensive care units in Belgium by site type, December 2022



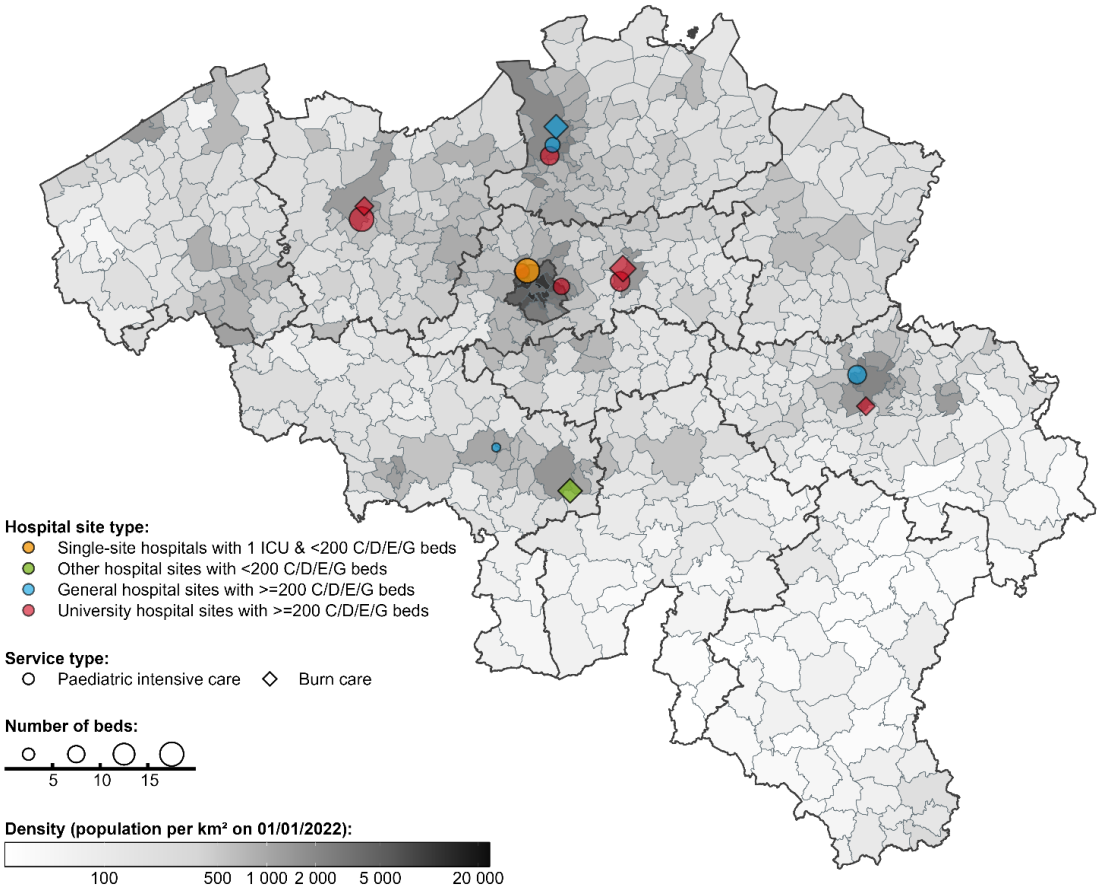
Sources: Statbel and Minimal Hospital Data (MZG – RHM).

Figure 2 – Geographical distribution of beds in general intensive care units in Brussels by site type, December 2022



Sources: Statbel and Minimal Hospital Data (MZG – RHM).

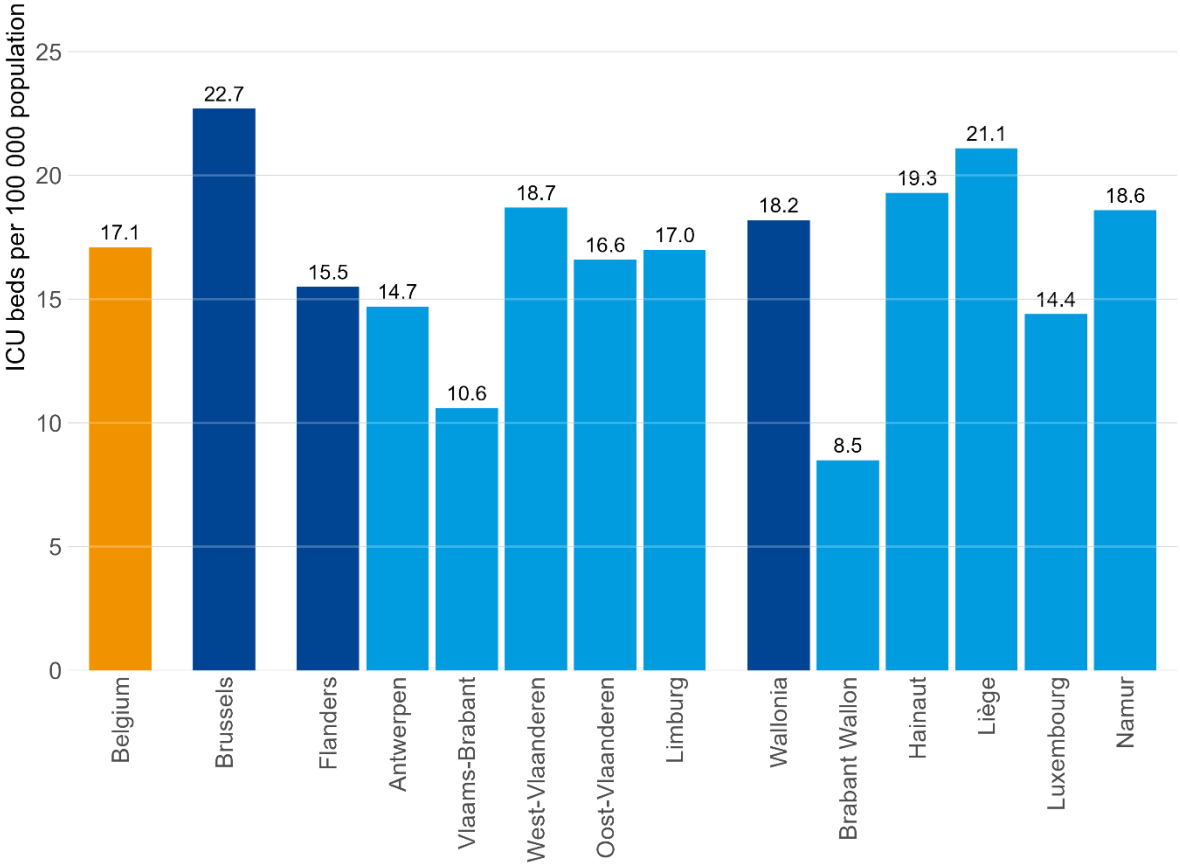
Figure 3 – Geographical distribution of paediatric intensive care and burn care beds in the hospital sites in Belgium, December 2022



Sources: Statbel and Minimal Hospital Data (MZG – RHM).

Figure 4 depicts, for each Belgian province and Brussels Capital Region, the number of general intensive care beds per 100 000 population in December 2022. Brussels counts 22.7 beds per 100 000 population, Wallonia 18.2 and Flanders 15.5, but important variation exists within regions. For example, in Flanders, the difference between Vlaams-Brabant and West-Vlaanderen is 8 beds per 100 000 population. In Wallonia, the differences are even larger with 8.5 beds in Brabant Wallon versus 21.1 beds in Liège. These differences can be partially explained by patients from a specific region or province receiving intensive care in a different region or province than their place of residence.

Figure 4 – Number of general intensive care beds per 100 000 population in the Belgian provinces and Brussels Capital Region, December 2022



Sources: Statbel and Minimal Hospital Data (MZG – RHM).

LARGE NUMBER OF SMALL INTENSIVE CARE SERVICES

Among the 119 hospital sites with a general intensive care unit in Belgium in December 2022, 19 sites have six or less 'licensed intensive care' beds[g] (two sites have less than the minimum capacity of six beds) (see Table 3 and Figure 5). Another 53 hospital sites have seven to twelve licenced beds. In Belgium, 60.5% of general intensive care units have a maximum of twelve beds. The proportion is 64.4% in Flanders, 57.8% in Wallonia, and 33.3% in Brussels. The median number of licensed beds per intensive care service is very similar between the regions. The largest intensive care service had 84 licensed general intensive care beds in December 2022. The right axis of Figure 5 shows the number of licensed C/D/E/G beds per hospital site.

[g] Actually, it is the function that is licensed, not the number of beds.

Paediatric intensive care and burn care units are mostly located in a hospital site that also has a general intensive care unit. There are two exceptions: a paediatric intensive care unit in Brussels which belongs to a hospital that is entirely dedicated to children and a burn care unit in Wallonia.

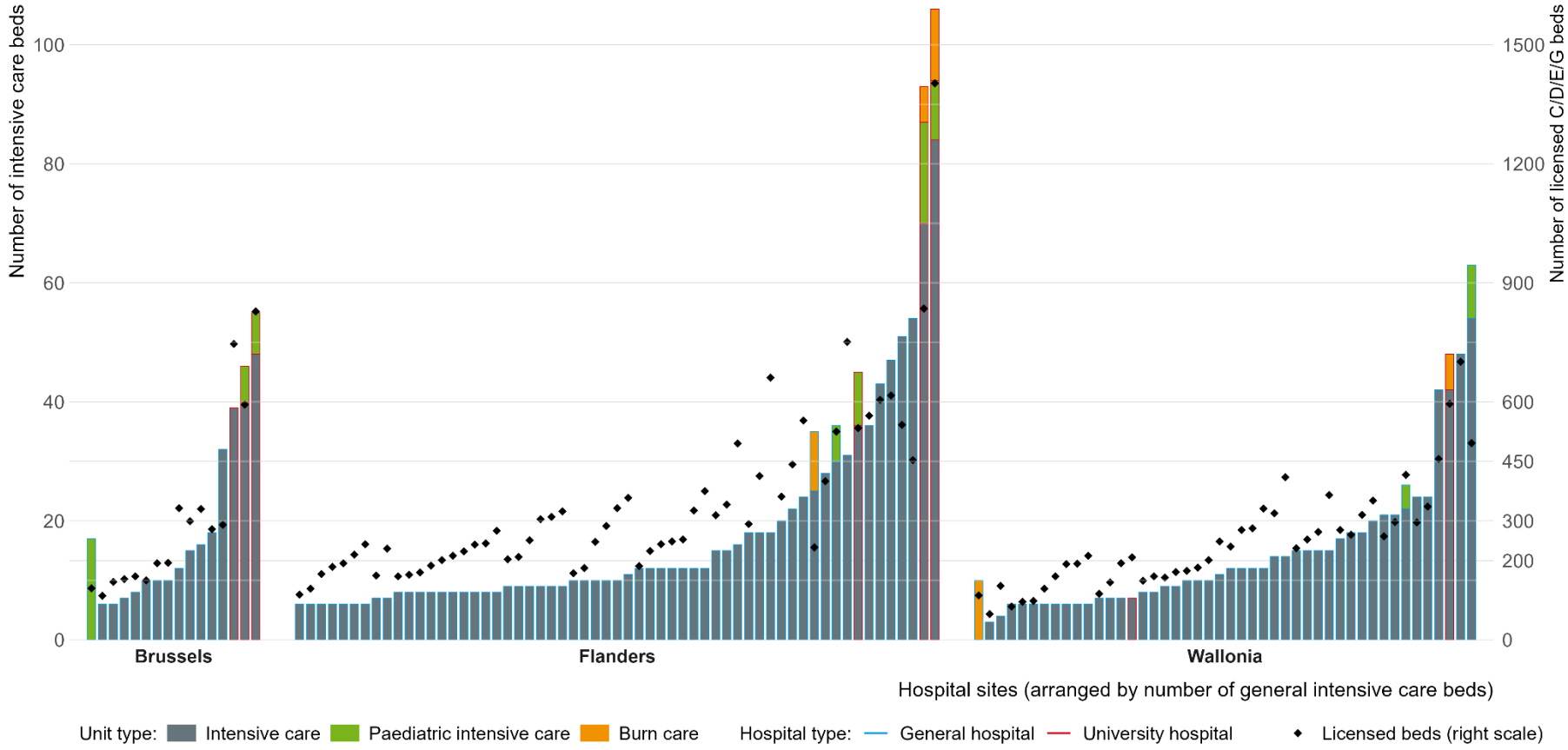
Figure 6 shows the number of units, by type of unit (general intensive care, paediatric intensive care and burn care) per hospital site and per region, with the sites ordered by region and number of general intensive care beds in December 2022. The large majority of hospital sites has only one intensive care unit, 29 sites have two or more general intensive care units. Hospital sites with the largest number of units (5, 6, 7 or 8) are in most cases sites that belong to a university hospital. The bed size of the units varies significantly between hospital sites.

Table 3 – Size of intensive care services (in terms of intensive care beds), December 2022

	Belgium	Brussels	Flanders	Wallonia
Number of intensive care services* with ≤ 6 licensed beds	19	2	7	10
Number of intensive care services with 7 to 12 licensed beds	53	6	31	16
Number of intensive care services with 13 to 20 licensed beds	20	3	7	10
Number of intensive care services with > 20 licensed beds	27	4	14	9
Median number of licensed beds per intensive care service	11	12	10	12

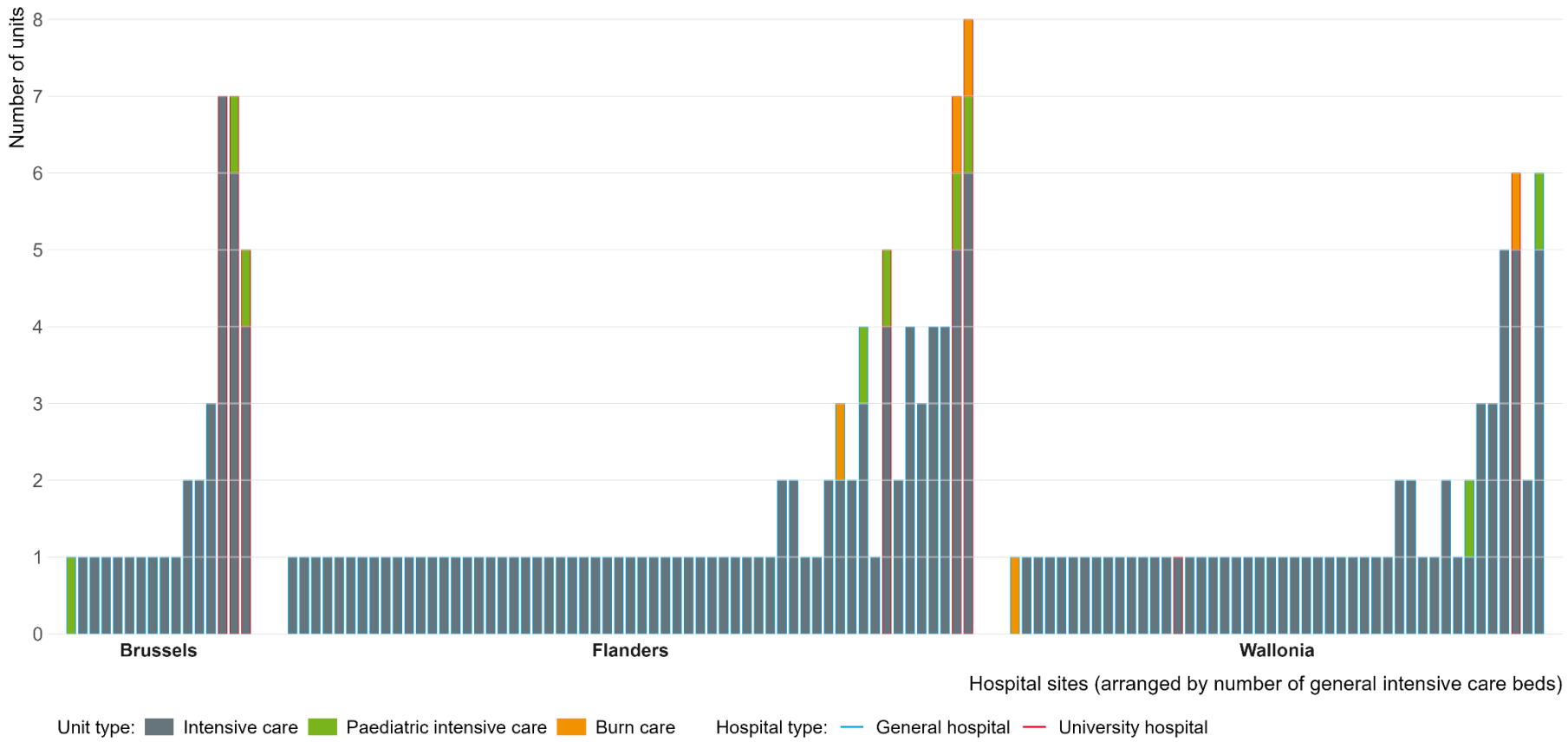
**Hospital sites with intensive care function and general intensive care unit.*
Sources: Minimal Hospital Data (MZG – RHM) for the number of beds and FOD – SPF for the number of hospitals/sites.

Figure 5 – Number of beds per type of unit (general, paediatric, burn), site and region, ordered by region and number of general intensive care beds, December 2022



Source: Minimal Hospital Data (MZG – RHM).

Figure 6 – Number of units per type of unit (general, paediatric, burn), site and region, ordered by region and number of general intensive care beds, December 2022

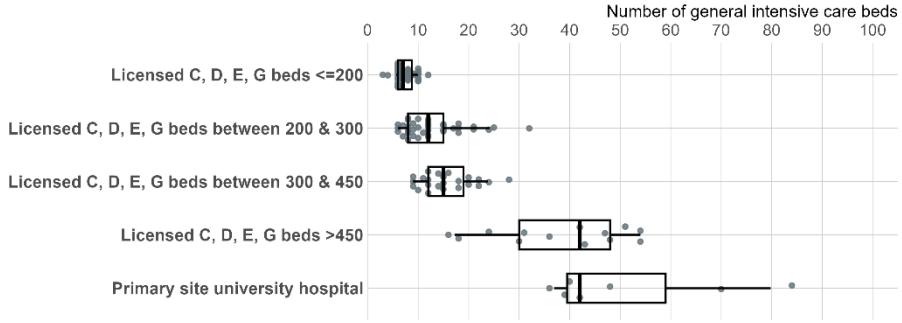


Source: Minimal Hospital Data (MZG – RHM).

Table 4 illustrates the distribution of general intensive care beds across hospital sites, where sites are classified by size (the number of licensed C/D/E/G beds) or hospital type. The number of intensive care beds increases with the size of the hospital site and is also larger in university hospitals. Large intensive care services (all units with general intensive care beds within a hospital site) are typically found in hospital sites with over 450 licensed beds or in university hospitals. The dispersion in the number of beds is larger in hospital sites with over 450 licensed beds.

Table 4 – Number of general intensive care beds according to hospital site size or type in Belgium, December 2022

Hospital site size or type	Number of hospital sites	Number of general intensive care beds				
		Minimum	P25	Median	P75	Maximum
Licensed C, D, E, G beds <=200	38	3	6	7	9	12
Licensed C, D, E, G beds between 200 & 300	38	6	8	12	15	32
Licensed C, D, E, G beds between 300 & 450	23	9	12	15	19	28
Licensed C, D, E, G beds >450	13	16	30	42	48	54
Primary site university hospital	7	36		42		84



Note: considered hospital sites have licensed intensive care function and general intensive care units.
Source: Minimal Hospital Data (MZG – RHM) for the number of beds and FOD – SPF for the number of hospitals/sites.

3 FINANCING OF INTENSIVE CARE SERVICES IN BELGIAN HOSPITALS

KEY POINTS

Hospital financing rules

- Belgian hospitals derive their revenue primarily from two sources: the Budget of Financial Means (BFM) and deductions from physicians' fees. The BFM is a closed-end budget that is divided into several parts and subparts, with subpart B2 being the largest component. This subpart covers costs related to clinical services provided by nursing and other non-medical staff, as well as most medical products. The B2 is allocated to hospitals through a complex point-based system. The largest share of these points, referred to as basic points, is broadly determined by the hospital's case mix, weighted according to the national average length of stay per pathology group (APR-DRG). Physicians working in Belgian hospitals are remunerated on a fee-for-service basis, and a portion of their fees is transferred to the hospital to contribute to the cost of medical care.
- In addition to basic points, hospitals receive supplementary points based on the volume of medical activity and nursing profiles for C-, D-, and E-beds.

Intensive care financing rules

- Intensive care units (ICUs) in Belgian hospitals are not assigned separate basic points, unlike other hospital services. Instead, their financing is partially derived from the basic financing associated with general hospital services, specifically from the basic points allocated to justified beds within C-, D-, and E-type services: 1 point per ICU bed comes from these basic points.
- In addition, hospitals receive supplementary points for intensive care activities. These ICU-specific points reflect the higher intensity and resource use in intensive care settings and are governed by detailed rules outlined in Article 46 of the Royal Decree of 25 April 2002.
- The calculation of supplementary points for intensive care involves three decile-based methods. These methods consider resuscitation acts, a ratio of residual intensive care points to total care days (NRG points), and a pathology-adjusted percentage of ICU days (NPERCIZ points), each contributing differently (20%, 40%, and 40% respectively) to the final point total. The total points from the three calculations are summed, then multiplied by the number of justified C-, D-, and E-beds to derive the number of supplementary points for 'beds of intensive nature'.
- To determine how many intensive care beds are financed, the number of supplementary points for 'beds of intensive nature' is divided by 4, as one point is already covered by the basic point system.
- As a result, financed intensive care beds represent a minimum of 2% of justified C-, D- and E-beds for hospitals ranking low in all three deciles, and a maximum of 10.25% for hospitals ranked highest in all three deciles.

Hospital-level results of intensive care financing

- The number of financed intensive care beds remained largely stable in most hospitals over the 2014-2023 period. However, significant deviations, ranging from 10 to over 20 beds, occur. Higher shares of intensive care beds are more common in larger hospitals but also occur in smaller ones. The lowest share (2%) appears across all sizes, but more often in smaller hospitals.

- There are discrepancies between the number of licensed and financed ICU beds. In some hospitals, less than 25% of licensed beds are financed, while in others, the number of financed beds equals or exceeds licensed capacity (up to 126%).
- Hospitals with low ratios of financed/licensed beds are often not the largest hospitals but can include mid-sized ones with substantial licensed ICU bed capacity.
- From 2017 to 2022, reductions in justified C- and D-beds are mirrored by similar declines in financed ICU beds, reaffirming the link between justified activity in general care and financed intensive care capacity. However, this pattern does not hold for E-beds, where trends diverge.
- Supplementary points (for justified C-, D- and E-beds and for intensive care beds) increase with the number of justified beds. In larger hospitals, the increase is more than proportional, reflecting a higher ratio of supplementary to basic points. The share of supplementary points coming from intensive care versus C-, D-, E-beds varies by hospital type, with university hospitals showing a 50-59% share and non-university hospitals ranging from 31-68%.
- A maximum of five points can be awarded per intensive care bed, which primarily impacts larger hospitals that would otherwise receive more. The gap between theoretical and actual point allocation can be as high as 28 points.
- Hospitals are ranked in deciles based on three ICU financing indicators: resuscitation acts, NRG points, and NPERCIZ. While there is a relatively strong overall correlation between rankings, in particular in the lowest and highest deciles, the exact ranking of hospitals may differ across indicators, especially between NRG and NPERCIZ.
- Decile rankings show greater stability over time for hospitals at the top and bottom of the distribution. For resuscitation and NPERCIZ rankings, the majority of hospitals remained stable or shifted by just one decile rank in the three observed years (2017, 2019 and 2022), suggesting high consistency. NRG rankings, however, showed greater fluctuation, with only 12% of hospitals remaining in the same decile throughout the period. Larger and university hospitals tend to show more stable decile rankings over time.
- Hospitals with more licensed C-, D-, and E-beds, especially university hospitals, generally occupy higher deciles across all ICU financing indicators. Conversely, smaller hospitals (<300 beds) show a broader spread, reflecting more variation in their ICU service profiles.
- When NRG decile ranks are compared to hospital-level nursing activity profiles, there is considerable variation within each decile. There appears to be an positive correlation between intensity of nursing care and NRG-decile classification, with higher mean technical score, time-competence points and share of high-technical NRGs in higher decile ranks, although important variability and exceptions remain.
- The NPERCIZ decile ranks in 2022 show modest associations with hospital-level ICU indicators such as mean severity of illness, comorbidity burden, and time spent in ICU to total length of stay ratio. Substantial within-decile variation is observed across all three ICU indicators, especially for comorbidity burden. While higher NPERCIZ deciles show a slight upward trend in mean severity of illness and time spent in ICU to total length of stay ratio (except in the middle deciles), the link with comorbidity burden is less clear.
- ICU stays in higher NPERCIZ deciles are more often related to complex conditions like neurosurgery and cardiac surgery. In contrast, lower deciles display a more heterogeneous case mix.

3.1 Hospital payment system

3.1.1 Basic principles

HOSPITAL BUDGET

Hospitals in Belgium generate revenue from multiple sources, with the two largest being the Budget of Financial Means (BFM) and deductions from physician fees. In 2023, the BFM accounted for 37% of total hospital revenue, while 38% came from physician fees.[19]

The BFM operates as a closed-end budget that is determined prospectively. It is divided into several parts and subparts, with subpart B2 being the largest component. In 2023, subpart B2 made up 36.3% of the BFM for acute hospitals (general and university).[20] This subpart covers costs related to clinical services provided by nursing and other non-medical staff, as well as most medical products. The budget for subpart B2 is set nationally and allocated to hospitals based on a point system. The total national budget is divided by the total number of B2 points 'earned' by all hospitals, determining the monetary value of one B2 point.

JUSTIFIED ACTIVITIES

Except for a few exceptions, points are earned based on services delivered, with a key concept being 'justified activities', which are calculated from the number, type and justified length of stay of admissions during reference years.

A justified length of stay is defined as the national average length for each APR-DRG/SOI (All Patient Refined-Diagnosis Related Group/Severity of Illness) category and is applied to each hospital's case mix. Multiplying this national average length of stay by a hospital's case mix determines the number of justified patient-days. Unlike many other countries, Belgium does not use a DRG-based per case payment system; instead, hospital budgets are allocated based on APR-DRG/SOIs, using weights derived from average length of stay rather than from cost weights.

The number of justified patient-days is divided by 365 and multiplied by the 'normative occupancy rate' to calculate the number of justified beds. For example, for a paediatric service the normative occupancy rate is 70%.

For C (surgical), D (internal medicine) and E (paediatric) beds, one justified bed corresponds to one point. For other services the number of points per justified bed is higher (for example, one justified bed in a neonatal intensive care (NIC)-unit corresponds to 6.25 points).

FINANCING STANDARDS

Besides licensing standards for staff (see Chapter 2), there are also financing standards. The point of departure for these financing standards are minimal nurse staffing ratios that have been set in the past for various types of nursing units.[21] The variation in the number of points per unit type reflects different financing standards applied to each unit. These standards are defined as the number of full-time equivalents (FTE) per number of licensed beds. For instance, a surgical unit (with C-beds) with an 80% occupancy rate is financed at 12 FTE for 30 licensed beds, equal to 0.4 FTE per bed (see Table 5). If a hospital does not comply with the 12/30 staffing requirement, it risks losing its license.

In the B2-part of the hospital payment system, a C-bed is allocated 1 point per justified bed, which is intended to finance the 12/30 ratio. Given a ratio of one point per justified bed, this translates to 2.5 points per FTE. For geriatric units, the basic financing standard is 13.33 FTE per 24 beds, comprising 12 FTE for nursing and care staff and 1.33 FTE for allied healthcare professionals.

In addition to the minimal nurse staffing ratios in Table 5 measures were taken to allocate additional budget to the hospitals for extra staff in general nursing units. Examples are collective labour agreements, float pools and the healthcare staff fund (*Zorgpersoneelsfonds / Fonds Blouses Blanches*). These extra measures and budget increased the number of FTE nursing staff per justified bed.

According to the Ministerial Decree (MD) of 2 August 1986, (a maximum of) five points are awarded per intensive care bed. Although this 'rule' was not included anymore in the MD of 30 December 1998 amending the 1986 decree, nor in any subsequent revisions of the intensive care financing regulations, it is still applied in the current funding of intensive care services. The five points per intensive care bed are the result of the financing standard (2 FTE nursing staff per licensed bed) and the fact that 2.5 points are needed for 1 FTE.

It is important to note that the 'monetary BFM value per FTE' does not necessarily reflect the actual labour cost per FTE, as it is influenced by the total size of the closed-end macro-level budget and the number of points allocated across hospitals.

Table 5 – Full-time equivalent (FTE) nursing staff and points for selected bedindices

Nursing unit	FTE nursing staff/ licensed bed	FTE/ licensed bed	B2 points per justified bed
Surgery (C)	12/30	0.40	1
Internal medicine (D)	12/30	0.40	1
Paediatrics (E)	13/30	0.43	1
Geriatrics (G)	12/24 (+1.33)	0.50	1.36
Intensive care (I)	2/1	2	5

PHYSICIAN FEES

Most hospital physicians are compensated through a fee-for-service model. Health insurance reimburses medical and paramedical services according to a fee schedule or nomenclature, which includes approximately 10 000 distinct covered services along with their corresponding payment rates or tariffs. Physicians cede part of their fees to the hospital to help cover the costs associated with providing medical care in the hospital. On top of the official fees, physicians can charge fee supplements to patients in specific circumstances. However, when a patient is admitted to the intensive care unit, it is not allowed to charge supplements.

Given the plans for reforming the nomenclature, this study did not further address physician fees.

3.1.2 Supplementary points for C-, D- and E-beds

The calculation of points described above applies to '**basic points**.' On top of the basic points, '**supplementary points**' are allocated to hospitals. Supplementary points are used to financially compensate hospitals with a heavier or more complex care profile. These points are intended to reflect higher staffing needs, patient acuity (this section), or specific care functions, such as intensive care (section 3.1.3).

To compensate hospitals for patient acuity in C-, D- and E-beds, they are allocated supplementary points which are based on the volume of medical activity and the nursing profile in these beds. A detailed breakdown of how supplementary points for C-, D- and E-beds are calculated, can be found in Article 46 of the Royal Decree (RD) of 25 April 2002. A distinction is made between supplementary points for C- and D-beds and for E-beds.

- Supplementary points for justified C- and D-beds (except for C-beds for same-day stays)
    - The points are based on the total value of medical and surgical acts (as defined in the fee schedule or nomenclature, a list of billing codes) provided per occupied bed for patients admitted to C- and D-services during the last two known years (acts for clinical biology, radiology, physiotherapy, and lump sum fees are excluded). Hospitals are classified into deciles according to the value of the medical and surgical acts.

- Hospitals receive supplementary points per bed based on the decile rank (see Table 6). However, only 20% of the points are awarded based on this ranking. These supplementary points are referred to as 'nomenclature points'.
- The remaining 80% of these points are summed for all hospitals and distributed according to NRGs (Nursing Related Groups) points. The NRG points are defined based on the market share of the hospital. The market share is determined based on the sum of the residual points from all care episodes (intensive and non-intensive) provided in C-, D-, L-, C/D-, CI-, DI-, and HI-beds[h]. These supplementary points are referred to as 'NRG points' (see Textbox 2).

Table 6 – Supplementary points per justified C- or D-bed, per decile based on the value of medical and surgical acts

Decile	Number of supplementary points per justified C- or D-bed
1	0
2	0
3	0
4	0.02
5	0.06
6	0.09
7	0.14
8	0.18
9	0.27
10	0.34

Textbox 2 – Calculation of residual points and market share

The **Nursing Minimum Data Set (VG-MZG / DI-RHM)** records nursing activities, interventions and observations at the level of an item. Each nursing item in the VG-MZG / DI-RHM is assigned both **time and competency points**. Time points reflect the duration needed for a task, while competency points indicate the required level of nursing expertise. Their product, known as time-competency points (or total points), represents the overall workload and complexity of care (see Chapter 4).

A **care episode** is defined as a time span that starts or ends at midnight or with a transfer between nursing units. Care episodes are classified based on their duration. There are five time groups in total: episodes lasting up to 3 hours, those lasting between 3 and 7 hours, episodes lasting from 7 to 11 hours, those lasting from 11 to 15 hours, episodes between 15 and 24 hours, and finally, care episodes that last exactly 24 hours. The time-competency points per item are aggregated based on the duration of the care episode, providing a measure of its overall care intensity through the total points score.

[h] C = surgical beds, D = internal medicine beds, L = beds for infectious diseases, CI = C-bed in intensive care, HI = C/D-bed in intensive care

Care episodes are scored on two scales: a technical score (0–10), reflecting the level of complex nursing interventions (like respiratory or circulatory support), and a basic care score (0–10), indicating the intensity of routine care (like hygiene or feeding). Based on these scores, episodes are categorised into five care groups: high- or medium-technical care, and high-, medium-, or low-basic care.

Nursing Related Groups (NRGs) group care episodes with similar nursing care needs into homogeneous categories. The classification into NRGs is based on the duration of a care episode, the composition of registered items and time-competency points. Within each NRG a distinction is made between care episodes with and without **an intensive care profile**. The latter are care episodes involving high-technical interventions in domain 2 in the VG-MZG / DI-RHM (complex physiological functions) and care episodes showing a high likelihood of belonging to the high-technical care group.

Care episodes are assigned to one of four **financing groups** based on the bed index:

- group CD: includes care episodes on bed indices C, D, L, CD, CI, DI, or HI. This group contains episodes classified as 'non-intensive' and episodes classified as 'intensive';
- group E: includes care episodes on bed indices E or EI. This group contains episodes classified as 'non-intensive' and episodes classified as 'intensive';
- group I: includes care episodes on bed indices CI, DI, EI, HI, C, D, CD, L, or E that are classified as 'intensive' based on their NRG profile;
- group 'other': contains all care episodes that do not meet the criteria for groups CD, E, or I. These care episodes are excluded from financing.

For each time group, the median number of points per care episode within a financing group is calculated. This median serves as the threshold for determining **residual points**. A care episode receives residual points equal to the amount by which its score exceeds the median. For example, if the median is set at 10 and a care episode scores 12 points, it receives 12 − 10 = 2 residual points.

The **market share** of a hospital for a financing group is the fraction of residual points it receives relative to the total residual points of all care episodes in that financing group nationwide. A market share is calculated for financing groups CD and E. For financing group I, deciles are used.

- Supplementary points for justified E-beds. The calculation follows the same general principles as for C- and D-beds, with the following key differences:
  - Points are based on expenses in occupied E-beds. This leads to a decile ranking and corresponding points as presented in (see Table 7). 70% of these points are awarded based on this ranking.
  - The remaining 30% are redistributed according to the market share based on NRG points using resiudal points in E- and EI-beds only.

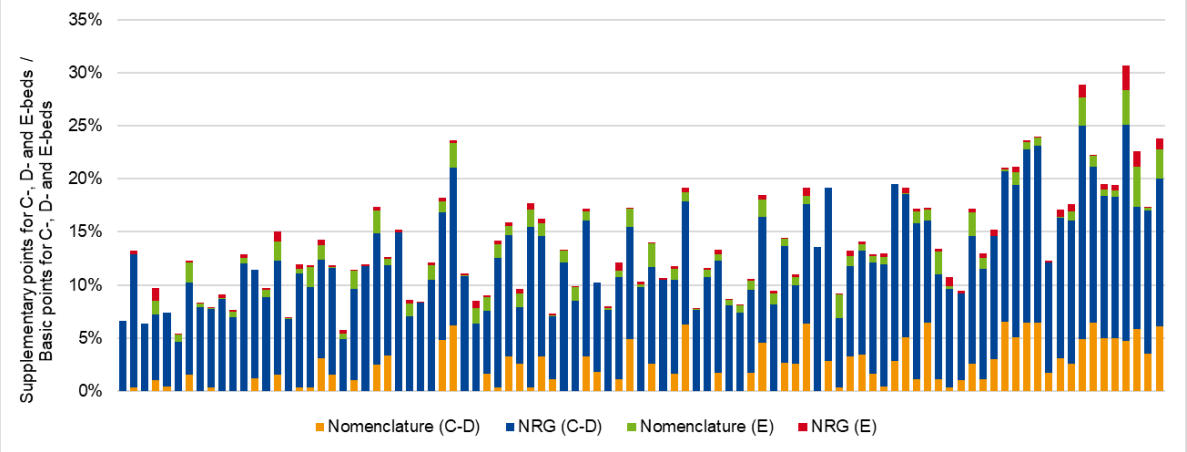
Table 7 – Supplementary points per justified E-bed, per decile based on the value of medical and surgical acts

Decile	Number of supplementary points per justified E-bed
1	0
2	0.01
3	0.05
4	0.10
5	0.13
6	0.15
7	0.18
8	0.20
9	0.25
10	0.38

In Figure 7, the ratio between the number of basic and supplementary points for justified C-, D- and E-beds is given. The percentage varies from 5.36% to 30.71% and tends to be higher for larger hospitals. For 10 hospitals, the share is larger than 10%. A few data points show exceptionally high supplementary ratios, exceeding 25%.

Figure 7 also shows the 'contribution' of the 'nomenclature points' and 'NRG points' for the different bed types (C-, D- and E-beds). The majority of supplementary points comes from NRG-points (cf. the weight of 80% of these points for C- and D-beds). Supplementary points from E-beds (green and red) contribute only a small fraction overall.

Figure 7 – Basic and supplementary points for justified C-, D- and E-beds, 2022



Note: Each bar represents a hospital (N=95). Hospitals are ordered by the number of justified C-, D- and E-beds.
Source: FOD – SPF.

3.1.3 Financing of intensive care services

The financing of intensive care services in Belgian hospitals is complex and differs from general hospital financing. Unlike other hospital services, no separate basic points are calculated for intensive care units. Instead, a portion of the basic points and justified C-, D-, and E-beds, is used to finance intensive care.

Moreover, in addition to the supplementary points for differences in medical activity volume and nursing profiles in C-, D- and E-beds, hospitals get supplementary points for activity in intensive care services. A detailed breakdown of the calculation of these supplementary points can also be found in Article 46 of the Royal Decree (RD) of 25 April 2002.

It should, however, be kept in mind that although intensive care points are mostly categorised as supplementary in the financing model, the operation of an intensive care bed – with the required staffing – demands five basic points for adequate financing.

These points are likewise based on the number of justified C-, D-, and E-beds. The calculation involves the following steps:

- First calculation: the total value of resuscitation acts provided to patients who were admitted to a C-, D-, E-, and G-service during the last two known service years. Hospitals are classified into deciles according to the value of these acts. They receive supplementary points per bed based on the decile (see Table 8). A share of 20% of these points is taken into account.
- Second calculation: the value of the ratio between the sum of residual points of intensive care episodes performed in C-, D-, E-, C/D-, L-, HI-, CI- and EI-beds, and the number of C-, D-, and E-days (intensive and non-intensive). Hospitals are classified into deciles according to the value of this ratio. They receive supplementary points per bed based on the decile rank (see Table 8). A share of 40% of these points is taken into account.
- Third calculation: hospitals are classified into deciles according to the scores as defined in Annex 8 to the RD of 25 April 2002 (see Textbox 2). As a first step, the proportion of intensive care days relative to the total number of hospital days is calculated at the national level. Second, this proportion is applied to each hospital's case-mix. Each hospital stay is weighted, with certain stays counting double, to calculate the hospital's pathology-adjusted percentage of intensive care days. Hospitals receive supplementary points per bed based on the decile (see Table 8). A share of 40% of these points is taken into account.
- Fourth calculation: the points per justified bed from the first, second, and third calculations are summed and the result is multiplied by the number of justified C-, D-, and E-beds. This gives the number of supplementary points for intensive care beds (literally, they are called 'beds of intensive nature'). The number of financed intensive care beds is determined by dividing the number of supplementary points by 4. The minimum number of beds is 6 (see Chapter 2).

The minimum share of intensive care beds in the total number of justified C-, D- or E-beds equals 2% (for hospitals in decile 1 to 4 for the 3 calculations), the maximum share is 10.25% (for hospitals in decile 10 upper half for the 3 calculations)[i].

[i] 2% = (0.08*0.2+0.08*0.4+0.08*0.4)/4 and 10.25% = (0.41*0.2+0.41*0.4+0.41*0.4)/4.

Table 8 – Supplementary points per justified C-, D- or E-bed, per decile based on the value of resuscitation acts, residual points or intensive care days

Decile	Number of supplementary points per justified C-, D- or E-bed
1	0.08
2	0.08
3	0.08
4	0.08
5	0.10
6	0.13
7 lower half	0.15
7 upper half	0.17
8 lower half	0.20
8 upper half	0.21
9 lower half	0.24
9 upper half	0.28
10 lower half	0.33
10 upper half	0.41

Textbox 2 – Calculation of scores as defined in Annex 8 of the RD of 25 April 2002

- **Data:** Minimal Hospital Data (MZG – RHM) from the last 3 known registration years
- **Stays:** All inpatient stays in general hospitals, except for stays of patients who spent at least half of their stay in an Sp-department, A-, K- or T-service, G-service; patients treated in a burn care unit who either fall under MDC 22 (burns) or within APR-DRG 004 or 005 and whose primary diagnosis starts with 940, 941, 942, 943, 944, 945, 946, 947, 948, or 949; patients belonging to APR-DRG 950, 951, 952, 955, 956, or MDC 14, MDC 15; long-term stays; incorrect stays[j].
- **Calculation of the national percentage of intensive care days per APR-DRG/SOI:**

$$NPERCIZ_{ji} = \frac{\sum_s \mathbf{IZdays}_{sji}}{\sum_s \mathbf{FACdays}_{sji}}$$

where

  - j: APR-DRG; i: SOI; s: selected stays.
  - $NPERCIZ_{ji}$: the national percentage of intensive care days classified underAPR-DRG j and SOI i, based on selected stays s.

[j] A-service = neuropsychiatry (observation and treatment), K = neuropsychiatry for children, T = neuropsychiatry (treatment), MDC = Major Diagnostic Category

- $\sum_s \mathbf{IZdays}_{sji}$: the sum of days in intensive care over all selected stays s classified under APR-DRG j and SOI i considering only stays longer than 24 hours.
- $\sum_s \mathbf{FACdays}_{sji}$: the sum of invoiced hospitalisation days over all selected stays s classified under APR-DRG j and SOI i.

- **Application of the national percentage to the case-mix of the individual hospital**: The case-mix of the individual hospital is determined based on the MZG – RHM of the last known registration year. For each stay x in hospital k classified under APR-DRG j and SOI i, the national percentage of intensive care days is applied to obtain a pathology-weighted percentage of intensive care days using the formula:

$$\boldsymbol{VPERCIZ_k} = \frac{\sum_j \sum_i \sum_x \left(M_x * \boldsymbol{NPERCIZ_{ji}} * \mathbf{FACdays}_{xkji}\right)}{\sum_j \sum_i \sum_x \mathbf{FACdays}_{xkji}}$$

where

- j: APR-DRG; i: SOI; x: hospital stay; k: hospital.
- $\boldsymbol{VPERCIZ_k}$: the pathology-weighted hospital percentage of intensive care days for hospital k.
- M_x: the multiplier applied per stay x, which is normally 1. It becomes 2 if the patient stayed in the intensive care unit and arrived via ambulance transport and/or if the patient stayed in intensive care and passed away. Both conditions cannot be combined, so that the maximum multiplier value per stay is 2.
- $\boldsymbol{NPERCIZ_{ji}}$: the national percentage of intensive care days classified under APR-DRG j and SOI i.
- $\mathbf{FACdays}_{xkji}$: the number of invoiced hospitalisation days for stay x in hospital k classified under APR-DRG j and SOI i.
- $\sum_j \sum_i \sum_x \mathbf{FACdays}_{xkji}$: the sum of invoiced hospitalisation days across all stays x, APR-DRG j and SOI i in hospital k.

To summarise:

- The budget that corresponds with the total of basic points and supplementary points finances three ‘types of care’: basic care in C-, D- and E-services, higher intensity care in these services and intensive care units. Basic care in C-, D- and E-services is financed by basic points and higher intensity care (measured by medical activity volume and nursing profiles) in these units is financed by supplementary points.
- Maximum 5 points are allocated for each intensive care bed, with 1 of those points derived from the basic points assigned to C-, D-, and E-beds (see further Table 10) and 4 derived from the above calculations. This is why, in the fourth calculation, the number of supplementary points is divided by 4 and not by 5. We mentioned before that the term ‘supplementary points’ for intensive care services causes confusion. In fact, the limitation to 5 points per bed essentially means that an intensive care bed receives only basic funding. This is because 5 points are required to finance the deployment of 2 FTEs per bed. In contrast, a C-, D- or E-bed receives basic points for standard staffing, based on the number of justified beds, and supplementary points based on higher care intensity (see section 3.1.2).
- Care episodes in financing groups CD and E are financed through the ‘market share’ system, while those in financing group I are financed through a ‘decile system’.

- The hospital budget (BFM) is calculated for the entire hospital rather than for individual hospital sites or units. Therefore, a hospital with multiple sites and one or more intensive care units receives a single budget for all its intensive care units combined.

3.1.4 An example

The example in Table 9 demonstrates the principles of the calculation of basic and supplementary points.

Table 9 – Example of the calculation of basic and supplementary points for a hypothetical hospital

Steps in the calculation	Result
Basic points	
Justified C-beds	122
Justified D-beds	122
Justified E-beds	11
Supplementary points for justified C-, D- and E-beds	
• *Decile medical and surgical acts (C- and D-beds) – see Table 6*	7
• *Nomenclature points (20% of C- and D-beds * points per bed)*	20%*0.14*(122+122) = 6.83
• *NRG points for C- and D-beds (provided by the FOD – SPF)*	28.21
• *Decile medical and surgical acts (E-beds) – see Table 7*	9
• *Nomenclature points (70% of E-beds * points per bed)*	70%*0.25*11 = 1.93
• *NRG points for E-beds (provided by the FOD – SPF)*	0.25
Total supplementary points for justified C-, D- and E-beds	37.32
Supplementary points for intensive care beds	
Decile first calculation – see Table 8 (decile 1)	5
Points	20%*0.10*(122+122+11) = 5.10
Decile second calculation – see Table 8 (decile 2)	8 lower half
Points	40%*0.20*(122+122+11) = 20.40
Decile third calculation – see Table 8 (decile 3)	7 lower half
Points	40%*0.15*(122+122+11) = 15.30
Total supplementary points for intensive care beds	40.80

In the example, total supplementary points for intensive care beds amount to 40.80 points. Dividing the supplementary points by 4 yields the number of financed intensive care beds, resulting in a total of 10 beds.

As mentioned before, part of the basic points for C-, D- and E-beds is used to finance intensive care beds. This is illustrated in Table 10.

This hospital has 122 justified C-beds. Table 9 gives the information necessary to calculate the number of C-beds that can be labelled as intensive care beds and are financed by basic points. The formula equals: (20%*value of decile 1 + 40%*value of decile 2 + 40%*value of decile 3) / 4 and this result is multiplied by the number of justified C-beds.

In the example of Table 9, the number of intensive care beds financed by basic points for C-beds equals (20%*0.10 + 40%*0.20 + 40%*0.15) / 4 = 0.04, multiplied by 122 gives 4.88 or 5 intensive care beds. The same calculation can be done for justified D- and E-beds.

A maximum of 5 points per justified C-, D- or E-bed can be awarded for an intensive care bed (see section 3.1.1).

Hence, if this hospital would only be financed for C-, D- and E-beds without taking account of medical activity volume and nursing profiles nor of intensive care activity, the hospital would be financed in the B2-part of the BFM for 255 points (1 point per justified bed). Instead, it receives a budget that corresponds to 331 points. The additional 76 points are partly meant for the higher medical activity volume and nursing profiles in C-, D- and E-beds and partly to finance intensive care beds. With a value per point equal to € 36 656.87 in 2024, this amounts to an additional budget of € 2785 922.

Table 10 – Example for the calculation of basic and supplementary points for a hypothetical hospital

	Number of beds	Basic points per bed	Supplementary points per bed	Total points
C without intensive care	122 - 5 = 117	1	0.14	117 + 0.14*117 = 133.38
D without intensive care	122 – 5 = 117	1	0.14	117 + 0.14*117 = 133.38
E without intensive care	11 – 0 = 11	1	0.25	11 + 0.25*11 = 13.75
Intensive care	10	1	4	10*5 = 50
Total	255			330.51

3.2 Assessment of financing rules

The explanation above highlights the complex nature of how hospitals are funded for their intensive care services. This section outlines the practical functioning of the financing system and connects the budget of each hospital to its activity profile (see Chapter 4), using data from the FPS Public Health (FOD – SPF). The dataset provides a breakdown of the different financing components for each individual hospital. Most figures rely on data from 2019 and 2022 to align with the nursing activity profile from 2019 and the general activity data from 2022, as outlined in Chapter 4.

Note that the number of hospitals included in the figures is lower than the total number of hospitals with an intensive care service (see Chapter 2). Hospitals in which only surgical and medical services exclusively for children or exclusively related to tumours are provided, are excluded from B2-financing. Also excluded from B2-financing are hospitals whose licensed beds have increased or decreased by at least 25%. For example, in 2022, this applied to four hospitals.

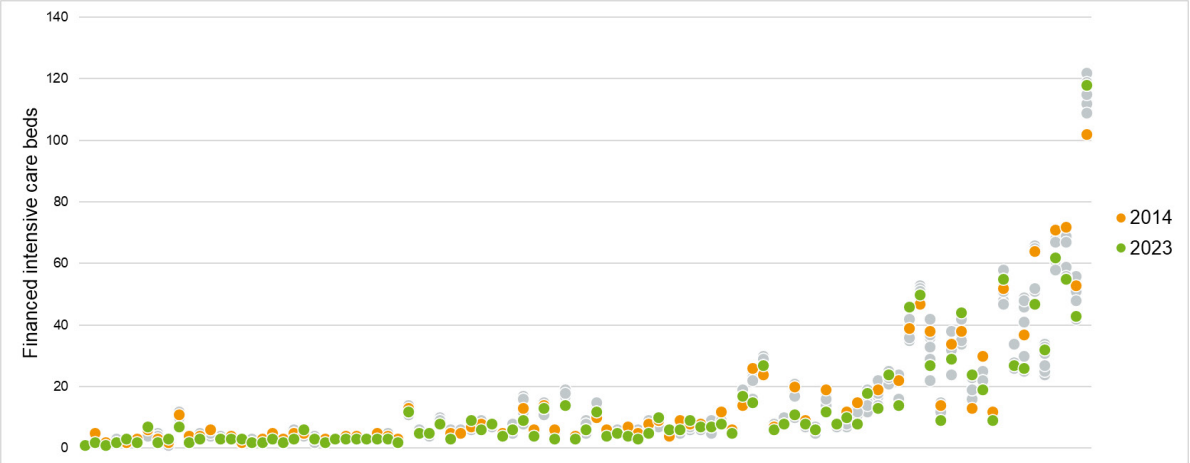
3.2.1 Financed and licensed intensive care beds

STABLE NUMBER OF FINANCED INTENSIVE CARE BEDS IN MOST HOSPITALS

Figure 8 presents the evolution of the number of financed intensive care beds per hospital for the period 2014-2023. The number of hospitals with intensive care beds varies between the years, for example, because of mergers. The number of beds has remained stable over the years for most hospitals. However, in some cases, variations of 10 to more than 20 beds are observed, representing a significant share of financed intensive care beds. Changes in bed numbers do not always occur in the same direction across hospitals.

At the macro level, the number of financed intensive care beds remained relatively stable, ranging from 1 297 beds in 2014 to 1 223 beds in 2023.

Figure 8 – Evolution of the number of financed intensive care beds per hospital, 2014-2023



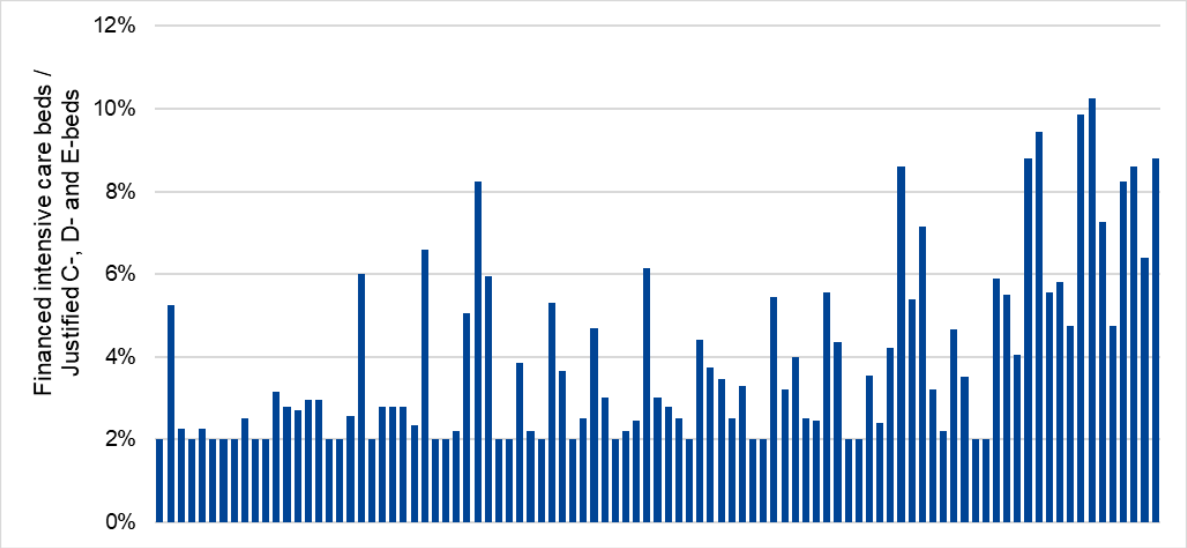
Note: Each dot represents a hospital (N=97), the colour represents the year. The years 2015-2022 are shown in grey. Hospitals that merged during the period are shown as a single dot for each year, regardless of the specific year the merger took place. Hospitals are ordered by the number of licensed C-, D- and E-beds.
Source: FOD – SPF.

VARIABLE SHARE OF FINANCED INTENSIVE CARE BEDS IN JUSTIFIED C-, D- AND E-BEDS

As mentioned before, the minimum share of intensive care beds in the total number of justified C-, D- or E-beds equals 2%, the maximum share is 10.25%. The share depends on the decile ranks for resuscitation acts, NRGs and intensive care days in the calculation of supplementary points for intensive care beds.

In Figure 9, hospitals are ordered by their number of justified C-, D- and E-beds. Most hospitals fall withing the 2% to 6% range, while a smaller group shows markedly higher proportions. Higher proportions occur more frequently, but not exclusively, among larger hospitals in terms of justified beds. Smaller hospitals can also exhibit relatively high proportions. Similarly, the lowest observed share of 2% appears across hospitals of all sizes, though it is more frequently found among smaller hospitals Smaller hospitals (in terms of justified C-, D- and E-beds) also appear among those with the highest shares indicating that a relatively large portion of their bed capacity is dedicated to intensive care.

Figure 9 – Share of financed intensive care beds in justified C-, D- and E-beds, 2022



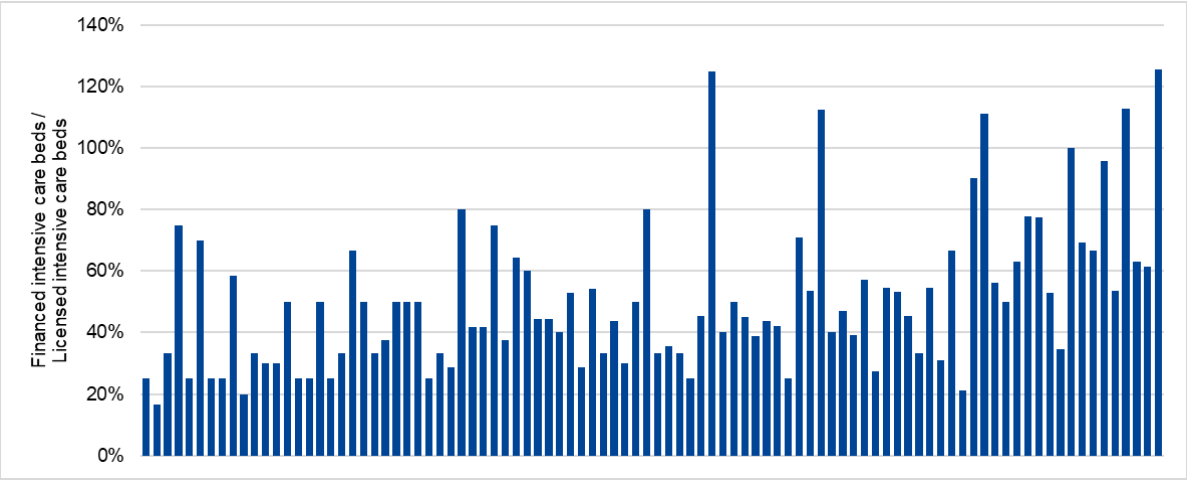
Note: Each bar represents a hospital (N=95). Hospitals are ordered by the number of justified C-, D- and E-beds.
Source: FOD – SPF.

LICENSED VERSUS FINANCED INTENSIVE CARE BEDS

Figure 10 compares the number of financed and licensed intensive care beds. Hospitals are sorted by the number of licensed intensive care beds.

The share of financed beds relative to licensed beds ranges from 17% to 126%. In six hospitals, the number of financed beds equals or exceeds the number of licensed beds. In contrast, 13 hospitals have 25% or fewer of their licensed beds financed, and 38 hospitals have 40% or fewer financed. While this does not concern the largest hospitals in terms of licensed intensive care beds, it does include some mid-sized hospitals.

Figure 10 – Comparison of the number of financed and licensed intensive care beds, 2022



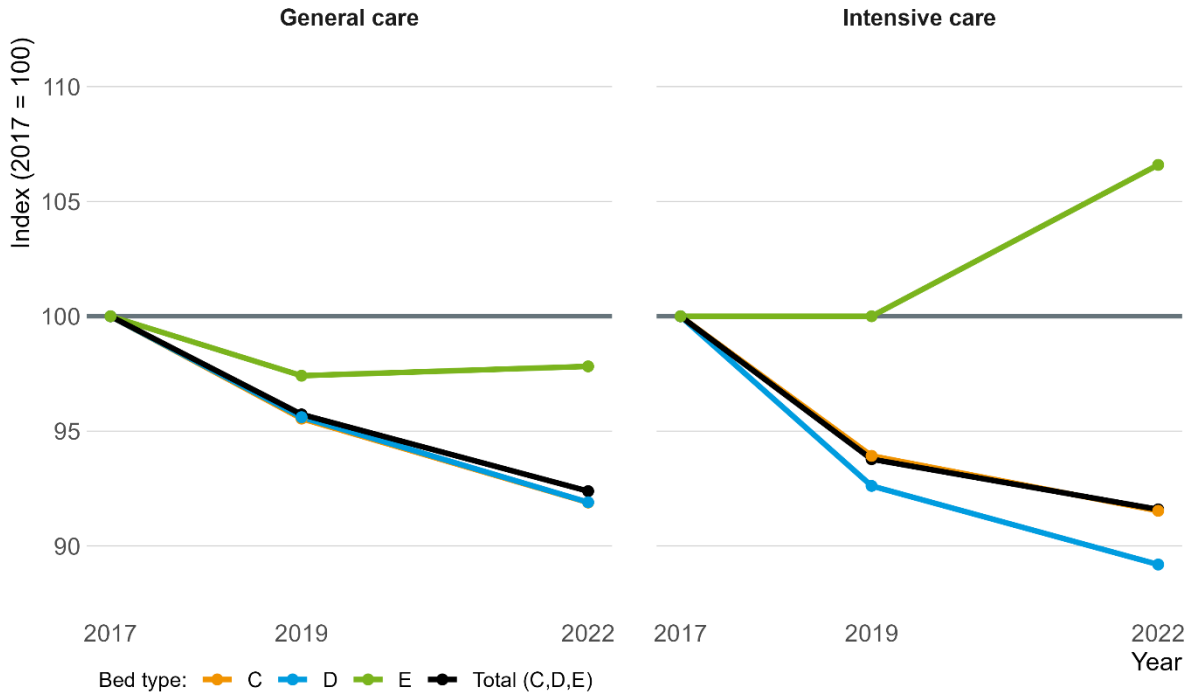
Note: Each bar represents a hospital (N=95). Hospitals are ordered by the number of licenced beds (PICU and general ICU).
Source: FOD – SPF.

CORRESPONDENCE BETWEEN EVOLUTION OF JUSTIFIED C-, D- AND E-BEDS AND FINANCED INTENSIVE CARE BEDS

Figure 11 compares the evolution of the number of justified C-, D- and E-beds and the number of financed intensive care beds in the period 2017-2022. Only hospitals without merger and with available data across all three years were included in the analysis. These exclusions reduced the sample size to 84 hospitals. The metric used is an indexed evolution, where values are scaled relative to 2017, which serves as the base year (index = 100). 'General care' refers to the evolution of justified C-, D- and E-beds, and their total. 'Intensive care' refers to the evolution of financed intensive care beds (based on the number of justified C-, D- and E-beds). Note that the trend in C-beds in general care is difficult to distinguish as the trend in C-beds appears underneath the trend in D-beds[k].

The number of justified C- and D-beds shows a downward trend between 2017 and 2022, which is mirrored by a similar decline in the number of financed intensive care beds based on those same bed-categories. In contrast, E-beds display a different pattern, with the trends in justified beds and financed intensive care beds not aligning. It is important to note that the number of financed intensive care beds is not only based on the number of justified C-, D- and E-beds. Also changes in decile rankings over time can have a substantial impact on the overall evolution of financed intensive care beds, particularly when such changes occur in larger hospitals in terms of justified beds.

Figure 11 – Evolution of justified C-, D- and E-beds and financed intensive care beds, 2017-2022



Source: FOD – SPF.

[k] In financing justified activity, no distinction is made between C- and D-beds. The total number of C- and D-beds is divided by two. For example, if a hospital has 88 justified C- and D-beds, this results in 44 C-beds and 44 D-beds. The actual activity in these units is not taken into account when assigning the specific bed codes.

3.2.2 Supplementary points

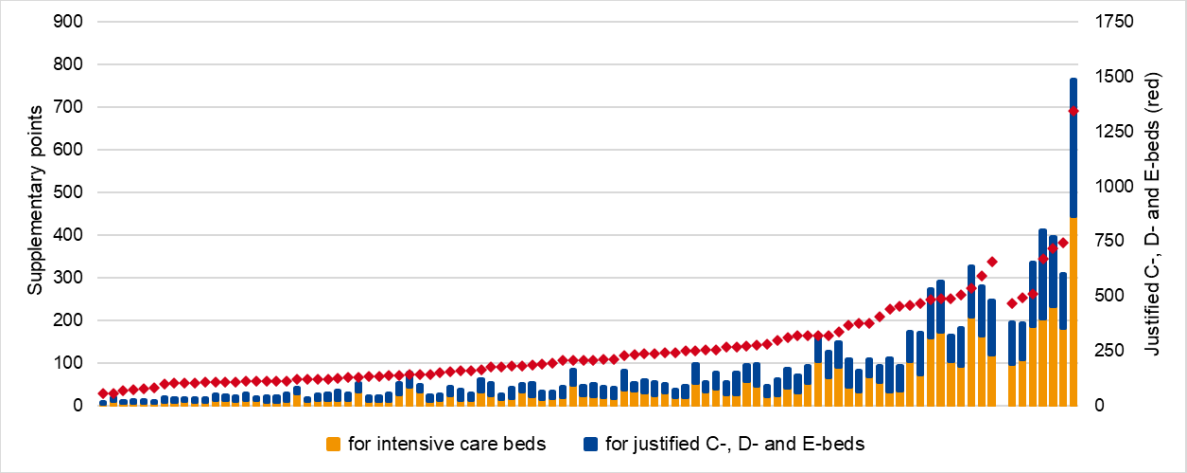
VARIABLE SHARE OF SUPPLEMENTARY POINTS FOR INTENSIVE CARE BEDS IN TOTAL SUPPLEMENTARY POINTS

Figure 12 presents the number of supplementary points for justified C-, D- and E-beds (blue; see section 3.1.2), the number of supplementary points for intensive care beds (orange; see section 3.1.3) and the number of justified C-, D- and E-beds (red; right-hand side of the figure). The results are presented separately for university hospitals and non-university hospitals.

Supplementary points generally increase with the number of justified beds. In line with Figure 7, this increase is more than proportional in larger hospitals, reflecting both a higher number of justified beds and a greater ratio of supplementary to basic points.

The composition of supplementary points varies by hospital. For some hospitals, the supplementary points for C-, D-, and E-beds are higher, while for others, the intensive care points make up the larger share. For university hospitals, the share of supplementary points for intensive care beds varies from 50% to 59%, for non-university hospitals the share varies from 31% to 68%.

Figure 12 – Supplementary points for justified C-, D- and E-beds and for intensive care beds, 2022



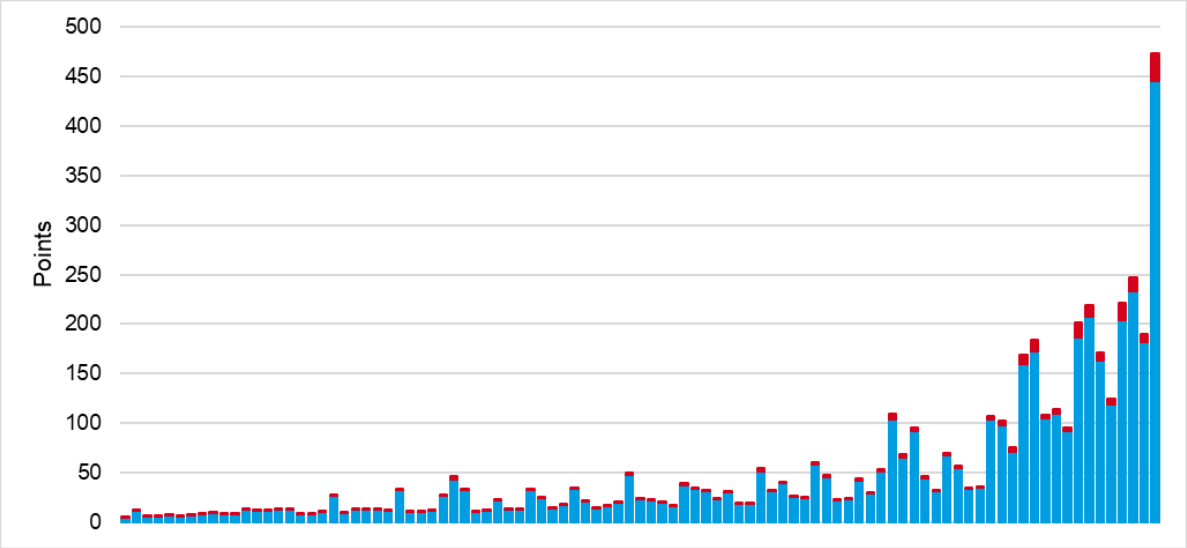
Note: Each bar represents a hospital (N=95). Hospitals are ordered by type (first non-university, then university) and by the number of justified C-, D- and E-beds.
Source: FOD – SPF.

LIMITATION OF FIVE POINTS PER BED PRIMARILY AFFECTS THE LARGER HOSPITALS

By applying the calculation for the supplementary points for intensive care beds, for some hospitals we end up with a higher total than the number of points hospitals actually receive, due to the rule that a maximum of five points per justified C-, D- or E-bed can be awarded for an intensive care bed. In Figure 13 the supplementary points for intensive care beds that hospitals actually receive (in blue) and the points that are not awarded because of the 5-points per bed rule (in red) are shown.

For many hospitals, especially those with fewer justified C-, D-, and E-beds, the red segments are either absent or minimal. In contrast, hospitals on the right side which have a higher number of justified beds, exhibit substantial red segments. This suggests that these hospitals would have been entitled to more points based on their activity and case mix, but the 5-point ceiling per bed constrains their actual allocation.

Figure 13 – Supplementary points for intensive care beds



Note: Each bar represents a hospital (N=95). Hospitals are ordered by the number of justified C-, D- and E-beds.
Source: FOD – SPF. The supplementary points for intensive care beds that hospitals actually receive (in blue) and the points that are not awarded because of the 5-points per bed rule (in red)

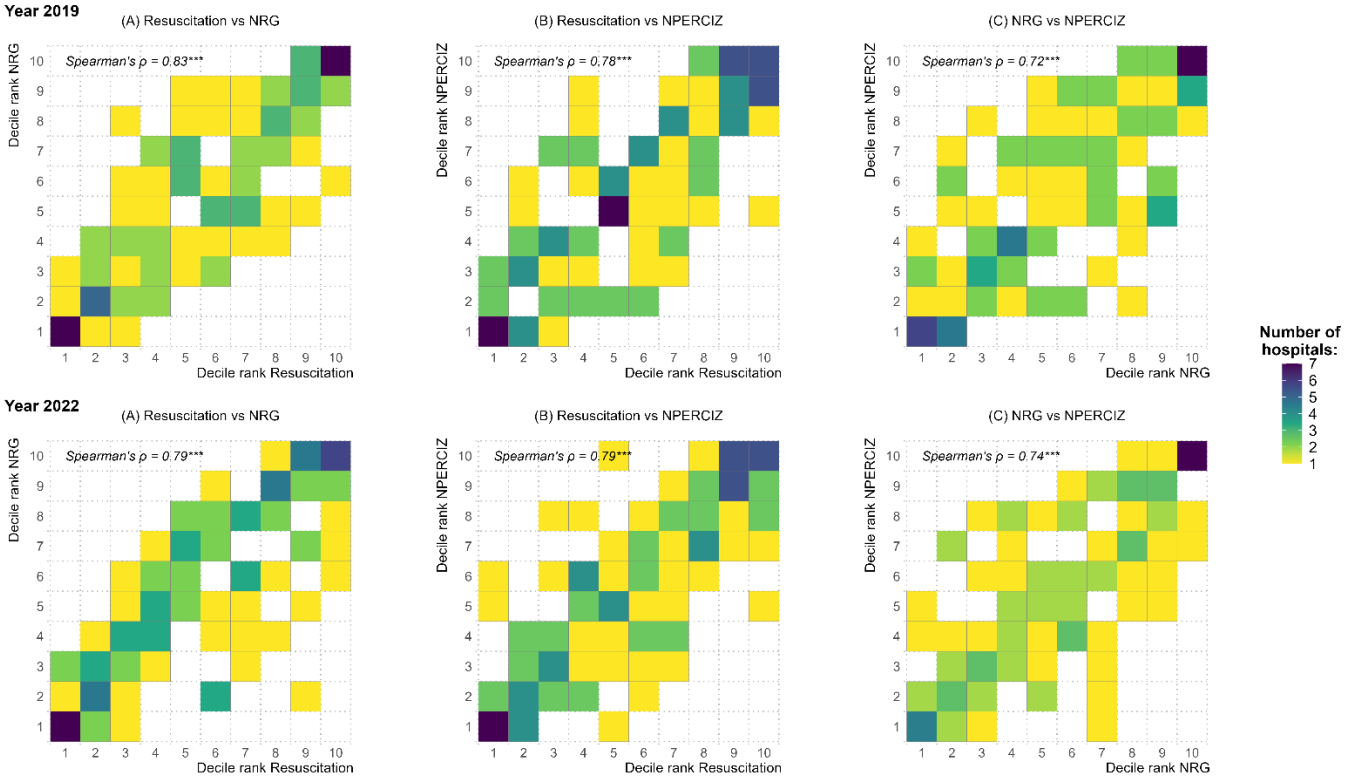
3.2.3 Decile rankings

LINK BETWEEN DECILE RANKS

For the financing of intensive care beds, hospitals are classified into deciles based on three criteria (see section 3.1.3): resuscitation acts, residual points of intensive care episodes (NRG) and the hospital's pathology-adjusted percentage of intensive care days (NPERCIZ). The heatmaps in Figure 14 present the correspondence between the rank in the three deciles in 2019 and 2022 (rows), per pair of deciles (columns). To prevent sample sizes from becoming too small, no distinction is made between the upper and lower halves of deciles 7 through 10. The colour intensity represent the number of hospitals for each combination of decile ranks. Perfect correspondence between two indicators would appear as darker shades concentrated along the diagonal.

Although the Spearman correlation coefficients are relatively high (between 0.72 and 0.83), it is clear that several hospitals rank differently for the three criteria. In both years and across decile pairs, agreement is highest in the lowest and highest deciles. Correlation is somewhat stronger between deciles based on resuscitation acts and NRG residual points and weaker between NRG and NPERCIZ deciles. This is also reflected visually, with more dispersed patterns and lighter shading in the corresponding heatmaps.

Figure 14 – Correspondence between deciles, 2019 and 2022



*Note: Spearman correlation with significance *** < 0.001; ** < 0.01; * <0.05*
Source: FOD – SPF.

EVOLUTION OF DECILE RANKS

Figure 15 illustrates the decile ranks per hospital for the years 2017, 2019 and 2022. The objective of this figure is to assess the stability of decile ranks at the hospital level over time. Only hospitals without merger and with available data across all three years were included in the analysis. These exclusions reduced the sample size to 88 hospitals.

For each hospital (rows) and each decile (columns), a line range represents the difference between the minimum and maximum decile rank observed over the three years. Individual data points for 2017, 2019, and 2022 are also shown using distinct marker shapes. Hospitals are sorted by the sum of all three decile ranks in 2022, and in case of a tie by the number of licensed C-, D-, and E-beds.

Overall, decile ranks appear relatively more stable at the top and bottom of the distribution and this across all 3 deciles, although some exceptions are observed. Importantly, stability in one indicator does not preclude substantial shifts in others.

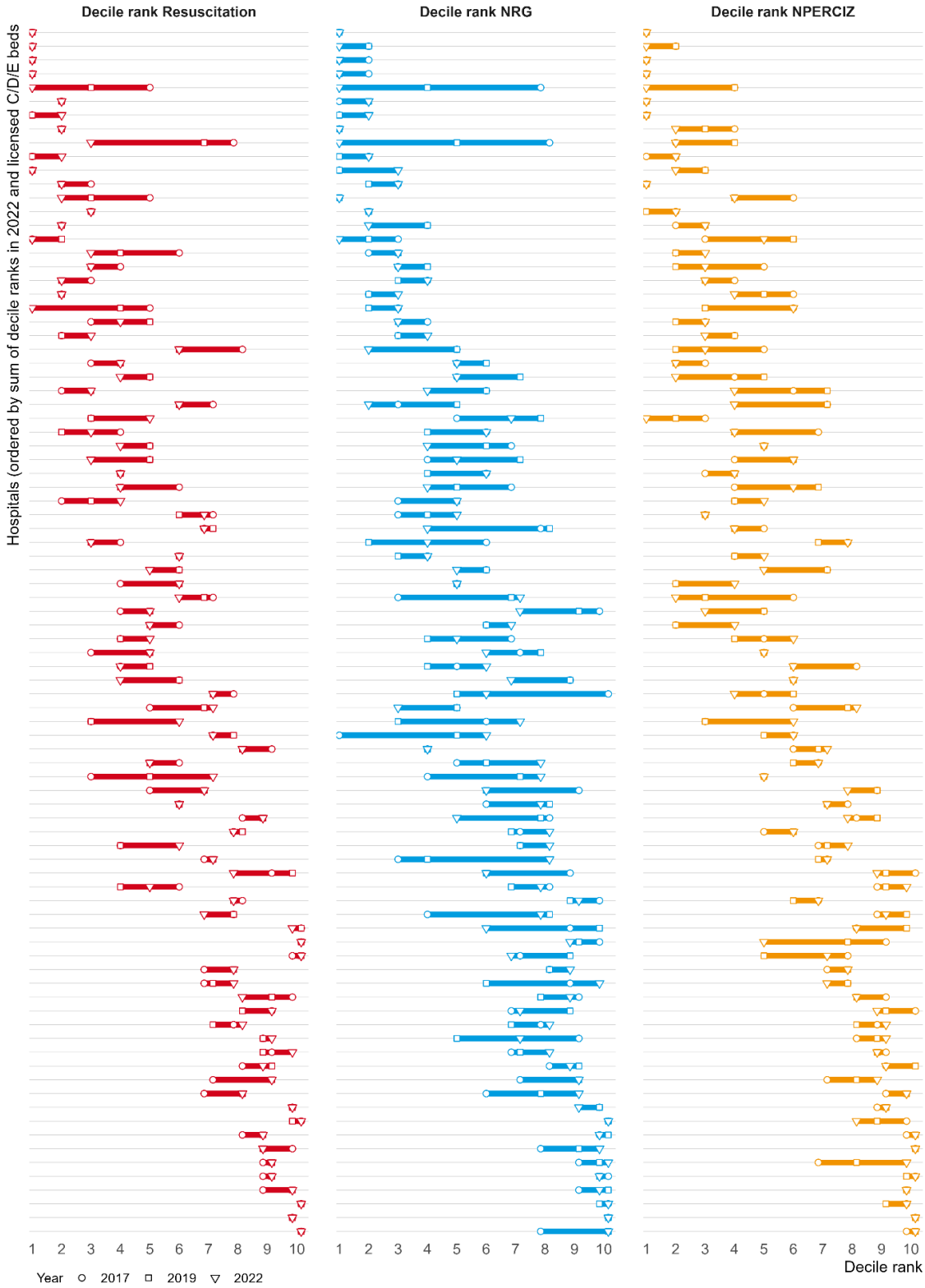
Figure 16 presents the same results, adding a distinction between type (university hospital or not) and size (number of licensed C-, D- and E-beds) of hospitals. Each bar represents the number of hospitals that experienced a certain range of change in their decile ranks across the three years, with the range calculated as the difference between the maximum and minimum decile ranks. A value of 0 indicates stability, i.e. either no shift or a shift from upper half to lower half within the same decile. The colours indicate the number of licensed C, D, and E beds in 2022.

Stability is highest for 'resuscitation' and NPERCIZ. For these indicators, 32% and 23% of hospitals had no change in decile rank (range = 0), and an additional 41% experienced only a one-rank shift, indicating strong consistency over time. The decile ranks based on NRGs show more variation. Only 12% of hospitals remained in the same decile rank. A notable number of hospitals (especially those in the 1-3 range) experienced moderate shifts in rank. It should be noted that over the years, significant

changes and improvements have been made to the NRG calculations. This might partly explain the greater variation in this indicator.

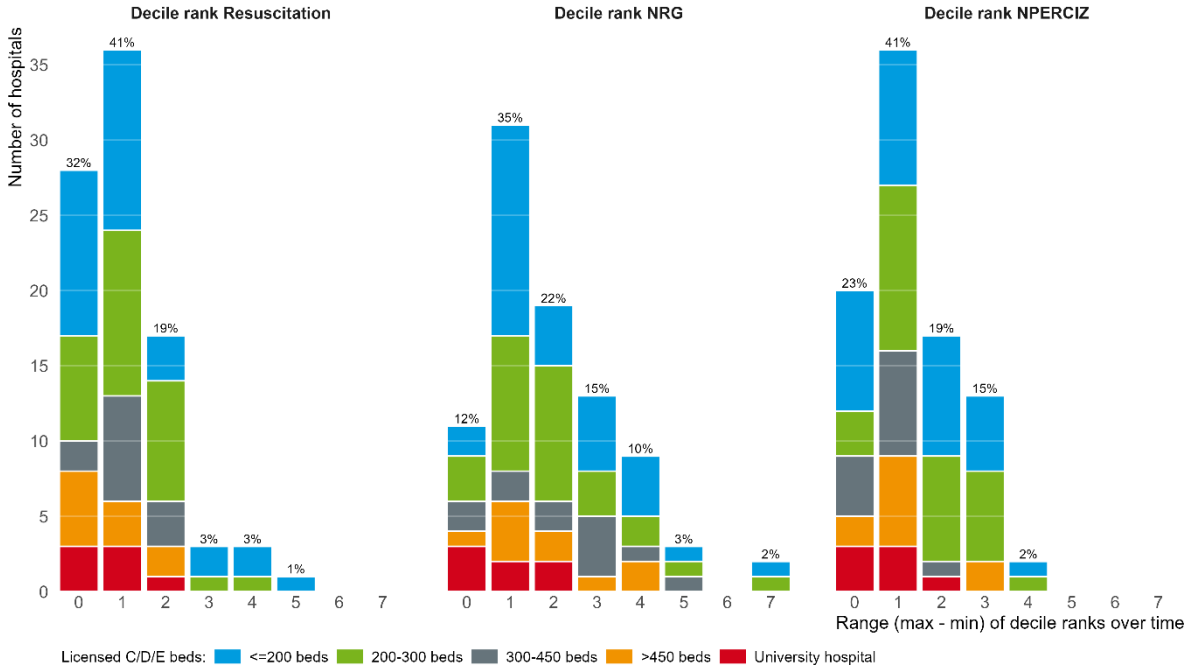
Wider shifts are rare. Only a few hospitals (≤3%) experienced shifts of four or more decile ranks, across all indicators. These are mainly smaller hospitals, whereas larger hospitals and university hospitals (orange, grey, red) show greater stability in their rankings.

Figure 15 – Evolution of decile ranks, 2017-2022



Note: To visually distinguish between upper and lower decile ranks, upper halves were increased by 0.15 and lower halves decreased by 0.15 (e.g. the upper half of decile 10 is shown as 10.15, and the lower half as 9.85).
Source: FOD – SPF.

Figure 16 – Evolution of decile ranks by hospital size and type, 2017-2022



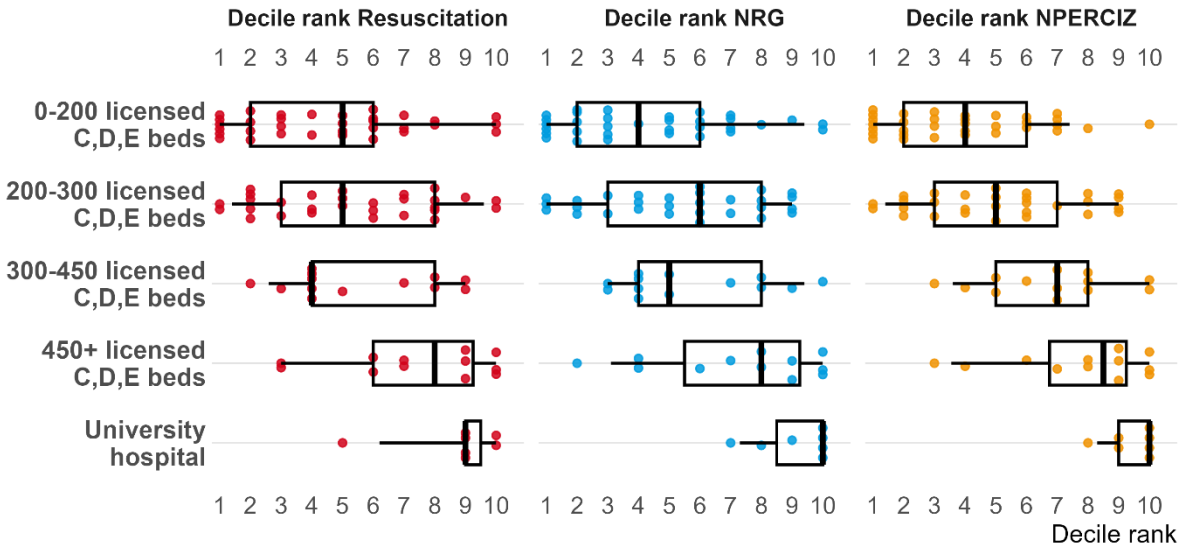
Source: FOD – SPF.

CORRESPONDENCE BETWEEN DECILE RANKINGS AND LICENSED BEDS

Figure 17 displays boxplots of decile rankings for hospitals in 2022 across the three ICU-related financing criteria: resuscitation (red), NRG (blue), and NPERCIZ (orange). The colours indicate the decile score per type without subdivision between upper and lower half. Hospitals are grouped by the number of licensed C-, D-, and E-beds and type (university hospitals).

University hospitals consistently rank in the highest deciles (mostly 9–10) across all three indicators, reflecting their central role in delivering complex ICU care. Hospitals with over 450 licensed C-, D- or E-beds also tend to rank in the higher deciles, with median decile ranks skewed toward the upper end of the scale, particularly for NRG and NPERCIZ. Hospitals in smaller size categories (<300 beds) display a wider spread in decile ranks, showing greater variability in ICU financing profiles.

Figure 17 – Correspondence between decile ranks and licensed beds by hospital size and type, 2002



Source: FOD – SPF.

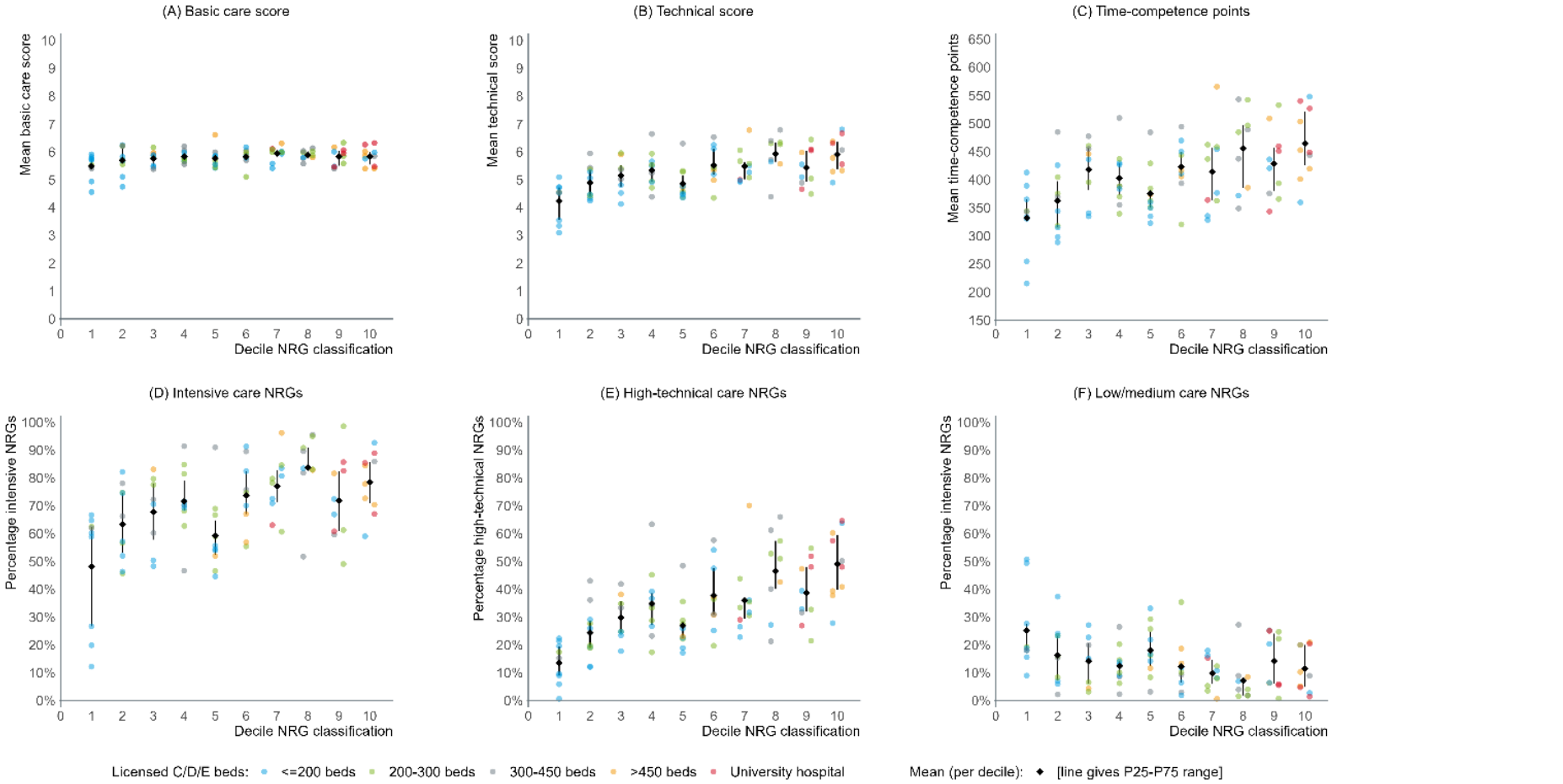
3.2.4 Supplementary points and activity profile of intensive care services

In this section we compare the decile rank of hospitals with the activity profile as outlined in Chapter 4. For the explanation of the used concepts, we refer to Textbox 1 and Chapter 4.

Figure 18 presents the nursing activity profile by hospital size (licensed C-, D- and E-beds) and type (university of not) and by decile for the NRG classification. Since hospital financing is allocated at the hospital level rather than the individual intensive care unit level, all care episodes in intensive care units were aggregated at the hospital level.

Comparing NRG decile ranks with hospital-level nursing activity profiles reveals substantial variation within each decile. Overall, there is a positive correlation between nursing care intensity and NRG classification: higher deciles tend to show higher average technical scores, more time-competence points, and a greater share of high-technical NRGs. However, significant variability and notable exceptions remain.

Figure 18 – Nursing activity profile and NRG-decile classification, by hospital size and type (2019)

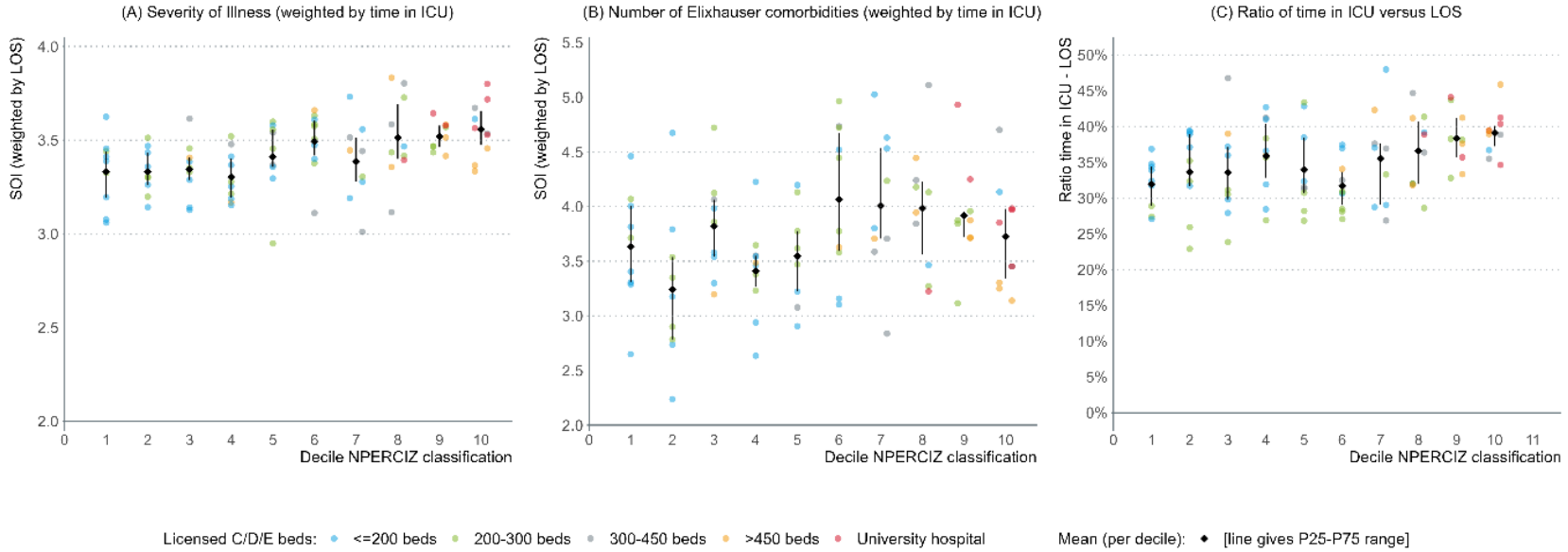


Note: Lines represent the range within each decile (excluding upper/lower halves); dots indicate the upper and lower half separately within each decile; the colour denotes the number of licensed C-, D-, and E-beds in 2019.
Source: FOD – SPF.

Figure 19 illustrates the relationship between NPERCIZ deciles in 2022 and three hospital-level ICU indicators: the mean severity of illness (SOI) category, the mean number of Elixhauser comorbidities, and the proportion of time spent in the ICU relative to the total length of hospital stay (LOS). The analysis includes hospital stays with an ICU admission (general ICU or PICU) in 2022. At the hospital level, the mean SOI and number of comorbidities are weighted by ICU length of stay (e.g. a patient with two ICU days contributes twice the weight of a patient with one ICU day). Each hospital is represented by a dot, colour-coded according to its number of licensed C-, D-, and E-beds in 2022.

Across all three measures, substantial within-decile variation is observed, particularly for the number of Elixhauser comorbidities. In Panel A, a slight upward trend suggests that hospitals in higher NPERCIZ deciles tend to have a higher mean SOI. In contrast, the association is less clear for the other two indicators. For comorbidity burden (Panel B), a distinction appears between the lower and upper five deciles, though variability is high. For the ICU-to-LOS ratio (Panel C), a modest upward trend is visible but appears disrupted in the middle deciles, indicating a non-linear relationship.

Figure 19 – Relation between NPERCIZ-decile classification and severity of illness, comorbidity burden and time in ICU, by hospital size and type (2022)

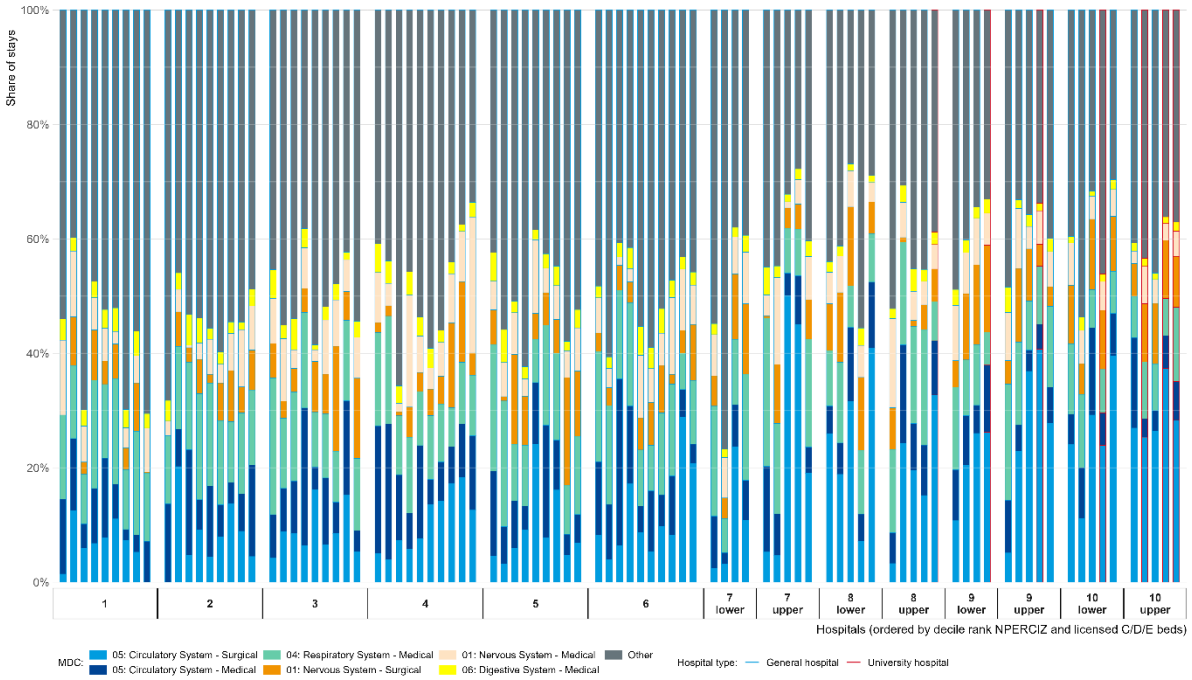


Source: FOD – SPF.

Figure 20 shows the relative distribution of Major Diagnostic Categories (MDCs) among hospital stays involving an ICU admission (general ICU or PICU) in 2022. Each bar represents a hospital, ordered by NPERCIZ decile (from 2022) and further ranked by the number of licensed C-, D-, and E-beds.

Figure 20 reveals that MDC 1 (nervous system), MDC 4 (respiratory conditions), and MDC 5 (circulatory conditions) account for a substantial proportion of ICU stays (see also Chapter 4). Yet, in the lower NPERCIZ deciles, a large share of stays fall under a heterogeneous mix of MDCs (labelled 'Other' and shown in grey). Another observation is that hospitals in the higher NPERCIZ deciles tend to have a relatively higher proportion of ICU stays related to neurosurgery and cardiac surgery.

Figure 20 – Distribution of ICU stays by Major Diagnostic Category (MDC), hospital, and NPERCIZ-decile classification (2022)



Source: FOD – SPF.

4 ACTIVITY PROFILE OF STAYS IN INTENSIVE CARE

KEY POINTS

- This chapter presents the activity profile of intensive care services in Belgian hospitals, focusing on general and paediatric intensive care and burn care units, excluding neonatal intensive care.
- To better characterise the heterogeneous group of general intensive care units, activity-based thresholds are applied to further classify them as medical (over 75% medical admissions), surgical (over 75% surgical admissions) or specialised (over 50% of admissions within a single Major Diagnostic Category (MDC), all either surgical or medical). These categories are not mutually exclusive; for instance, a unit may be both specialised and surgical. Units that do not meet any threshold are classified as mixed. Specialised, surgical, and medical units collectively are referred to as non-mixed units.
- The analysis is based on 2019 and 2022 Minimal Hospital Data (MZG – RHM) for the general activity profile and on 2019 Nursing Minimum Data Set (VG-MZG / DI-RHM) for nursing activity.
- A stay in intensive care refers to any inpatient stay that involves an admission to a general intensive care, paediatric intensive care, or burn care unit at any time during a hospital stay. For the analysis of patient transfers, multiple stays of the same patients are linked.

General activity profile

- The number of general intensive care stays decreased by 12.6% from 2019 (124 984 stays) to 2022 (109 256 stays), while paediatric intensive care and burn care stays increased by 21.4% and 11.8%, respectively. In 2022, 76.2% of general intensive care stays were in mixed units, 13.0% in specialised units, 7.4% in surgical units (excluding specialised units), and 3.5% in medical units (excluding specialised units). Specialised units primarily focus on cardiac surgery.
- In 2022, 56.5% of general intensive care stays took place in Flanders, 29.4% in Wallonia, and 14.1% in Brussels. Compared to the relative share in general intensive care beds, the activity share is slightly higher in Flanders and lower in Wallonia (see Chapter 2).
- Most general intensive care stays (52.3%) occurred in large general (>450 licensed C/D/E/G beds) or university hospitals, while paediatric intensive care was mostly in university hospitals, except for one small dedicated paediatric hospital. Burn care was exclusively provided in burn care units in large and university hospitals. The share of mixed general intensive care units in large general hospitals (76.7%) is almost twice as large as in university hospitals (39.1%). Specialised intensive care units are mainly found in university hospitals (share of 43.6% versus 11.2% in large general hospitals).
- In 2022, the number of intensive care stays per hospital site ranged from 124 to 5 577 (and to 4 504 for general intensive care units only). Approximately 40% of sites (47 out of 119) recorded fewer than 500 stays in general intensive care. General intensive care units in Wallonia had fewer patient stays per hospital site compared to those in Brussels and Flanders, with substantially lower median and quartile values. Only two hospital sites (both in Flanders) offer the full spectrum of paediatric intensive care, burn care and (a subtype of) general intensive care.
- In Flanders, hospital sites with fewer than 1 500 stays in general intensive care units exclusively have mixed units. In contrast, one single-unit site in Brussels and six in Wallonia, each with fewer than 500 stays, are designated as medical units, indicating that fewer than 25% of admissions involve surgical cases.
- The average daily occupancy rate in intensive care services was 67%, peaking at 80% in late November and December. General intensive care followed a similar pattern (66%), while paediatric and burn care recorded higher rates of 76% and 72%. Seasonal peaks align with periods of increased respiratory infections, particularly among young children.

- Occupancy rates varied widely across hospital sites, with the greatest differences seen during the December peak. Nearly one in four intensive care services operated at or above their licensed capacity during that period. Over the year, general intensive care services in 59% of hospital sites exceeded 100% occupancy at least once, while 71% recorded minimum occupancy below 30%, predominantly in smaller hospital sites.
- Mean daily occupancy rates in general intensive care increased with hospital size, ranging from 61% in sites with ≤200 licensed beds to 74% in university hospital sites. Hospitals with more than 450 licensed beds averaged 69%, while mid-sized categories remained around 64%. Smaller hospitals showed greater variability, with more extreme minimum and maximum values and wider interquartile ranges.
- Intensive care stays rates per 1 000 population generally increase with age and peak in the 75–79 age group. Patients aged 60-79 account for just over half of all general intensive care stays, while those aged 80 and above represent an additional 18%, despite a slight decline in rates. Men have higher stay rates than women across all age groups; for example, at the peak age group of 75-79 years, rates are 46 per 1 000 for men and 26 for women.
- More elevated rates are also observed among newborns and children under 5, primarily in paediatric intensive care. In 2022, 56.4% of stays in paediatric intensive care were for children aged 0-4 years.
- Burn care units showed a more even distribution of activity across age groups.
- The proportion of planned hospital stays (with part of the stay in an intensive care service) varies by unit type, being highest in paediatric intensive care (38%) compared to general intensive care (35%) and burn care (34%).
- Most patients (73% in general intensive care up to 83% in burn care) are discharged home after a hospital stay involving intensive care. However, this proportion declines with age, while in-hospital mortality and discharges to nursing homes become more common. Among patients aged 80+, for example, 57% are discharged home, while 13% are discharged to a nursing home.
- General intensive care and burn care units have a higher proportion of surgical treatments (55%) compared to paediatric intensive care units (42%). Surgical treatments increase with age, peaking at 65-79 years. For all age groups, the share of surgical treatments in non-mixed general intensive care units is larger than the share of medical treatments in these units.
- The most common conditions (MDCs) vary by unit type: circulatory system (surgical) in general intensive care (21.5%) and respiratory system (medical) in paediatric intensive care (23.3%). Burn care units focus mostly on burn treatments.
- At the APR-DRG level, paediatric intensive care and burn care units show a higher prevalence of specific conditions, such as bronchiolitis and specific types of burns. In contrast, mixed general intensive care units do not show a strong concentration of particular conditions. Non-mixed general intensive care units, however, more frequently treat cardiac-related APR-DRGs, including APR-DRG 174 (percutaneous cardiac intervention with AMI), APR-DRG 166 (coronary bypass w/o AMI or complex PDX), APR-DRG 183 (percutaneous structural cardiac procedures) or APR-DRG 163 (cardiac valve procedures w/o AMI or complex PDX).
- The most common conditions in intensive care vary by age group, with injuries and poisoning being most frequent in younger adults, circulatory system issues in older adults, and respiratory illnesses in young children.
- General intensive care (15.6%) and paediatric intensive care units (17.9%) have a lower proportion of low-severity patients (severity of illness or SOI-level 1) compared to burn care units (25.5%), but overall severity distributions are similar when we combine the two lowest and two highest groups.

- Patients in general intensive care units are more likely to have multiple comorbidities (≥ 3) compared to paediatric intensive care and burn care units, largely due to differences in patient age profiles, as comorbidities tend to increase with age. Mixed and non-mixed general intensive care units yield similar results.
- There is only a moderate correlation between SOI-level and the number of comorbidities. While higher SOI levels generally involve more comorbid conditions, all SOI levels include patients with varying numbers of comorbidities.
- Nearly half of all stays in intensive care last only one or two days, with 54.6% in general intensive care, 48.2% in paediatric intensive care, and 41.0% in burn care. However, stays of at least 30 days are more common in burn care units (7.5%) compared to general (2.2%) and paediatric (1.9%) intensive care. The patterns are similar for mixed and non-mixed general intensive care units. In single-site single-unit general intensive care services, there are relatively more short hospital stays that include intensive care.
- The median time in general intensive care units is about 1.9 days, with only slight differences between regions and hospital types. The length of stay in burn care units shows more variability but should be interpreted cautiously due to a smaller number of cases.
- In general intensive care units, urgent admissions (via ambulance or mobile urgency group/paramedical intervention team [PIT]) are associated with longer time in intensive care. The share of admissions involving emergency transport cases increases from 27.2% for stays under 24 hours in intensive care to 53.1% for stays of 10 days or more. This pattern is less pronounced for paediatric intensive care and burn care units.
- In general intensive care units, inpatient mortality increases with the time in intensive care, rising from 8.7% for stays under 24 hours to 35.6% for stays of 10 days or more. This trend is less clear in paediatric and burn care units.
- In 2022, 1 875 intensive care transfers occurred, of which 75% inter-hospital and 25% within-hospital. Transfers were most frequent in patients aged 60-79, while the oldest patients (80+) were relatively underrepresented and patients aged 30-59 overrepresented. Nearly all transfers involving the youngest age groups (0-20 years) occurred between different hospitals. Most transfers between intensive care services occurred early after admission, with over 15% on the same day and over 30% of inter-hospital transfers on day one. However, a substantial share (5-10%) took place after 14 days in intensive care.
- Within-hospital transfers most frequently involve patients treated for respiratory system conditions, transplant cases and circulatory system conditions. The main MDCs after inter-hospital transfers relate to circulatory and respiratory system conditions. There is a shift from medical to surgical treatments in APR-DRG registration before and after transfer, suggesting that inter-hospital transfers appear to be driven by a need for specialised surgical interventions (e.g. cardiac surgery, transplants) and complex medical care.
- Inter-hospital intensive care transfers mostly originated from smaller hospital sites (≤300 beds, 58%) and mixed general intensive care units (87%). Many were directed to larger hospitals (>450 beds, 22%) and university hospitals (51%). Within-hospital transfers were more concentrated in smaller sites and less often involved specialised units. Transfers in intensive care services frequently flowed from sites in less densely populated areas and smaller city hospitals to university hospitals and larger sites in urban centres.

Nursing activity profile

- Care intensity is assessed using the Nursing Minimum Data Set (VG-MZG / DI-RHM), which records nursing activities and interventions at the care episode level. A care episode is defined as a period that begins or ends with a transfer between nursing units or at midnight. Care episodes are classified based on technical and basic care scores, Nursing Related Groups

(NRGs), and time-competency points, which quantify workload and complexity. Additionally, registered items are used to identify care episodes that involve frequent monitoring of vital parameters, mechanical cardiocirculatory or respiratory support, which are characteristic of intensive care services (flagged care episodes).

- Care intensity measures are used to assess variation in care intensity between different intensive care service units, within intensive care services, and to identify higher-intensity general care units that may function as intermediate care units.
- Data are used from 95 401 care episodes across 23 822 stays in 203 general and paediatric intensive care and burn care units within 125 hospital sites and 99 hospitals. The average number of care episodes per stay is 4. There is substantial variation in care episodes per unit (median: 413, P25-P75: 306-588) and per site (median: 504, P25-P75: 342-817), and the distribution is right-skewed. A substantial proportion of care episodes (44.7%) have a duration of less than 24 hours.
- The different measures of care intensity are strongly intercorrelated but show only a weak association with patient comorbidity burden. Considerable variability in care intensity is observed across units, with mean technical scores typically ranging between 4.5 and 6.5. Other indicators of technical complexity, including the proportion of intensive NRGs, medium- or high-technical care, and flagged care episodes, also show broad dispersion. The distributions of these indicators are left-skewed, with most units clustering at higher proportions and a smaller subset exhibiting lower values.
- Compared to mixed general intensive care units, paediatric intensive care units have lower levels of technical care and higher levels of basic care, while burn care units have lower levels of both. This reflects differences in patient population (age, comorbidity burden) and treatment types. Medical intensive care units have lower technical care levels, like paediatric units, but treat patients with higher comorbidity burdens. Surgical units have the highest level of technical care and mean time-competence points. Specialised units show the greatest variability, ranking among the highest and lowest in technical care, basic care, short care episodes and comorbidity burden.
- Lower levels of care intensity are found in hospitals with a single site and a single intensive care unit, as well as in hospitals and hospital sites with a smaller number of beds. In contrast, units predominantly providing high-technical care are concentrated in primary sites of university hospitals and larger hospital sites. Not only are higher levels of care intensity observed in university hospitals and hospitals with a larger number of beds, but also greater variation, as these hospitals generally operate multiple intensive care service units. This may reflect differences in specialisation, treatment options, and patient case-mix.
- A consistently high level of basic care is found in all general (mixed, surgical, medical, specialised) intensive care units, irrespective of intensive care or hospital bed size. There are indications that units providing more technical care also tend to have higher basic care scores.
- All hospital sites treat a mix of patients with varying care needs and comorbidity burden. Although case-mix differences are not strongly related to the bed size of intensive care services, there are indications that the relative share of higher-intensity patients is lower in sites with fewer beds and higher in mid-sized sites, whereas the largest sites accommodate both highly technical care patients and those requiring high levels of basic care due to unit specialisation (e.g. paediatric intensive care, burn care units, or specialised units).
- An analysis of the ratio of high-intensity care episodes (95th percentile) to median-intensity care episodes within a site shows that the difference in care intensity between a top and median intensive patient is smaller in sites with a more pronounced intensive profile. In contrast, in sites with a lower intensive profile, care intensity is more variable, suggesting that these units may be less accustomed to treating high-intensity patients. No clear relationship is found between this

ratio and the number of intensive care beds. This ratio also varies considerably among university hospitals.

- 34 (out of 994) general care units had at least 10% care episodes involving frequent monitoring of vital parameters, mechanical cardiocirculatory or respiratory support, while 3 intensive care service units did not attain this threshold. This threshold was set to identify units that may function as intermediate care units. In the selection, 3 sleep care units were identified and excluded as they were not considered potential intermediate care units, leaving 31 units for analysis. Compared to intensive care service units, these general care units have, on average, more care episodes per unit, fewer care episodes per patient, and a higher proportion of short care episodes (< 24 hours).
- Among the 31 identified units, 8 specialised in cardiac care, 4 in post-anaesthesia care (PACUs), 4 in neurological disorders and stroke, and 4 in respiratory conditions. Additionally, 11 mixed units combined cardiac, neurological, and respiratory care, with 5 labelled as step-up or step-down units in the survey (see Chapter 7). Mixed units and PACUs account for the largest share of units with a high proportion of flagged care episodes. Flanders has the highest number of selected units (20), a broader unit type distribution, and a greater prevalence of units with high shares of flagged care episodes. Hospital sites with at least 12 intensive care service beds also feature a greater diversity of unit types and a higher proportion of units exceeding 30% flagged episodes.
- General care units have lower care intensity than most intensive care service units, though their care levels are similar to the least intensive care unit settings. Substantial variation also exists in technical and basic care scores in general care units, with variation in basic care being more pronounced than in intensive care service units.

4.1 Introduction

This chapter outlines the activity profile of intensive care services in Belgian hospitals, covering general intensive care, paediatric intensive care, and burn care services. Neonatal intensive care is excluded from this analysis.

The description of the activity profile is divided into two parts. Drawing on data from the Minimal Hospital Data (MZG – RHM) for the years 2019 and 2022, the first part (section 4.1) provides an overview of the number, duration, and distribution of inpatient stays in intensive care services, as well as the age-gender and clinical profile of the patient population. Additionally, it examines the variability of these features across different hospital sites. In a last section, transfers between intensive care services of different hospital sites are analysed.

The second part (section 4.2) focuses on the intensity of nursing care provided in intensive care units, using 2019 data from the Nursing Minimum Data Set (VG-MZG / DI-RHM). It explores variations in nursing care intensity both between and within intensive care units, and identifies general care units that frequently perform technical nursing activities.

4.1 General activity profile

The objective of this part is to provide a general overview of the activity in intensive care services, as well as the age-gender and clinical profile of the patient population. Attention is paid to variation and differences between regions, types of intensive care (general, paediatric, burn), sites and type of hospitals, and to transfers.

4.1.1 Data and methodology

4.1.1.1 Minimal Hospital Data

We use the Minimal Hospital Data (MZG – RHM) for the years 2019 and 2022. The MZG – RHM is a comprehensive database that contains compulsory, pseudonymised medico-administrative information on all hospital episodes in Belgian acute hospitals. It covers inpatient stays, day-care admissions, and emergency room contacts. Each hospital (general and university) submits its MZG – RHM data to the Federal Public Service for Health, Food Chain Safety, and Environment (FOD – SPF), regardless of the patient's insurance status.

For each pseudonymised stay, the dataset includes unit, site and hospital identifiers indicating where the hospitalisation occurred, patient demographics (e.g. age, gender, place of residence), arrival and departure time, sequence of nursing units, principal and secondary diagnoses (International Classification of Diseases, 10th Version, Clinical Modification (ICD-10-CM)), admission and discharge details (e.g. place before admission, in-hospital death, discharge disposition). It also contains information necessary for the assignment of Diagnosis Related Groups (DRGs).

Belgium uses the 3M™ APR-DRG (All Patient Refined Diagnosis Related Group) system to classify hospital stays. The APR-DRG system refines the basic DRG structure by introducing two additional subclassifications: Severity of Illness (SOI) and Risk of Mortality (ROM).

- *Severity of Illness (SOI)* measures the extent of physiological decompensation or loss of organ function, categorised into four levels: minor, moderate, major, and extreme.
- *Risk of Mortality (ROM)* assesses the likelihood of death during hospitalisation, also classified into the same four levels: minor, moderate, major, and extreme.

Patients are grouped into one of 332 APR-DRGs (version 38), each with four SOI levels, based on a combination of factors including the principal diagnosis, secondary diagnoses, procedures (coded using ICD-10-BE), patient age and gender, and, in specific cases, discharge status (e.g. for DRGs related to alcohol/drug use) or birthweight (for DRGs of neonates). Two residual APR-DRGs – APR-DRG 955 (invalid principal diagnosis) and APR-DRG 956 (ungroupable stay) – are used for hospital stays where clinical information is atypical or invalid, making SOI classification irrelevant.

Note that the MZG – RHM data do not include information on physiological parameters or any other intensive care-specific data that would allow to calculate intensive care-specific metrics of severity of illness such as the APACHE (Acute Physiology And Chronic Health Evaluation) score.

4.1.1.2 Data selection

We included all hospitalisations where the patient was admitted to an intensive care (general or paediatric) or burn care unit at any point during their stay. For the analysis of patient transfers, we expanded the selection to include all previous or subsequent hospital stays in acute hospitals (but not in intensive care or burn care) for patients identified in the initial selection.

Intensive care units with a patient population comprising more than 50% neonates were classified as neonatal intensive care units and excluded from the analysis. Similarly, units with more than 50% of their patient population being children aged 15 or younger (excluding neonates) were classified as paediatric intensive care units. One mixed care unit with 50% intensive care beds was included as a general intensive care unit (see also Chapter 2). Moreover, a further classification of general intensive care units was applied to distinguish between:

- Specialised intensive care unit: a general intensive care unit where more than 50% of admissions fall under a single Major Diagnostic Category (MDC), either medical or surgical;
- Medical intensive care unit: a general intensive care unit in which over 75% of admissions are for medical cases;
- Surgical intensive care unit: a general intensive care unit in which over 75% of admissions are for surgical cases;
- Mixed intensive care units: general intensive care units not belonging to the previous categories.

Hospital sites may have multiple intensive care or burn care units, and each hospital can have multiple sites. For the analysis in this section, units of the same type (paediatric intensive care, general intensive care, or burn care) within each hospital site were aggregated.

The term *intensive care services* is used to collectively refer to general intensive care, paediatric intensive care and burn care units.

4.1.1.3 Data manipulation

COMORBIDITY BURDEN

In addition to severity of illness, we calculated the number of AHRQ (*Agency for Healthcare Research and Quality*) Elixhauser comorbidities. Based on the diagnostic information in the MZG – RHM, the AHRQ algorithm identifies 38 comorbidities which predate the hospital admission and are expected to have an impact on both mortality and readmission risk, and hospital resource use.[22, 23] For each stay we computed the number of Elixhauser comorbidities of the patient.

TIME IN INTENSIVE CARE AND OCCUPANCY RATES

In addition to length of stay of the admission, which is the difference between date of admission and date of discharge, we calculated the time spent in intensive care services. For this analysis, admission and discharge times from the MZG – RHM data, accurate to the hour, were used to estimate the time spent in each type of unit, i.e. paediatric intensive care, general intensive care (further divided into specialised, medical, surgical or mixed) or burn care.

Time spent in intensive care was used to calculate daily bed occupancy rates at the national level, at the level of intensive care services in a hospital site (aggregating all units), and further disaggregated by type of unit (general and paediatric intensive care and burn care). Bed occupancy rates are defined as the ratio – expressed as a percentage – of the total time patients spent in intensive care (measured in days) to the number of licensed beds available on a given day, as recorded in the MZG – RHM dataset. It should be noted that when reporting occupancy rates for a hospital site with multiple units, variations in occupancy between units may be masked. For example, an overall occupancy rate of 80% may reflect one unit operating at full capacity and potentially experiencing organisational strain, while another is functioning at only half capacity.

Bed occupancy rates do not take into account periods when beds are temporarily out of service (e.g. for cleaning between discharge and admission). However, it was assumed that a bed remains reserved for – or occupied by – a patient in cases where discharge and readmission occur within a 12-hour interval. A typical example is a patient undergoing a surgical procedure in an operating theatre who subsequently returns to the intensive care unit. In such cases, the time away is considered as time spent in intensive care. Additionally, because the MZG – RHM data register stays by the year of discharge, hospital stays with a discharge in 2023 but an admission in the final months of 2022 are recorded under 2023 and do not appear in the 2022 dataset. As a result, activity for that period is underestimated. To address this, a second important methodological choice was made: hospital stays from the final months of 2021 with discharge in 2022 were duplicated, with dates adjusted accordingly, to counterbalance this underestimation. A comparable methodology was applied in previous KCE reports on maternity and paediatric services.[24, 25]

TRANSFERS BETWEEN INTENSIVE CARE SERVICES

For the analysis of transfers, multiple stays of the same patient were linked. Data on the sequence of nursing units were used to identify stays involving a transfer from an intensive care service at one hospital site to an intensive care service at another hospital site, either within the same hospital or between different hospitals. A transfer was defined as a case where the intensive care service was the last unit visited in the sending hospital site and the first unit visited in the receiving hospital site. Units labelled *TRANS* (a fictitious unit used to manage patient transfers between hospitals) and *URG* (emergency room unit) were excluded from the analysis, as both may play an intermediary role in the transfer process. If either of these units appeared as the last unit in the sending hospital or the first unit in the receiving hospital, the preceding or subsequent unit was examined to determine whether it was an intensive care unit.

4.1.2 Results

4.1.2.1 Selection of stays

The total number of selected stays in intensive care services amounts to 137 000 stays in 2019 and 122 268 stays in 2022. Of these, 6 981 (2019) and 7 080 stays were exclusively in a neonatal intensive care. These stays were excluded from the analyses. This results in a total of 130 019 stays in 2019, distributed as follows:

- The majority were in general intensive care units (124 984 stays);
- 4 258 were in paediatric intensive care units;
- 1 090 were in burn care units.

In 2022, there were 115 181 stays, broken down as follows:

- The majority were in general intensive care units (109 256 stays);
- 5 169 were in paediatric intensive care units;
- 1 219 were in burn care units.

There is some overlap between units, as shown in Figure 21 and Figure 22. Specifically, some stays involved transitions between general and paediatric intensive care units (176 in 2019, 167 in 2022) or between burn care and intensive care (97 in 2019, 123 in 2022).

In the following sections, we primarily present results for 2022.

Figure 21 – Number of stays by type of unit and passage through multiple units in 2019

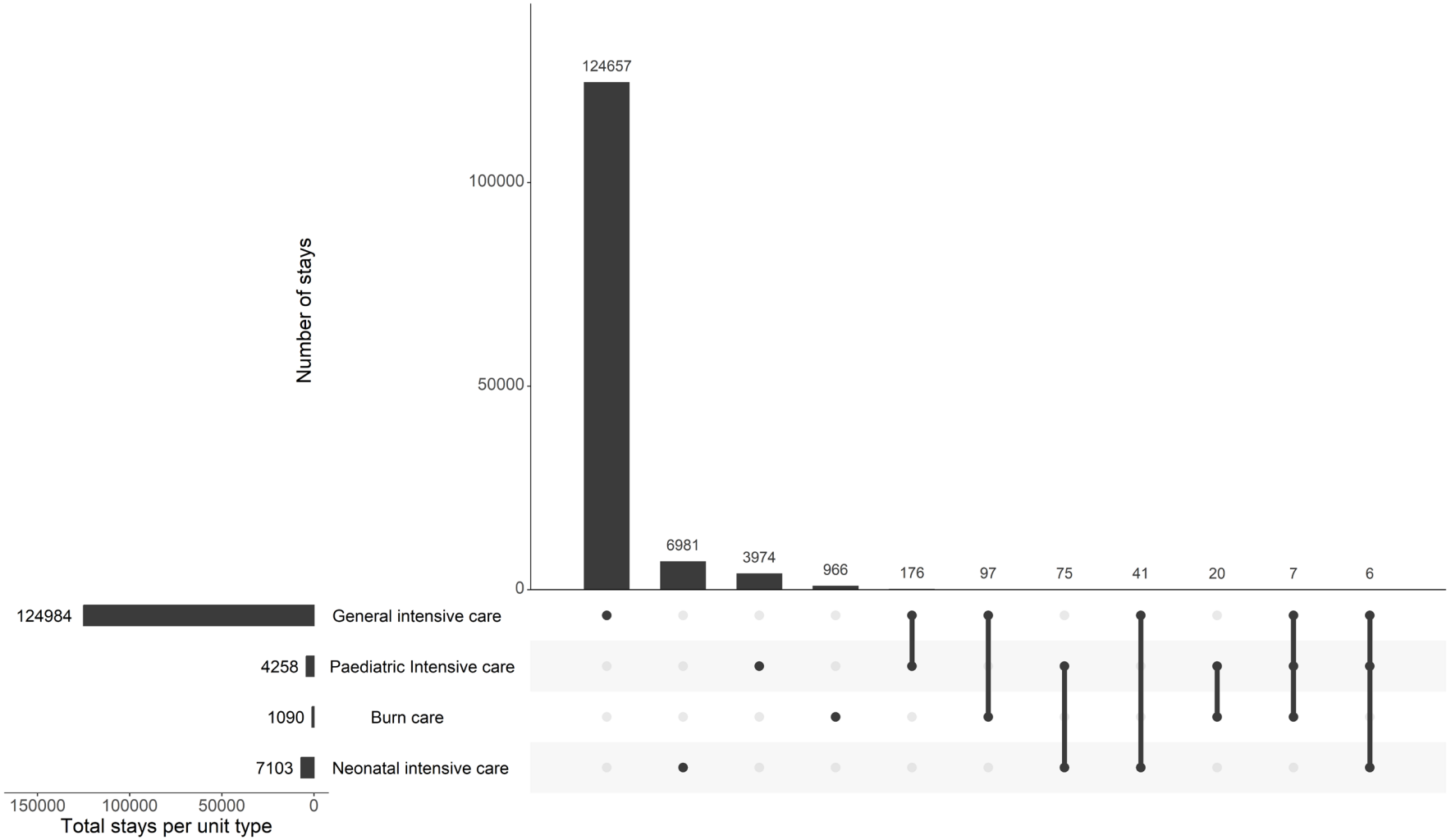


Figure 22 – Number of stays by type of unit and passage through multiple units in 2022

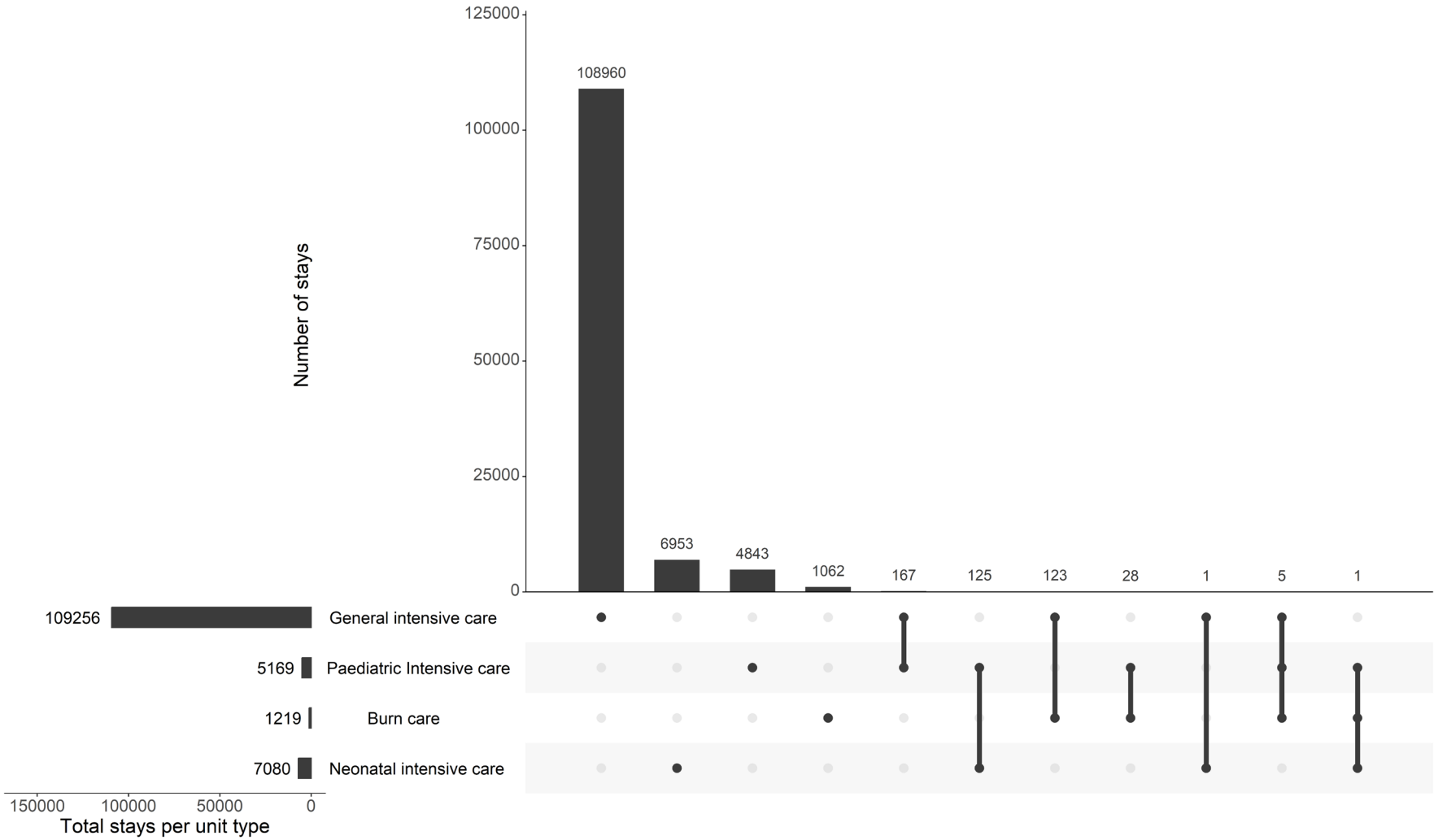


Table 11 shows the number of hospital sites with a general intensive care unit and the number of units, by type of site (size and university or not) and unit in 2022. In general, specialised (mainly for cardiac surgery) and surgical units are present more frequently in large general and university sites while medical units are found more frequently in smaller hospital sites.

Table 11 – Number of hospital sites with a general intensive care unit and the number of units, by type of hospital site and unit in 2022

Site type	General intensive care units	Specialised units	Medical units	Surgical units
<=200 licensed C/D/E/G beds	38 (40)	0 (0)	7 (7)	1 (1)
200-300 licensed C/D/E/G beds	38 (50)	2 (2)	1 (1)	3 (3)
300-450 licensed C/D/E/G beds	23 (29)	0 (0)	0 (0)	1 (1)
>450 licensed C/D/E/G beds	13 (39)	5 (5)	1 (1)	5 (6)
Primary site university hospital	7 (38)	7 (13)	2 (2)	6 (10)
Total sites (units)*	119 (196)	14 (20)	11 (11)	16 (21)

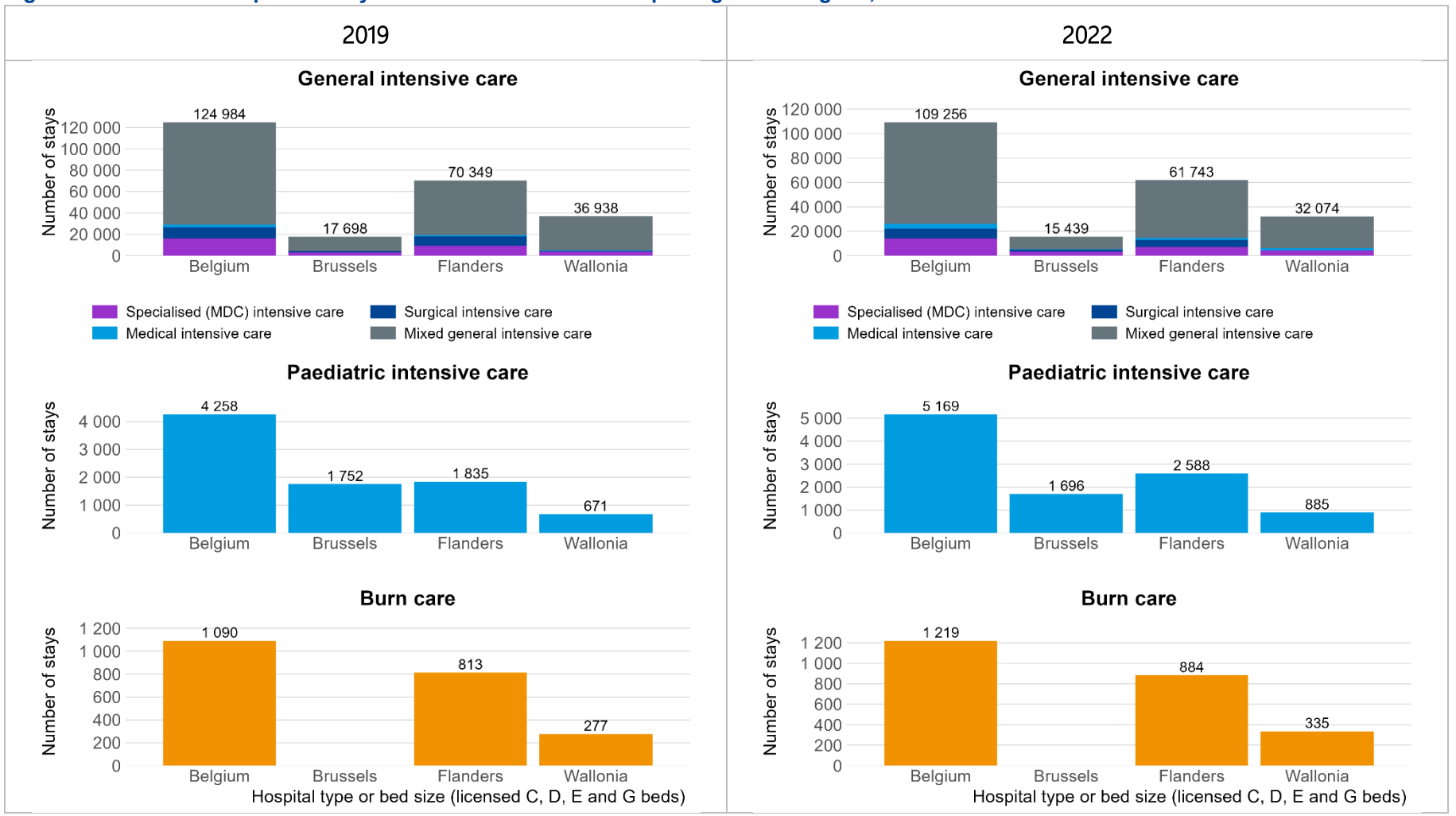
Note: number of hospital sites (number of units). Selected hospital sites are sites with at least one licensed C, D, E or G-bed.
Source: Minimal Hospital Data (MZG – RHM).

4.1.2.2 Number and geographical distribution of inpatient stays in intensive care services

Among the 109 256 stays in general intensive care units in 2022, 56.5% took place in Flanders, 29.4% in Wallonia and 14.1% in Brussels as illustrated by Figure 23. For paediatric intensive care, the shares are equal to 50.1%, 17.1% and 32.8%, respectively. The results for 2019 are similar to those for 2022. The main difference is in the total number of stays. While the total number of inpatient stays in general intensive care units decreased with 12.6% between 2019 and 2022, the total number of inpatient stays in paediatric intensive care and burn care units moved in the opposite direction with an increase of 21.4% and 11.8%, respectively.

In Belgium's general intensive care units in 2022, 76.2% of stays occur in mixed units, 13.0% in specialised units, 7.4% in surgical units, and 3.5% in medical units. The share of mixed units is higher in Wallonia (80.7%) than in Flanders (76.5%) and Brussels (65.4%).

Figure 23 – Number of inpatient stays in intensive care services per region in Belgium, 2019 and 2022



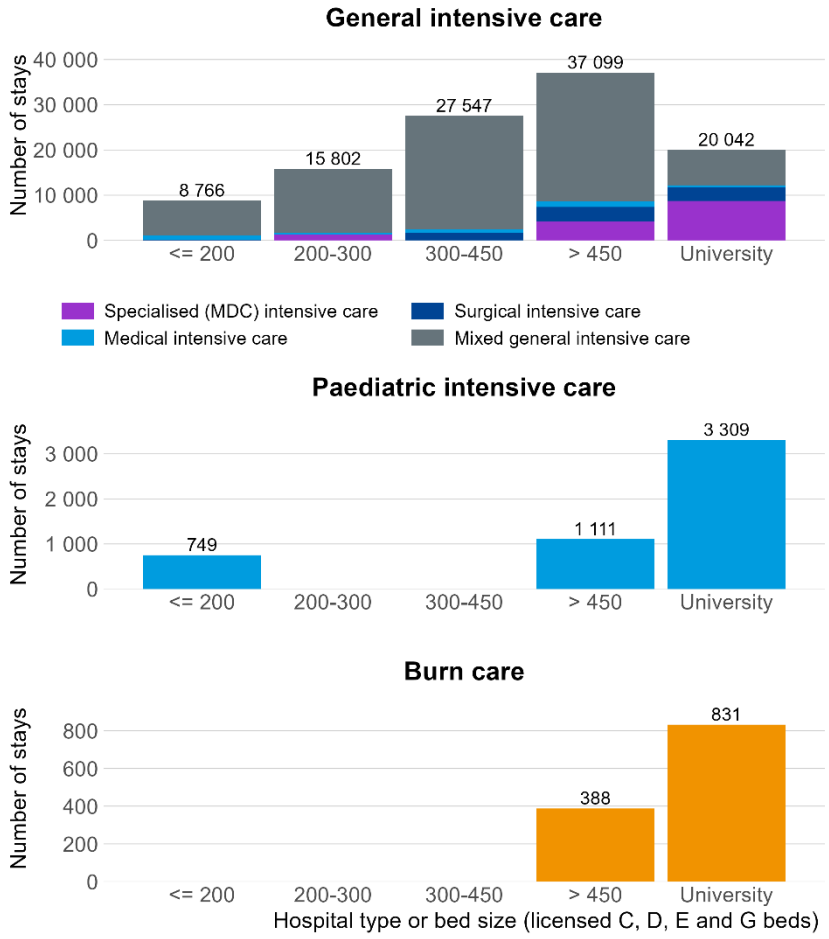
Note: 1 stay in general intensive care units in 2019 took place in two sites in different regions and is counted in both regions. Some stays passed through different types of units and are counted in each type of unit (see Figure 21 and Figure 22). The Minimal Hospital Data (MZG – RHM) do not contain information on the burn care centre in the Queen Astrid Military Hospital in Neder-over-Heembeek (Brussels).

INTENSIVE CARE ACTIVITY IS PERFORMED IN ALL TYPES OF HOSPITALS

General intensive care is performed in small and large general hospitals (in terms of the number of licensed C/D/E/G beds) and in university hospitals (see Figure 24). Nevertheless, most stays (52.3%) occur in large general or in university hospitals and 25.2% in medium-sized hospitals (300-450 beds). Only 8% of stays is performed in small (≤ 200 beds) hospitals. Although paediatric intensive care is concentrated in large and university hospitals, 14.5% takes place in one small hospital which is entirely dedicated to children. Burn care services are provided exclusively in large general hospitals (31.8%) and university hospitals (68.2%).

The share of mixed general intensive care units in large general hospitals (76.7%) is almost twice as large as in university hospitals (39.1%). Specialised intensive care units, defined as general intensive care units where more than 50% of admissions fall under a single MDC, are mainly found in university hospitals (share of 43.6% versus 11.2% in large general hospitals).

Figure 24 – Number of inpatient stays in intensive care services by hospital type or bed size (licensed C, D, E and G beds) in Belgium, 2022



Note: Some stays passed through different types of units and are counted in each type of unit (see Figure 21 and Figure 22).
Source: Minimal Hospital Data (MZG – RHM).

VARIABILITY OF INTENSIVE CARE SERVICES ACROSS BELGIAN HOSPITALS

Figure 25 shows the number of inpatient stays per type of intensive care service, per hospital site and per region for 2022. Hospital sites are ordered per region and number of stays in a general intensive care unit.

The total number of stays per hospital site varies from 124 to 5 577 stays. The mean (median) number of stays for general intensive care (all subtypes), paediatric intensive care and burn care is equal to 920 (588) stays, 565 (466) stays and 244 (198) stays respectively. Approximately 40% of sites (47 out of 119) recorded fewer than 500 stays in general intensive care. Only two hospital sites offer the full spectrum of paediatric intensive care, burn care and a subtype of general intensive care, and they are both located in Flanders.

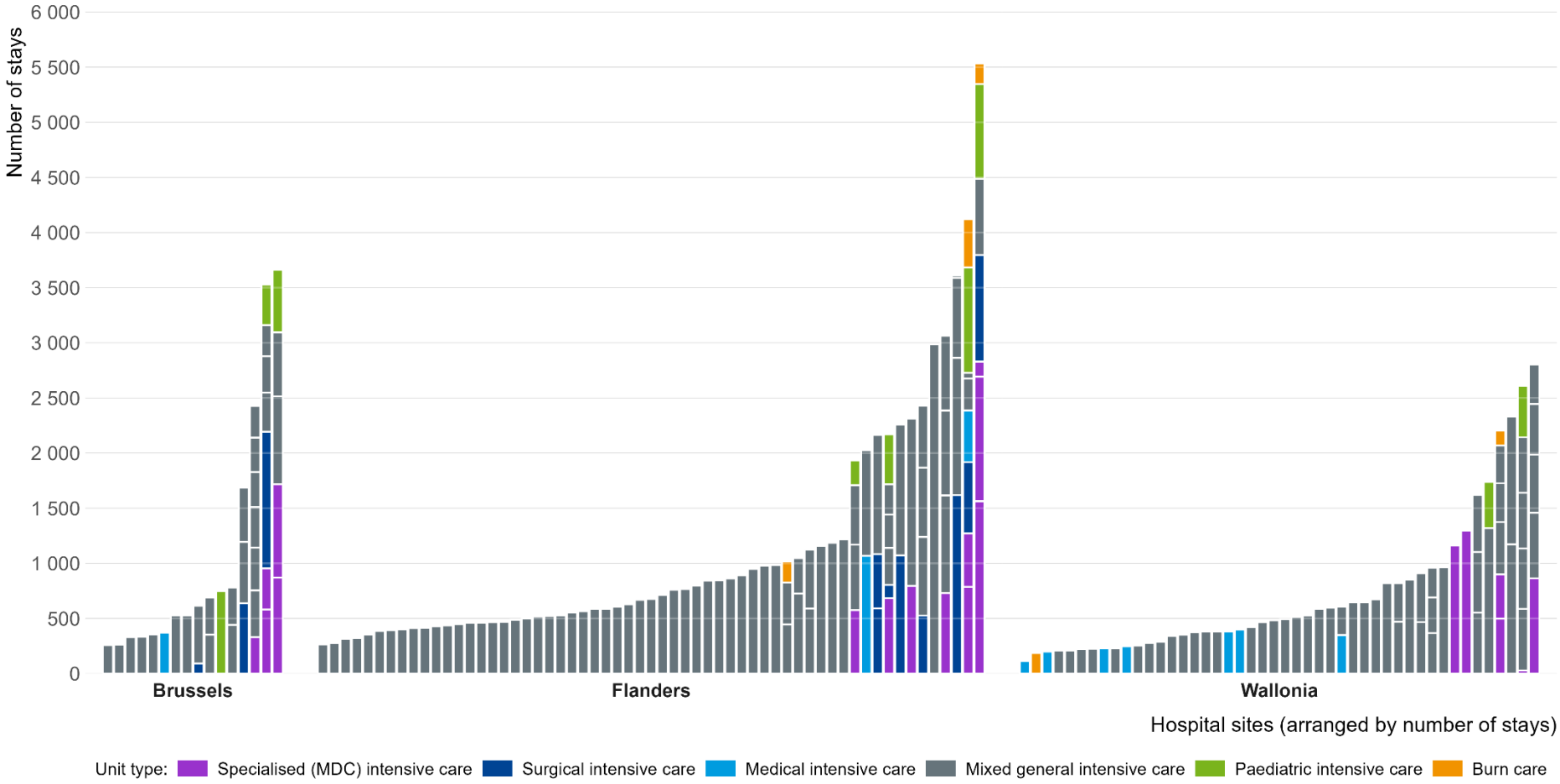
There are fairly significant differences between the regions. The maximum number of stays in a hospital site with a general intensive care unit varies from 4 504 stays in Flanders, 3 156 stays in Brussels to 2 803 stays in Wallonia; for paediatric intensive care the maximum numbers are 1 008 stays in Flanders, 749 stays in Brussels and 466 stays in Wallonia. There is only burn care in Flanders (maximum number of stays is 478) and Wallonia (maximum number is 190).[l]

All hospital sites in Flanders with fewer than 1 500 stays in general intensive care units are classified as mixed units. In Brussels (one site) and Wallonia (six sites), it is notable that some single-unit sites with fewer than 500 stays are classified as medical, indicating that fewer than 25% of the admissions involve surgical cases. A noticeable break in the distribution of the number of stays in general intensive care units can be noticed from less than 1 000 stays to more than 1 500 stays in Brussels and Wallonia and from approximately 1 200 stays to more than 1 500 stays in Flanders. Specialised intensive care units are concentrated in hospital sites with a large number of stays (see also Figure 24).

In general, we can conclude that patient volume in general intensive care is substantially lower per hospital site in Wallonia compared to Brussels and Flanders (p25=296 versus 357 in Brussels and 464 in Flanders; p50=494 versus 536 in Brussels and 677 in Flanders; p75=853 versus 1 234 in Brussels and 1 142 in Flanders).

[l] The MZG – RHM do not contain information on the burn care centre in the Queen Astrid Military Hospital in Neder-over-Heembeek.

Figure 25 – Number of inpatient stays in intensive care services per type of unit, site and region, ordered by region and stays in intensive care service, 2022



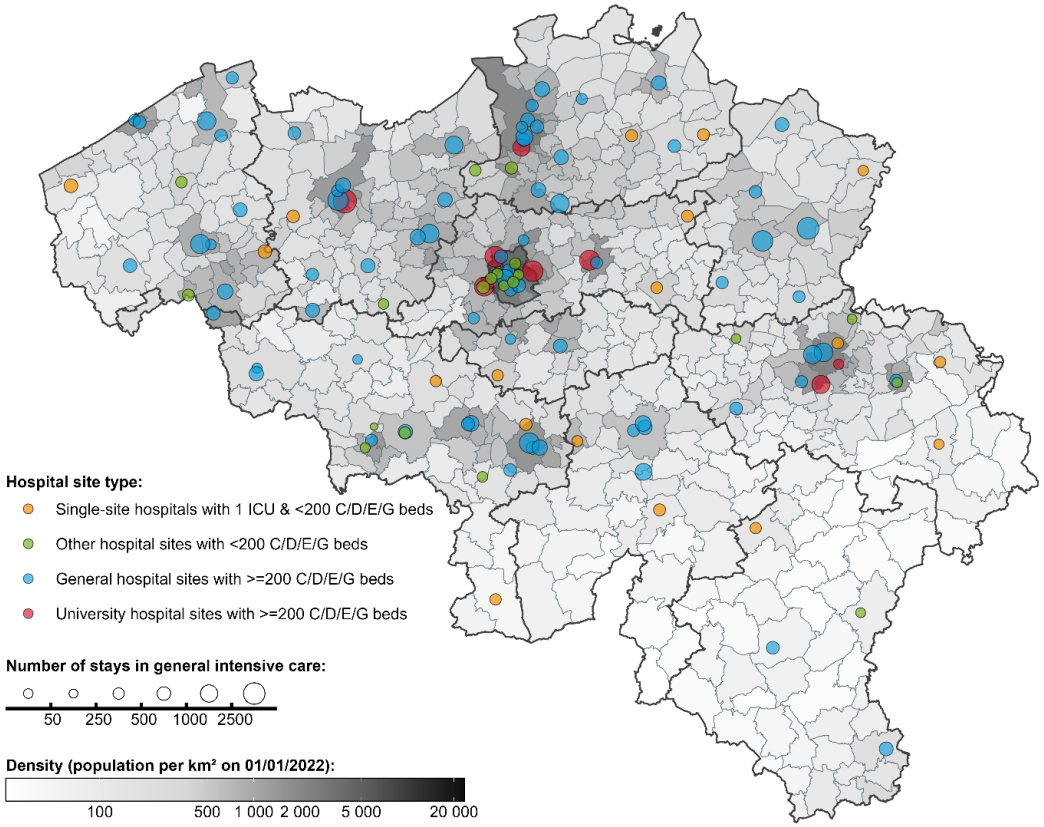
Note: Stays taking place in more than one hospital site are counted once for each site, 490 stays took place in multiple sites, resulting in a slight over-counting.
Source: Minimal Hospital Data (MZG – RHM).

Figure 26 shows the geographical distribution of the selected stays in general intensive care units in general and university hospitals in 2022. A distinction is made between stays in (1) a hospital with one site, one general intensive care unit and less than 200 C/D/E/G beds (18 sites); (2) other sites with less than 200 C/D/E/G beds (20 sites); (3) other general hospital sites (73 sites) and (4) university hospital sites (8 sites). Larger services (in terms of number stays) are represented by a larger circle. Figure 1 in Chapter 2 presents the same information, but it defines the size of a service based on the number of general intensive care beds.

Intensive care services are unevenly distributed across the country, and this distribution only partially correlates with population density. Single site hospitals with fewer than 200 C/D/G/E beds and with one intensive care unit (depicted in orange in Figure 26) are primarily located in sparsely populated areas. On average, they have a slightly higher number of stays than other small hospital sites (depicted in green) (449 stays versus 335 stays).

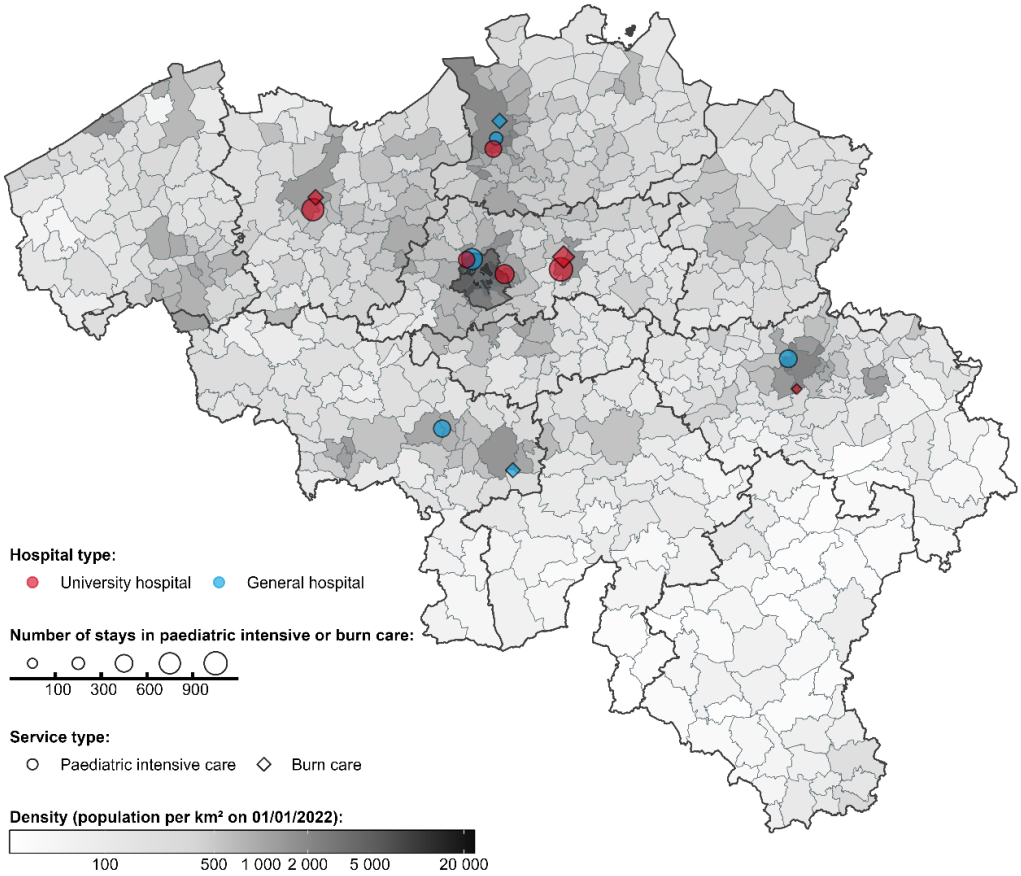
Figure 27 shows the same information for paediatric intensive care and burn care units.

Figure 26 – Geographical distribution of inpatient stays in general intensive care units in Belgium by site type, 2022



Note: 488 stays took place in two hospital sites and 2 stays took place in three hospital sites and are counted once for each site, resulting in a slight overcounting.
Sources: Statbel and Minimal Hospital Data (MZG – RHM).

Figure 27 – Geographical distribution of inpatient stays in paediatric intensive care and burn care units in Belgium, 2022



Sources: Statbel and Minimal Hospital Data (MZG – RHM).

4.1.2.3 Occupancy rates

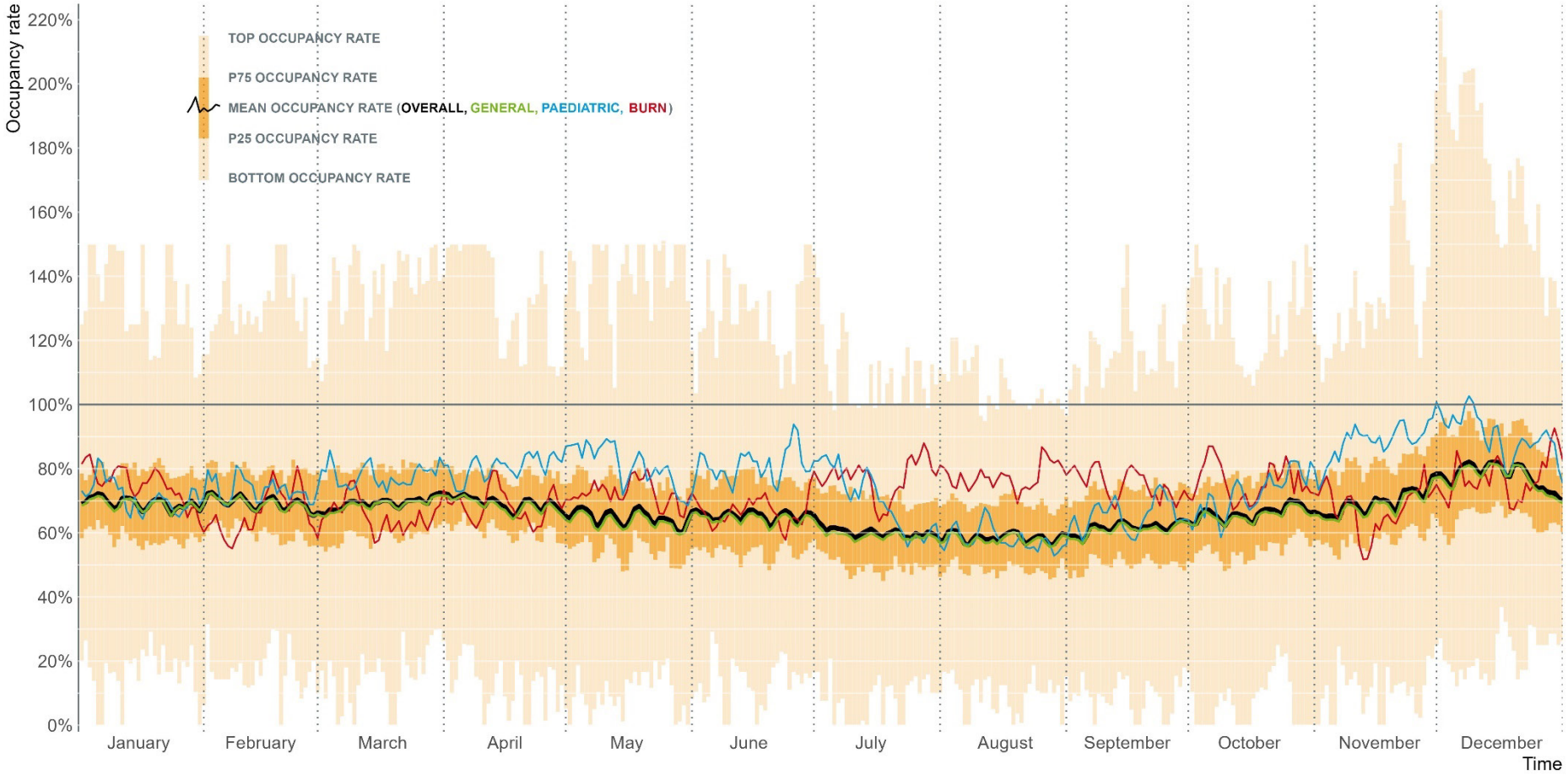
Figure presents the national-level daily bed occupancy rates for intensive care services in 2022. To provide insight into inter-hospital variation, the orange bars in the background represent the distribution of daily occupancy rates across hospital sites. The lighter-coloured bars indicate the full range (minimum to maximum), while the darker-coloured bars denote the interquartile range (P25–P75). The bold black line shows the national mean daily occupancy rate. Superimposed on this are the mean daily occupancy rates for general intensive care (green), paediatric intensive care (blue), and burn care (red). The black and green lines closely overlap, reflecting that the majority of ICU beds and activity pertain to general intensive care.

NATIONAL OCCUPANCY RATE AVERAGED 67%, WITH A PEAK IN DECEMBER

On average, the national daily ICU occupancy rate in 2022 was 67%, remaining relatively stable throughout the year, generally fluctuating between 60% and 70%, with a pronounced increase in late November and December, when it peaked at around 80%.

Occupancy rates in general intensive care closely mirrored the national trend, with an average rate of 66%. In contrast, paediatric and burn care units recorded higher average rates of 76% and 72%, respectively. Due to the smaller number of beds in these units, occupancy rates displayed greater volatility, with occupancy rates in paediatric intensive care units exceeding 100% on four separate days.

Figure 28 – Daily average bed occupancy rate in intensive care services at the national level, 2022



Source: Minimal Hospital Data (MZG – RHM).

Figure 29 – Distribution and mean bed occupancy rate in general intensive care units, ordered by region and number of stays in general intensive care, 2022



Source: Minimal Hospital Data (MZG – RHM).

MARKED INTER-HOSPITAL VARIATION, ESPECIALLY DURING PEAK PERIODS

As shown by the orange bars, there is substantial heterogeneity in occupancy across hospital sites. This variability is most pronounced during the December peak but is also evident throughout the year. With the exception of the summer months, the maximum observed occupancy consistently exceeded 100%, demonstrating that some services were operating beyond their licensed capacity. In December, the 75th percentile approaches the 100% threshold, indicating that nearly one in four intensive care services was operating at or above licensed bed capacity during that period. Conversely, on most days throughout the year, a quarter of intensive care services (the lowest 25%) recorded occupancy rates below 60%.

Clear seasonal variation in occupancy rates is observed. Burn care units exhibit higher activity in summer and early autumn, a pattern opposite to that of general and paediatric intensive care units. Paediatric intensive care units show elevated occupancy between March and early July, and again in November and December, closely aligning with the epidemiological curve of respiratory infections in young children.[26] In 2022, increased RSV activity was recorded between March and early July and again in November-December, while influenza-like illness peaked in March-April and December. Also in general intensive care units there is a seasonal trend, with occupancy patterns aligning with respiratory infection peaks in older adults (65+). Specifically, RSV peaked in December, while influenza-like illness was increased in March-April and December. The impact of COVID-19 peaks on occupancy rates in intensive care services appeared limited, with waves in 2022 occurring in January-early February, March, July, and December.

WEEKDAY–WEEKEND DIFFERENCES ARE LIMITED

A limited weekday-weekend pattern was observed, with slightly lower occupancy rates during weekends. This suggests that fluctuations in intensive care activity are only marginally influenced by reductions in planned care over the weekend.

LOWER OCCUPANCY AND GREATER VARIABILITY IN SMALLER HOSPITAL SITES

Figure 29 displays the distribution of daily bed occupancy rates in general intensive care units across individual hospital sites, disaggregated by region and arranged by the number of stays. Each vertical bar represents one hospital site and shows the range (minimum to maximum), interquartile range (P25-P75), and mean occupancy rate (white diamond) over the year. Colours reflect the number of licensed C, D, E, G beds at each site, with primary sites of university hospitals highlighted in red.

No substantial regional differences are observed in mean daily occupancy rates. However, they increase with hospital size. University hospital sites report the highest mean occupancy (74%), followed by hospital sites with over 450 licensed beds (69%). In contrast, sites with less than 200 beds average 61%, with other size categories averaging around 64%.

Both high and low extremes are common, suggesting that some hospital sites face persistent capacity pressures while others operate with considerable reserve capacity. Approximately 59% of intensive care services (75 out of 119 sites) exceed 100% occupancy at least once during the year, a trend most frequent in smaller hospitals. At the upper end, 5% (6 out of 119 sites) record a 75th percentile above 100%, suggesting they operated over licensed capacity for more than 90 days. At the lower end, 71% (84 out of 119 sites) report minimum occupancy below 30%, almost exclusively in sites with fewer than 450 beds. Additionally, 4% (5 out of 119 sites) have a 25th percentile below 30%, indicating prolonged low occupancy.

Overall, the pattern indicates that smaller hospital sites with fewer licensed beds and lower ICU activity exhibit greater variability in occupancy. This is most evident in hospital sites with ≤200 beds and those with 200-300 beds, where minimum and maximum occupancy values are more extreme and interquartile ranges wider. In contrast, variability is significantly lower in sites with more than 450 beds and in university hospital sites. A similar trend is observed when categorising by general intensive care bed size, with occupancy rates more stable in units with over 40 beds.

4.1.2.4 Patient profile of inpatient stays in intensive care services

LARGE AGE AND GENDER DIFFERENCES IN USE OF INTENSIVE CARE SERVICES

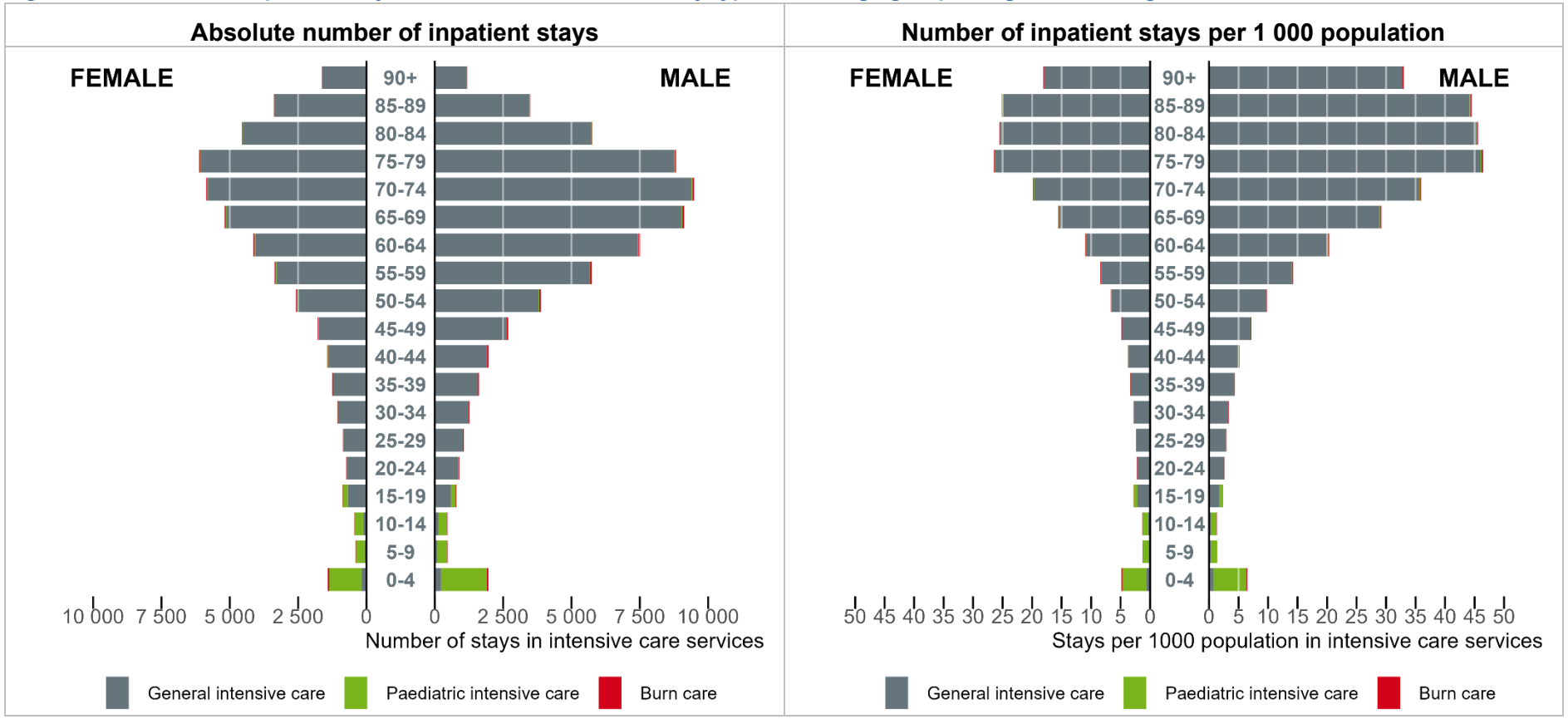
The left panel of Figure 30 shows the absolute number of inpatient stays by age group and gender and type of unit in Belgium in 2022; the right panel shows the number of stays per 1 000 population.

The number of stays in general intensive care units increases with age, except for the oldest age groups. This pattern applies to the absolute number of stays and to the number per 1 000 population. Patients aged between 60 and 79 account for just over half of all general intensive care stays, while those aged 80 and above represent an additional 18%.

The number of stays per 1 000 population is less than 10 for female patients until the age of 59, and until the age of 54 for male patients. From these age groups onwards, the number of patients per 1 000 population rapidly increases to a maximum of 26 for female patients between 75 and 79 years old, and to 46 for male patients of the same age. Also for the oldest age groups, the number of stays per 1 000 population is very different between male and female patients: for female patients the number remains about 25 until the age of 90, while for male patients it is approximately 45 also until the age of 90.

In 2022, 56.4% of stays in paediatric intensive care concerned children between 0 and 4 years old. In burn care units, there is a more equal distribution of age.

Figure 30 – Number of inpatient stays in intensive care services by type of unit, age group and gender in Belgium, 2022



Note: Some stays passed through different types of units and are counted in each type of unit.
Source: Minimal Hospital Data (MZG – RHM).

ORIGINS AND DESTINATIONS OF INTENSIVE CARE PATIENTS

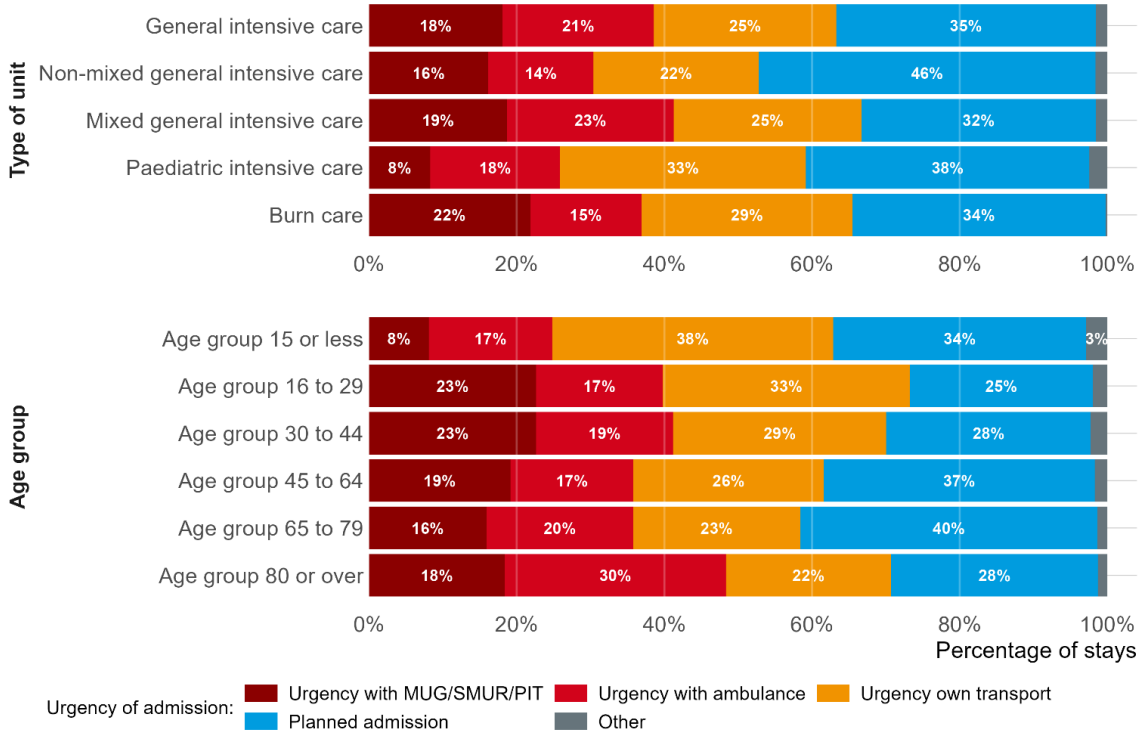
It is important to note that a stay in intensive care is defined as any hospitalisation that includes an admission to a general intensive care, paediatric intensive care or burn care unit at any point during the stay. Consequently, the interpretation of variables such as the urgency of admission (Figure 31), place of admission (Figure 32), or discharge disposition (Figure 33) may not necessarily directly relate to the use of intensive care services but is instead reflective of the entire hospitalisation.

Figure 31 shows the urgency of admission by type of unit and age categories. The urgency is derived from the mode of transport to the hospital and from the distinction between a planned and unplanned stay. The mode of transport can be own transport, an ambulance or a mobile urgency group (MUG – SMUR) / paramedical intervention team (PIT).

The share of each mode of transport and the share of planned versus unplanned stays largely differ between type of unit and between age categories. The share of planned stays is higher for paediatric intensive care (38%) than for general intensive care (35%) and burn care (34%), and ranges from 25% for the age group 16 to 29 years to 40% for the age group 65 to 79 years. The mobile urgency group/PIT is the least used mode of transport for children (cf. age group and paediatric intensive care). For other age groups as well as for general intensive and burn care, the proportion of admissions via the mobile urgency group or PIT varies between 16% and 23%. For the three types of intensive care and for all age groups except the oldest group (80 or over) patients mainly arrive at the hospital by private transport, this is particular the case for the youngest age group (38%). The ambulance is the most commonly used mode of transport for the oldest age group (30%).

General intensive care units are divided into mixed and non-mixed units, where non-mixed refer to a specialised, medical or surgical unit. The share of planned admissions is substantially larger for hospital stays including a stay in a non-mixed (46%) versus a mixed general unit (32%). The opposite holds for ambulance as the mode of transport: 14% for non-mixed versus 23% for mixed general units.

Figure 31 – Urgency of inpatient stays in intensive care services by type of unit and age in Belgium, 2022



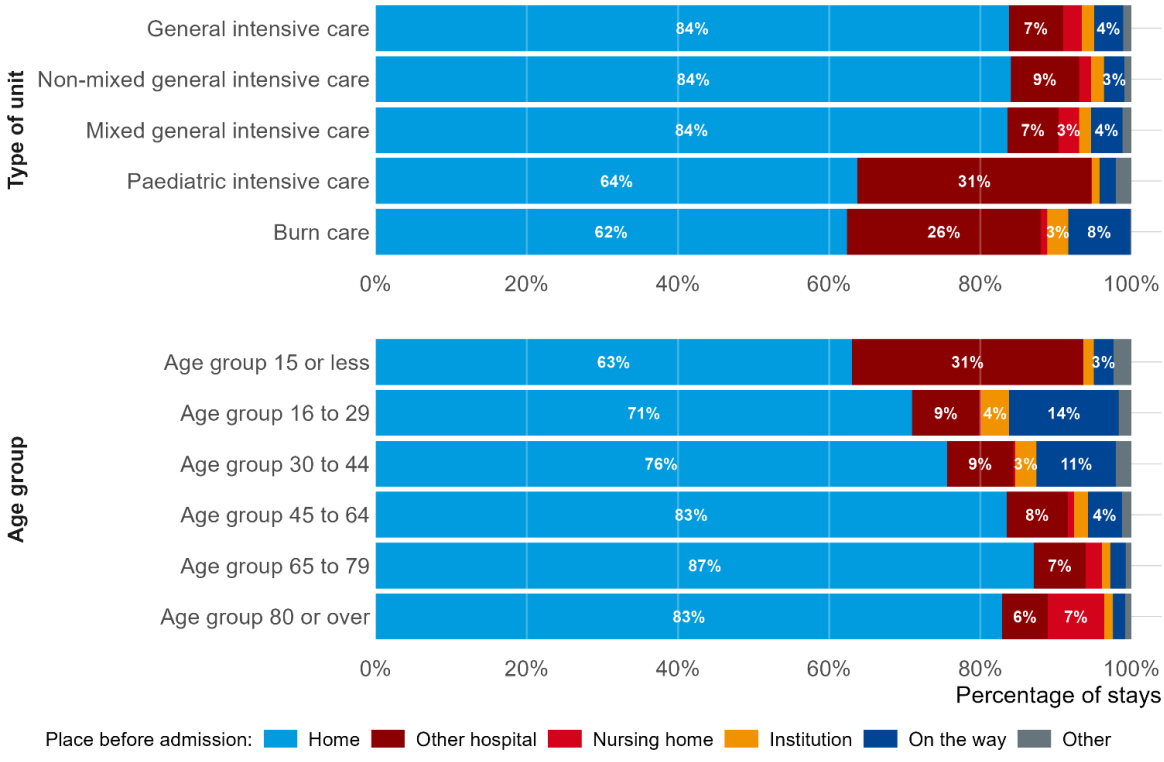
Source: Minimal Hospital Data (MZG – RHM).

Figure 32 and Figure 33 show the place before and after admission of inpatient stays with part of the stay in intensive care.

For most patients, the place of residence before admission is home. The proportion of patients coming from home increases with age (except for the oldest age group) and is significantly higher for admissions to a general intensive care unit (84%) compared to a paediatric intensive care unit (64%) or a burn care unit (62%). Patients in paediatric intensive care units and burn care units are more frequently transferred from another hospital. While the transfer rate ranges from 7% to 9%, it rises to 31% for children. There is no difference in the place of residence before admission between non-mixed and mixed general intensive care units. Among patients aged 16 to 44 years, 11% to 14% are admitted while on the way. For other age groups, this percentage is much smaller. For burn care unit admissions, the proportion is 8%. Additionally, 7% of patients aged 80 and older are admitted from a nursing home.

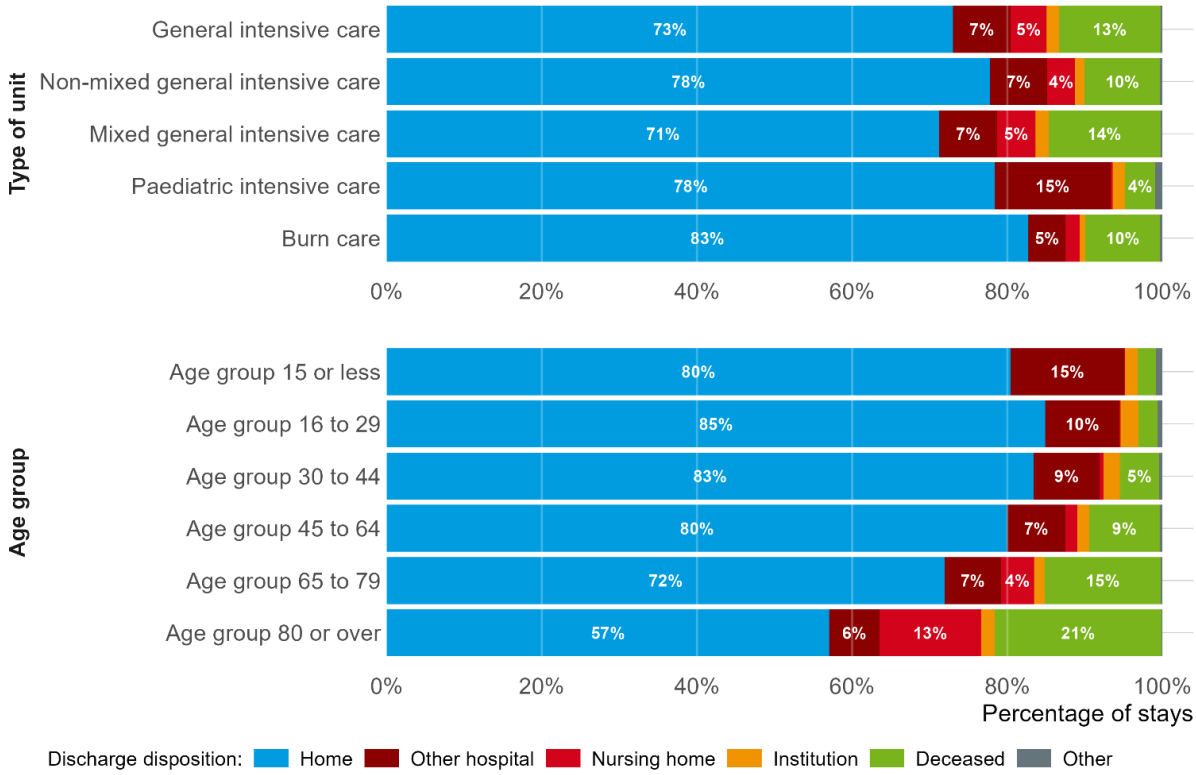
Most patients (ranging from 71% for mixed general units to 83% for burn care units) are discharged home after their hospital stay. There is a slight difference between mixed (71%) and non-mixed (75%) general units. However, for the oldest age group, this proportion is only 57%. A notable finding when comparing Figure 32 and Figure 33 is that this percentage is substantially smaller than the proportion of patients admitted from home (83%). Additionally, patients aged 80 or older are more frequently discharged to a nursing home (13%) than admitted from one (7%). As expected, the percentage of patients that die during their hospital stay increases with age, up to a share of 21% among patients aged 80 or older (see also Chapter 6).

Figure 32 – Origin of inpatient stays in intensive care services by type of unit and age in Belgium, 2022



Source: Minimal Hospital Data (MZG – RHM).

Figure 33 – Discharge dispositions of inpatient stays in intensive care services by type of unit and age in Belgium, 2022



Source: Minimal Hospital Data (MZG – RHM).

4.1.2.5 Clinical profile of patients

CLINICAL PROFILE OF PATIENTS IS MORE DIVERSE IN GENERAL INTENSIVE CARE THAN IN PAEDIATRIC INTENSIVE CARE OR IN BURN CARE UNITS

Hospital stays in intensive care services can be classified into two broad categories: stays with a medical treatment and stays with a surgical treatment (see Figure 34). For general intensive care and burn care units, the proportion of surgical treatments is about 55% in 2022, while for paediatric intensive care units this share is only 42%. For general intensive care and paediatric intensive care units, the mean shares were more or less the same in 2019, while for burn care units the proportion of surgical treatments was lower than in 2022. The share of surgical treatments in general intensive care units is higher in (most) university hospitals (see Figure 35). The median value was higher in Brussels (50.5%) than in Flanders (47.0%) and in Wallonia (42.1%) in 2022. Contrary to the mean value, the median value was lower in 2022 than in 2019 in the three regions.

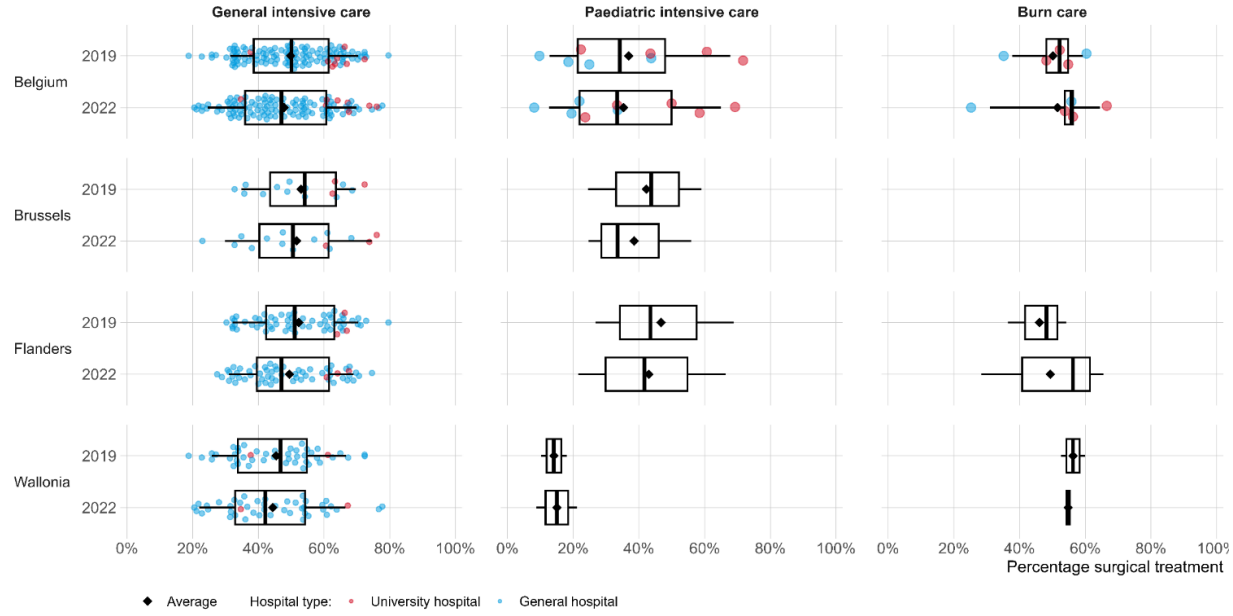
Figure 36 shows that the share of surgical interventions increases by age until the age of 80. The highest share is found in the age group of 65 to 79 years. Moreover, for age groups below 45 years, and particularly the youngest age group, medical treatments accounted for more than half of the activity in 2022, with their share increasing between 2019 and 2022. However, given that younger patients represent a smaller share of overall activity (see section 4.1.2.4), this increase is not reflected in the average values, except for paediatric intensive care. For all age groups, the share of surgical treatments in non-mixed general intensive care units is larger than the share of medical treatments in these units.

Figure 34 – Medical or surgical treatment by type of unit in 2019 and 2022



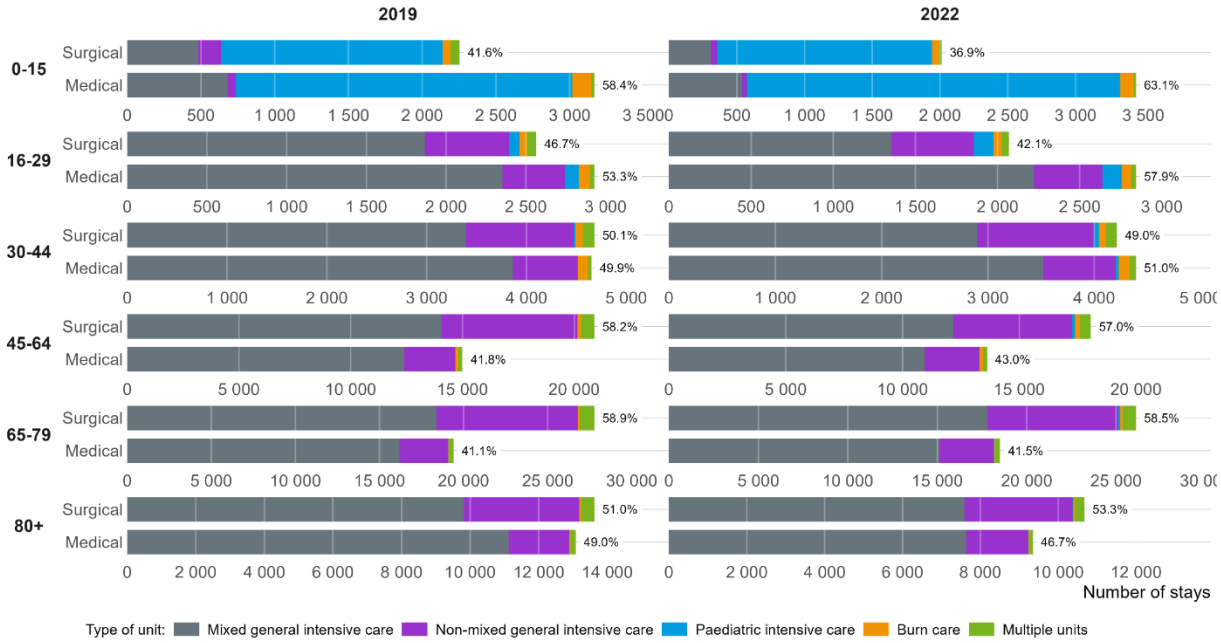
Source: Minimal Hospital Data (MZG – RHM).

Figure 35 – Distribution of share of surgical treatment in intensive care services by type of unit, hospital site and region in 2019 and 2022



Note: Boxes are drawn from first quartile to third quartile with the median as inside line, whiskers are drawn from the 5th to the 95the percentile
Source: Minimal Hospital Data (MZG – RHM).

Figure 36 – Medical or surgical treatment by type of unit and age group in 2019 and 2022



Source: Minimal Hospital Data (MZG – RHM).

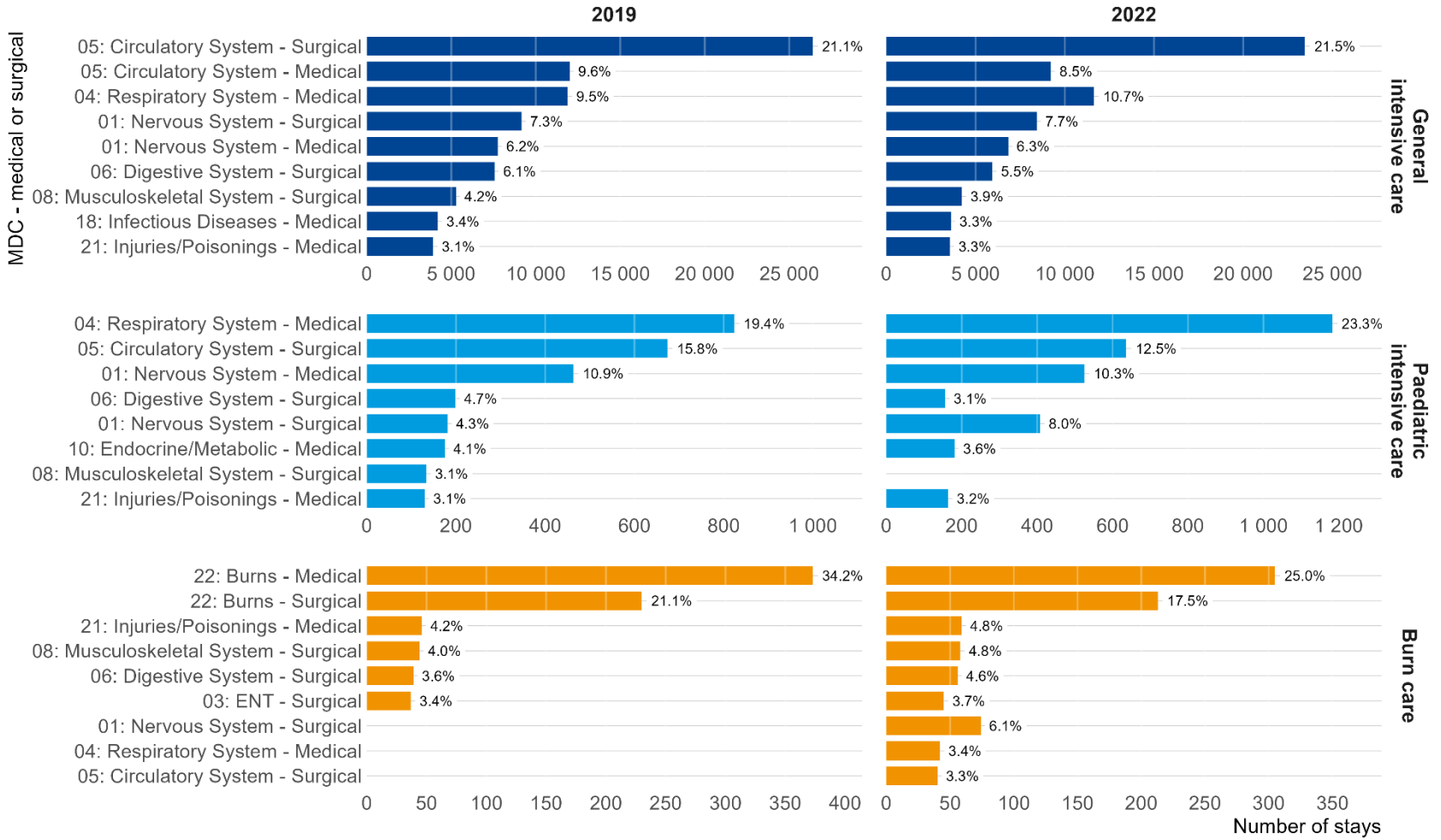
A further classification into MDCs shows very different profiles depending on the type of unit (see Figure 37). For MDCs which represent at least 3% of activity per type of unit, most treatments were related to the circulatory system (surgical) in general intensive care units (21.1% in 2019 and 21.5% in 2022), to the respiratory system (medical) in paediatric intensive care units (19.4% in 2019 and 23.3% in 2022) and to burns (medical: 34.2% in 2019 and 25.0% in 2022; surgical: 21.1% in 2019 and 17.5% in 2022) in burn care units. Some notable differences in the proportion of MDCs between the two years are observed for treatments related to the nervous system (surgical) in paediatric intensive care units (from 4.3% to 8.0%), for burns in burn care units (medical and surgical), and for three types of treatment in burn care units: nervous system (surgical: from <3% to 6.1%), respiratory system (medical: from <3% to 3.4%) and circulatory system (surgical: from <3% to 3.3%). It should be kept in mind, however, that the number of stays in burn care units is relatively low.

At the APR-DRG level (see Figure 38) examining APR-DRGs that represent at least 2% of activity in a type of unit, we identify the following significant findings. In general intensive care units, there is no strong concentration of activity. In 2022, the most common APR-DRG only represented 3.9% of all stays which means that the reasons for admission to intensive care are very diverse. In contrast, in paediatric intensive care and burn care units, a limited number of APR-DRGs are more prominently present (APR-DRG 138 'bronchiolitis & RSV pneumonia' in paediatric care units; APR-DRG 844 'partial thickness burns w/o skin draft' and APR-DRG 842 'burns with skin graft except extensive 3rd degree burns' in burn care units).

The importance of the MDCs and APR-DRGs varies by age group (see Figure 39). In 2022, MDC 21 (injuries/poisoning – medical) is the most frequent MDC in general intensive care units for patients aged 16-29 years (17.1%) and 30-44 years (9.6%), primarily due to APR-DRG 817 (intentional self-harm and attempted suicide). Among patients aged 45 years and older, MDC 05 (circulatory system – surgical) becomes the most frequent MDC (more than 20%), while it remains below 10% in younger age groups. The underlying APR-DRGs, however, differ by age group with heart failure more important among patients over 80 years and coronary bypass or cardiac valve procedures more important in patients aged 45 to 79 years. Among the youngest age group (0-15 years), MDC 04 (respiratory system – medical) accounted for 24.7% of stays in 2022 (all types of units), particularly due to bronchiolitis, RSV pneumonia and other pneumonia. In 2019 this share was only 18.4%. Diseases of the nervous system, both medical (e.g. seizures) and surgical (e.g. craniotomy) appear among the top 6 MDCs for all age groups.

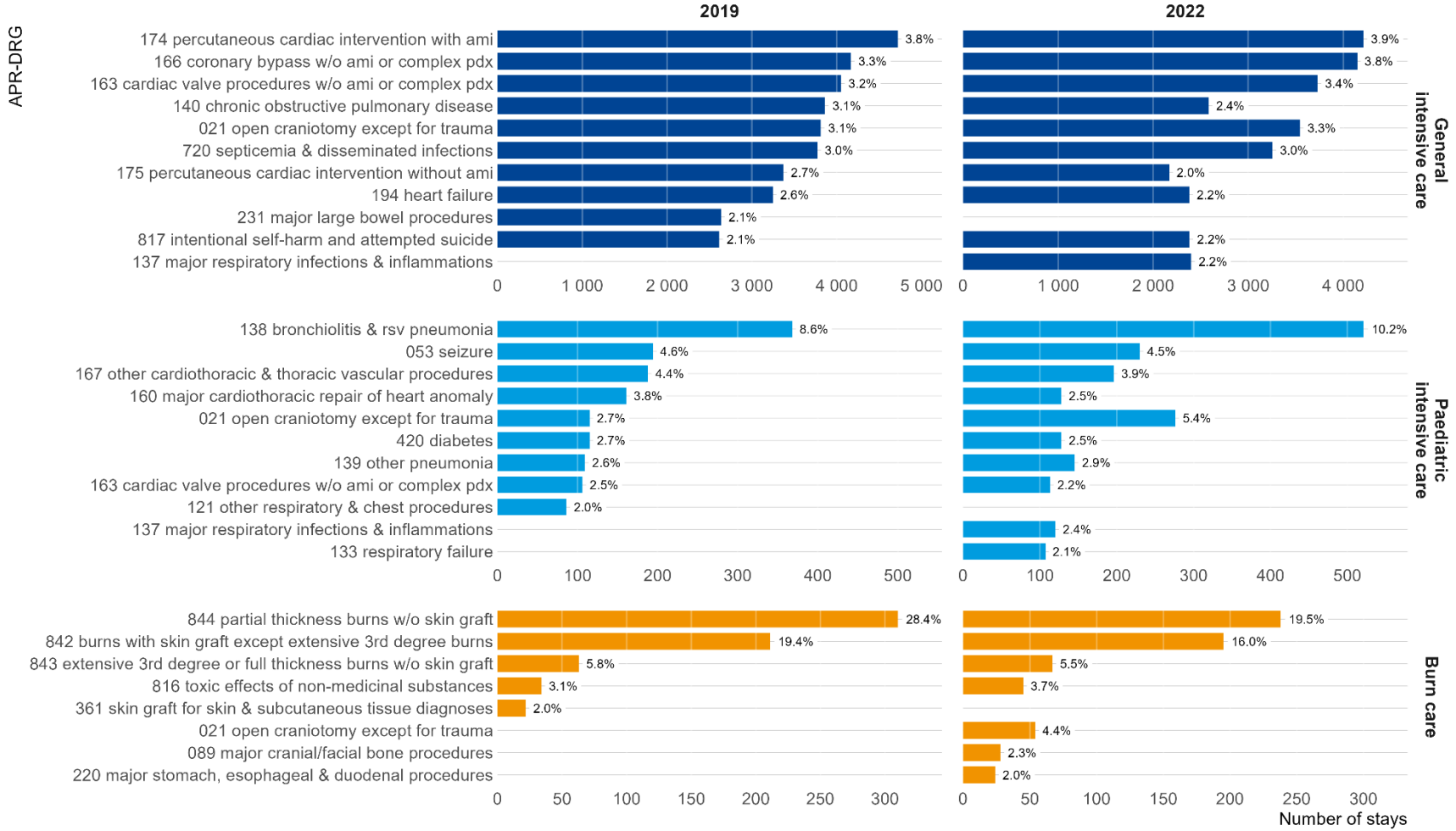
The share of care that is provided in mixed versus non-mixed general intensive care units, largely differs between MDCs and APR-DRGs. In general, the share of care provided in non-mixed general intensive care units is larger for MDC 05 (circulatory system – surgical), APR-DRG 174 (percutaneous cardiac intervention with AMI), APR-DRG 166 (coronary bypass w/o AMI or complex PDX), APR-DRG 183 (percutaneous structural cardiac procedures) or APR-DRG 163 (cardiac valve procedures w/o AMI or complex PDX).

Figure 37 – Most frequent MDCs (3% activity share or more) for inpatient stays by type of unit, ordered by activity share in 2019



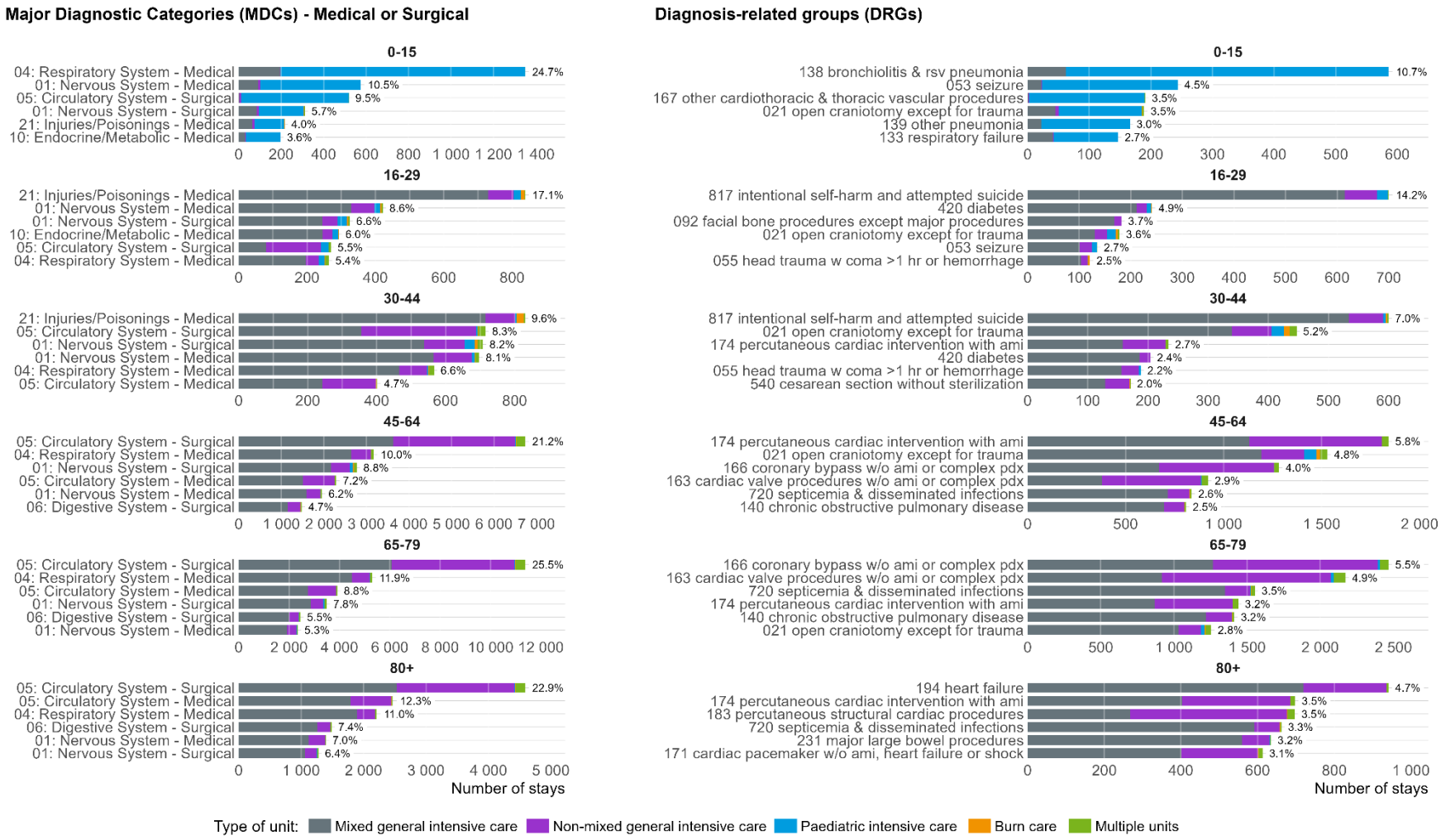
Source: Minimal Hospital Data (MZG – RHM).

Figure 38 – Most frequent APR-DRGs (2% activity share or more) for inpatient stays by type of unit, ordered by activity share in 2019



Source: Minimal Hospital Data (MZG – RHM).

Figure 39 – Most frequent medical / surgical MDCs and APR-DRGs by age group, ordered by activity share in 2022



Source: Minimal Hospital Data (MZG – RHM).

SEVERITY OF ILLNESS IS HIGHER IN GENERAL INTENSIVE CARE UNITS

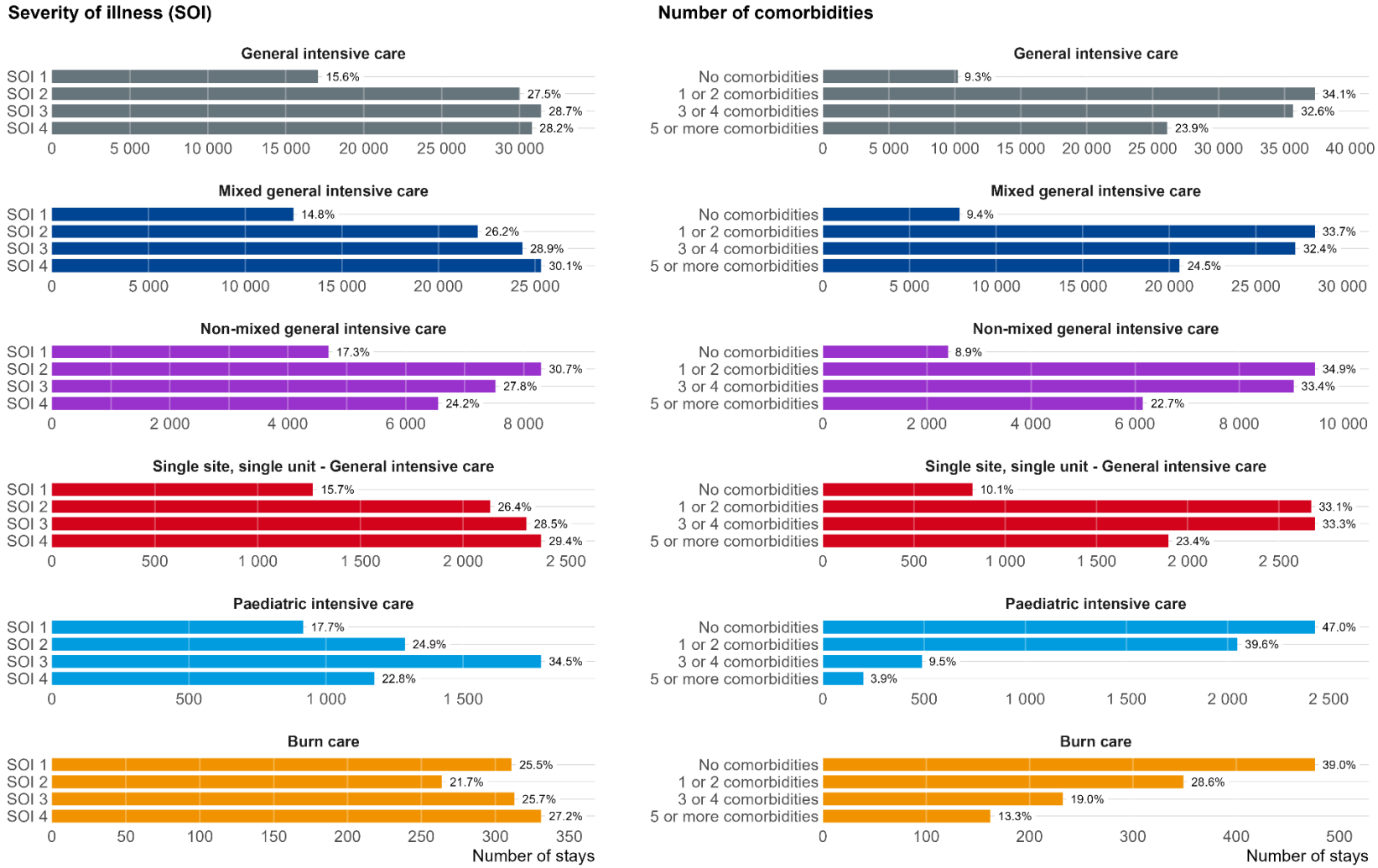
The proportion of stays with SOI-level 1 is substantially lower in general intensive care (15.6%) and paediatric intensive care units (17.9%) than in burn care units (25.5%) (see Figure 40). However, when we combine the two lowest and two highest groups, then the proportion of both groups is more or less the same across unit types (56.9% in SOI-3 & 4 for general and paediatric intensive care and 52.9% for burn care units). Within general intensive care units, there is a slight difference in the share of SOI-levels between mixed and non-mixed units (for example, 24.2% SOI-4 in non-mixed units versus 30.1% in mixed units). When we combine the two lowest and two highest groups, then the proportion of SOI-1 and 2 is 41% in mixed units versus 48% in non-mixed units. The proportion of stays per SOI-level in single-site single-unit intensive care services is comparable to the proportion in mixed general intensive care units.

When severity of illness is measured by the number of comorbidities, differences between unit types are more pronounced. While for only 9.3% of stays in a general intensive care unit patients have no comorbidities, this percentage amounts to 47.5% for paediatric intensive care and to 39.0% for burn care units. And conversely, the number of patients with multiple comorbidities (≥ 3) is much higher in general intensive care units (56.5%) than in both other types (12.9% in paediatric intensive care and 32.3% in burn care). The significant difference between general and paediatric intensive care units is undoubtedly linked to the different age profile of patients in both unit types, as the number of comorbidities typically increases with age. Patients in burn care units often include younger individuals, such as those involved in accidents, who are less likely to have multiple health conditions. Burn care units primarily focus on treating acute injuries caused by burns. Mixed and non-mixed general intensive care units yield similar results.

Figure 41 shows the same information but with the results split by age group. The share of stays (all types) with SOI-level 1 and 2 decreases as patients get older, except for the youngest age group (from 59.7% for patients aged 16 to 29 years to 35.6% for patients aged 80 years and older). For patients aged 65 and older the share of SOI-level 4 is more than 30%.

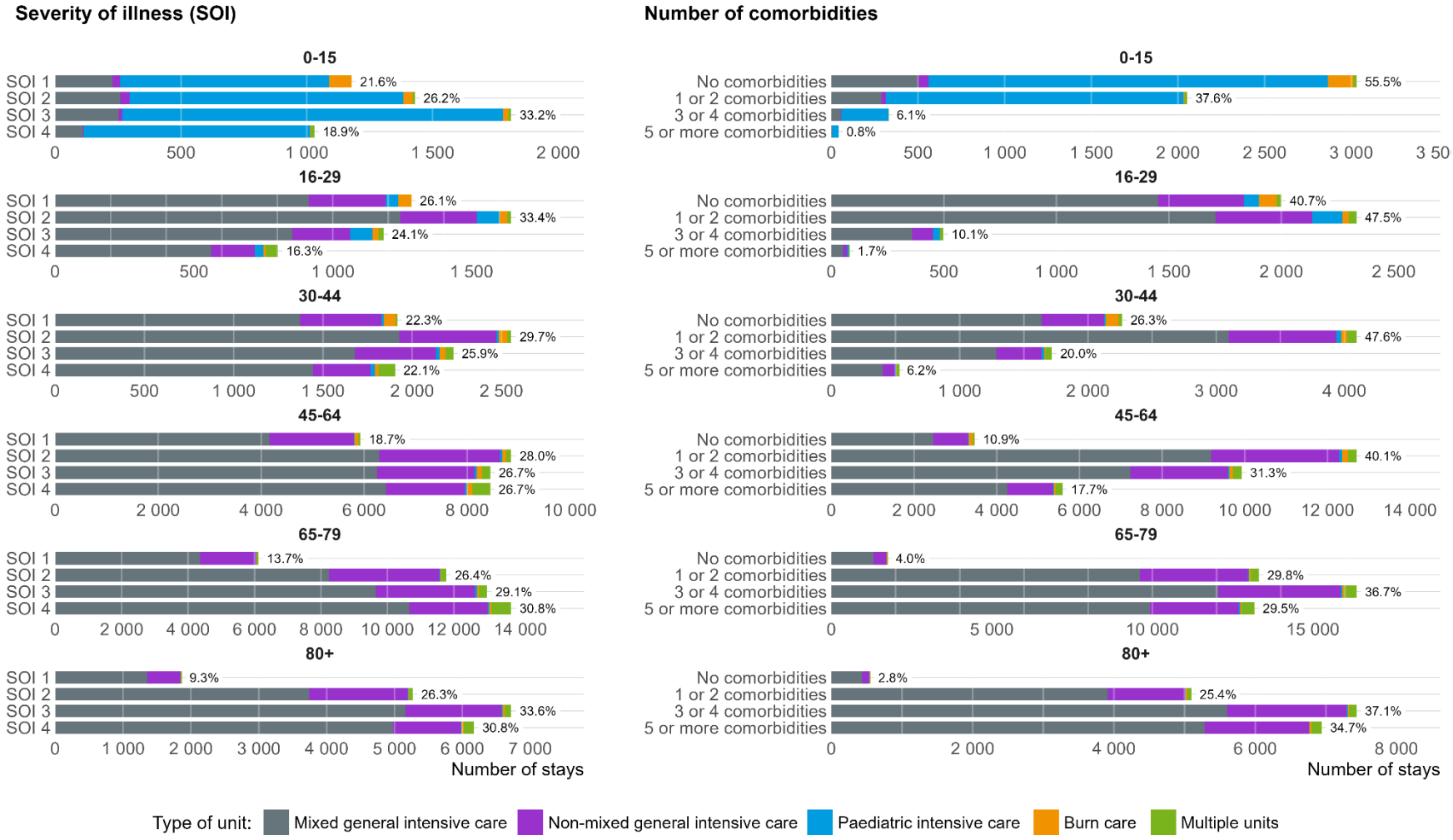
A similar pattern emerges when severity of illness is assessed based on the number of comorbidities. While 55.6% of patients under 16 have no comorbidities, this proportion drops to only 2.8% among those aged 80 and older. Up to the age of 45, approximately three out of four patients have a maximum of two comorbidities. However, beyond this age, the proportion declines sharply, reaching about one out of four patients in the oldest age group.

Figure 40 – Severity of illness and number of comorbidities of inpatient stays by type of unit, 2022



Source: Minimal Hospital Data (MZG – RHM).

Figure 41 – Severity of illness and number of comorbidities of inpatient stays by type of unit and age group, 2022

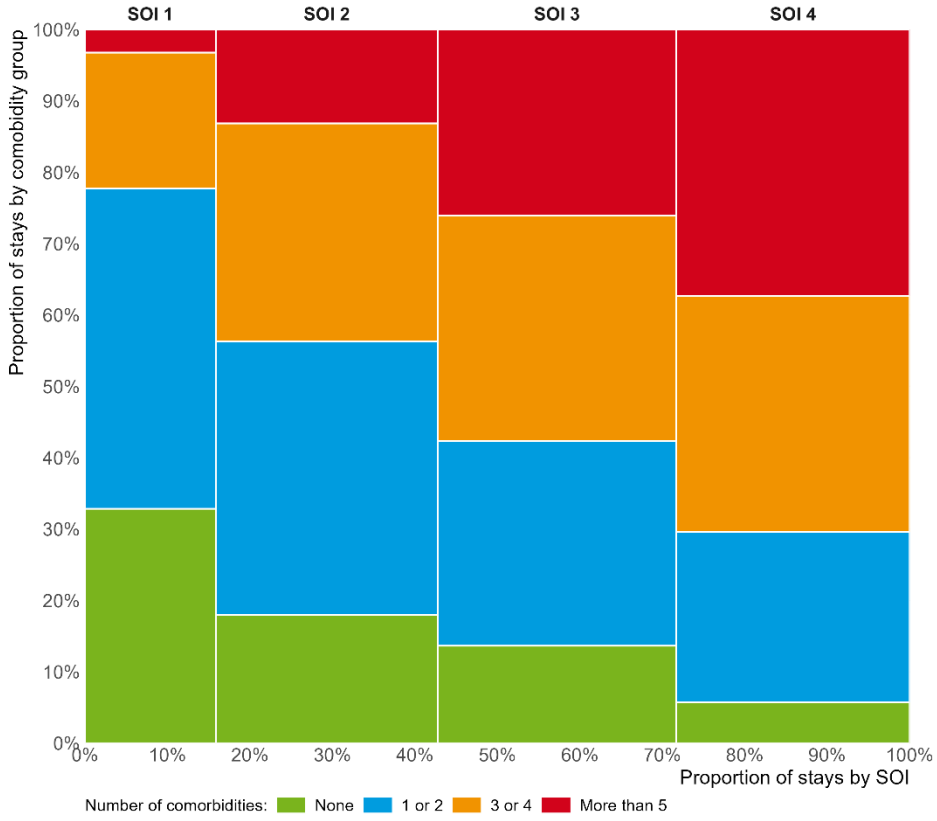


Source: Minimal Hospital Data (MZG – RHM).

ONLY A MODERATE OVERLAP BETWEEN SOI-LEVEL AND NUMBER OF COMORBIDITIES

Figure 42 combines both measures of severity of illness without distinction between the three unit types (general intensive care, paediatric intensive care and burn care). We discuss some notable findings. First, all SOI-levels are present in all categories of number of comorbidities but, as expected, there is a greater overlap between the lowest SOI-levels and the lowest number of comorbidities (and the highest SOI-levels and the highest number of comorbidities). Second, the proportion of stays with patients having 3-4 comorbidities is more or less the same for SOI-levels 2, 3 and 4. Third, the proportion of stays with patients having a maximum of two comorbidities is still 42.4% in stays with SOI-3 and 29.6%% in stays with SOI-4. And vice versa, in stays with SOI-1 or SOI-2 the proportion of patients having three or more comorbidities is 22.3% and 43.7%, respectively.

Figure 42 – Relation between severity of illness and number of comorbidities for intensive care services, 2022



Source: Minimal Hospital Data (MZG – RHM).

4.1.2.6 Length of stay in intensive care

MOST SHORT STAYS IN INTENSIVE CARE

Figure 43 illustrates the total length of the hospital stay (top panel), with the duration in intensive care services represented as a subset (bottom panel). For a substantial proportion of stays with at least part of the stay in intensive care, the length of stay is at least 30 days: 13.0% in a general intensive care unit, 8.8% in a paediatric intensive care unit and 20.3% in a burn care unit. A duration in intensive care of at least 30 days, however, is much less frequent: 2.2% in a general intensive care unit, 1.9% in a paediatric intensive care unit and 7.5% in a burn care unit. In general, the share of stays in intensive care decreases as the length of hospital stay increases (all types). Nearly half of the stays have a duration of one or two days in intensive care (54.6% in general intensive care unit, 48.2% in paediatric intensive care unit and 41.0% in burn care unit). The patterns are similar for mixed and non-mixed general intensive care units. In single-site single-unit general intensive care services, there are

relatively more short hospital stays that include intensive care. The distribution of time spent in intensive care shows no major shift between 2019 and 2022, with most stays remaining short and only a slight increase in longer stays (30+ days) (results not shown).

LIMITED VARIABILITY IN LENGTH OF STAY ACROSS HOSPITAL TYPES

Figure 44 shows some variability in time in intensive care services across different hospital types. The median duration in general intensive care units is 1.9 days. In Wallonia, the median duration is somewhat higher (2.04 days) than in Brussels and Flanders (both 1.79 days). The duration is very similar across different types of hospitals, with the type being defined by the number of beds or whether or not it is a university hospital (the median duration varies from 1.79 days to 1.92 days). Also the rest of the distribution is similar between regions and hospitals, except for the p5-value which varies from 0.13 days for medium-sized hospitals and 0.17 days for university hospitals to 0.58 days for large hospitals (>450 licensed beds).

The same conclusion holds for paediatric intensive care units. For burn care units, the distribution of time in intensive care varies between regions and between hospitals, but the results should be interpreted with caution due to the small number of stays.

BUT CLEAR LINK BETWEEN LENGTH OF STAY AND MODE OF TRANSPORT IN GENERAL INTENSIVE CARE UNITS

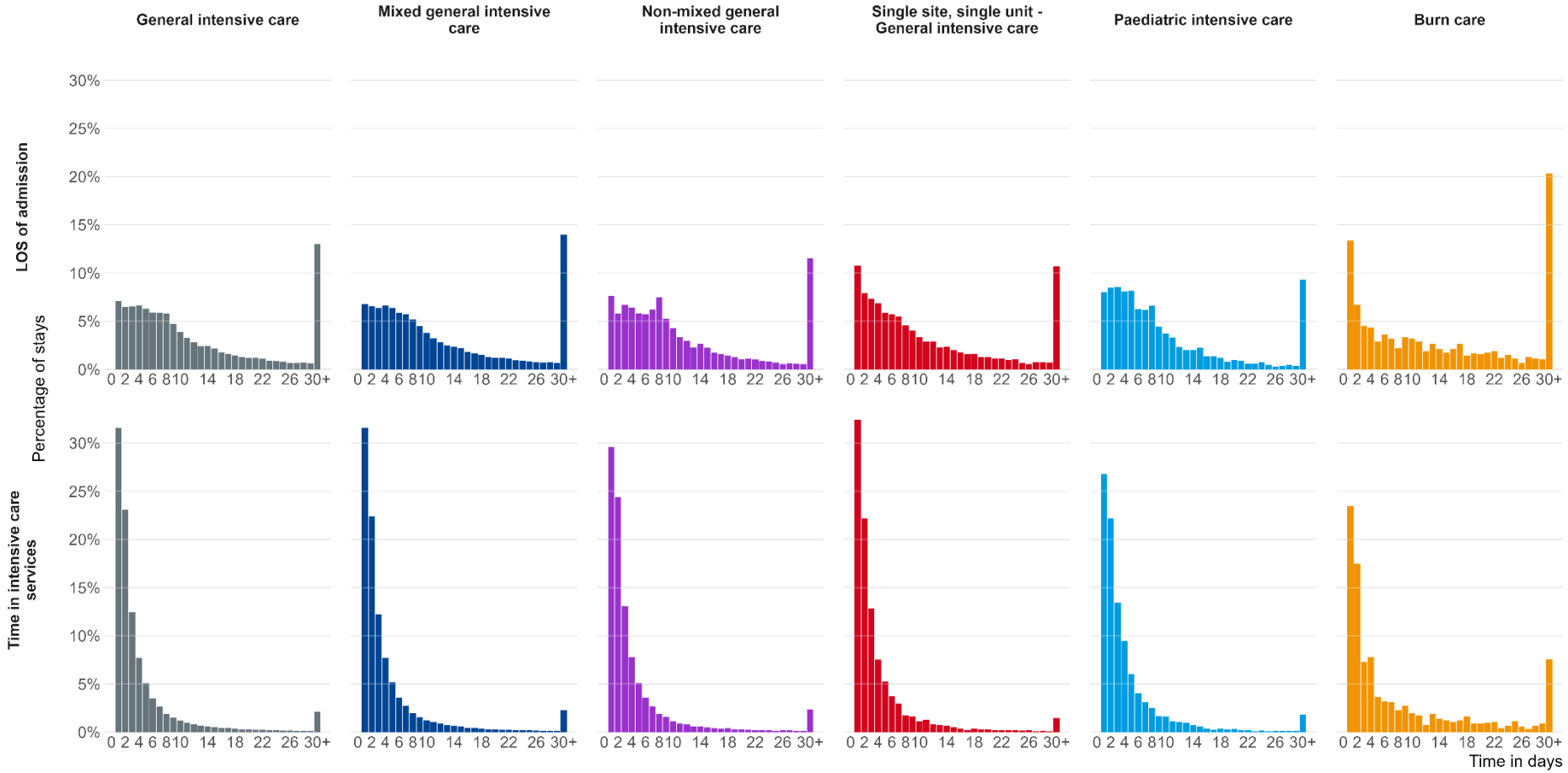
As illustrated by Figure 45, the more urgent the hospital admission, the longer the stay in a general intensive care unit. For example, for a stay with a duration of less than 24 hours in intensive care, the mode of transport to the hospital for 27.2% of stays is an ambulance, mobile urgency group or PIT. This percentage increases with the duration in intensive care to 53.1% for stays of at least ten days. The share of planned admissions ranges from 19.0% to 28.7% for durations of 3 to 9 days, but is substantially higher for stays with a duration of maximum 2 days, reaching as high as 48.4% for a duration of 24 hours or less. The share of own transport ranges from 22.9% to 27.7%. The relationship between mode of transport and length of stay is less evident for paediatric intensive care and burn care units.

INPATIENT MORTALITY INCREASES WITH DURATION IN GENERAL INTENSIVE CARE UNITS

In general intensive care units, higher mortality (with mortality defined by whether the patient survives the hospital stay) is associated with increased time spent in intensive care (see Figure 46). However, this pattern is not observed in paediatric intensive care or burn care units. In 8.7% of stays with a duration of less than 24 hours in intensive care, the patient dies during the hospital stay. This percentage decreases to 7% for stays with a duration in intensive care of two days and then gradually rises to 35.6% for stays with a duration in intensive care of ten days or more.

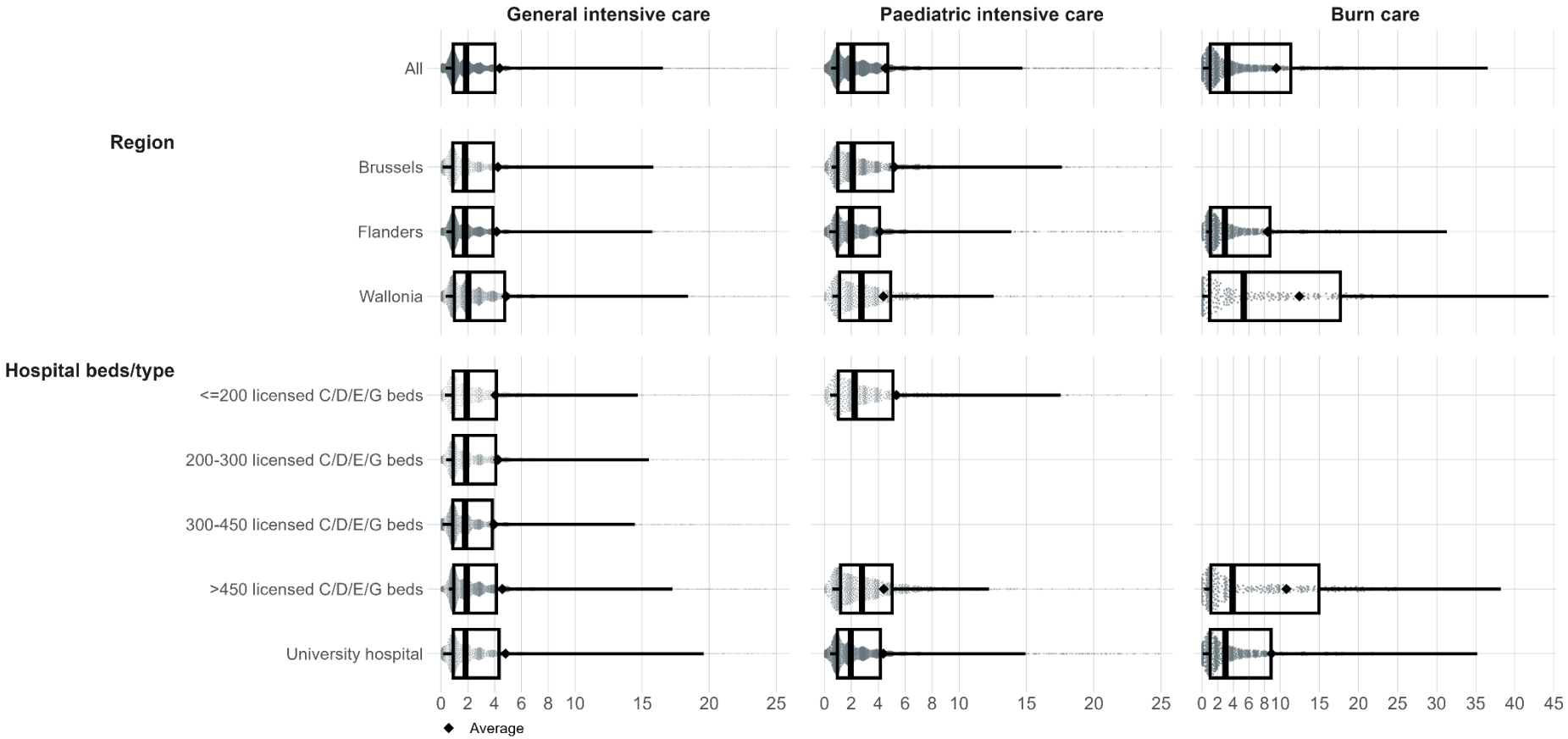
In paediatric intensive care units, the percentage ranges from 1.9% to 3.7%, except for stays with a duration in intensive care of ten days or longer, where it rises to 10.2%. In burn care units, no clear relation between mortality risk and the length of stay is found.

Figure 43 – Length of stay distribution for inpatient stays in intensive care services by type of unit, 2022



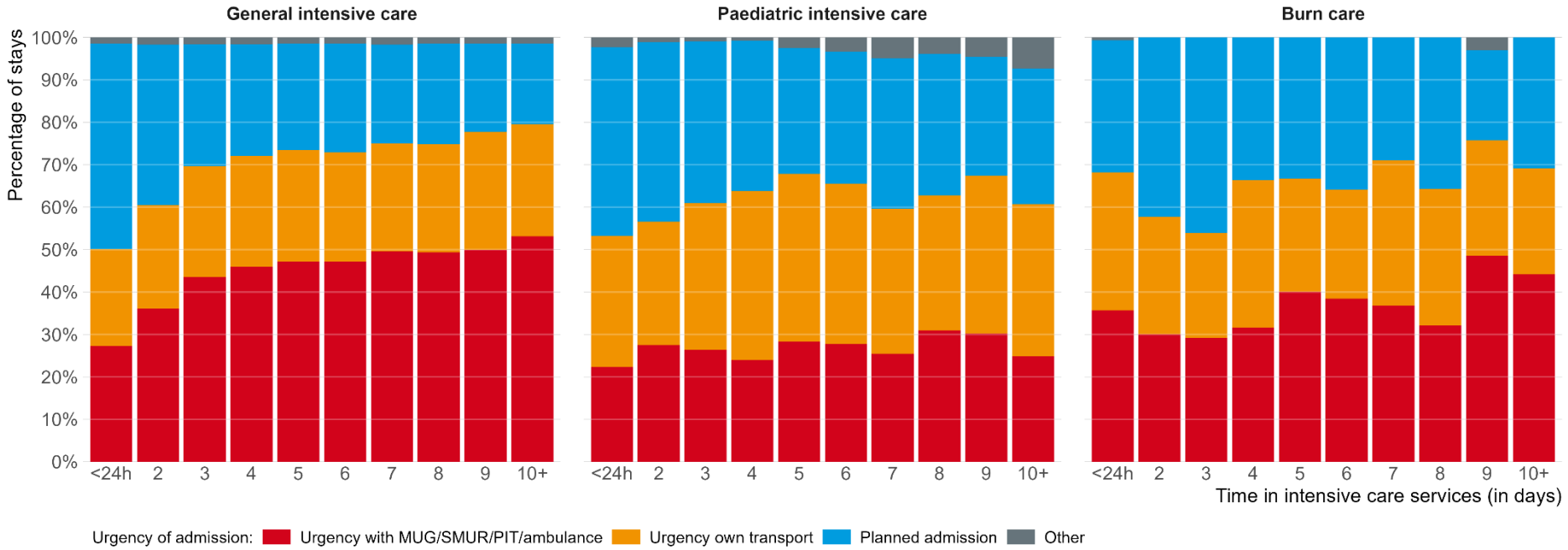
Note: LOS of admission is the length of the entire hospital stay from admission to discharge, not limited to the time spent in the intensive care service. Time in intensive care is the total time spent in intensive care during a hospital stay, which may be interrupted and take place in different units and/or sites.
Source: Minimal Hospital Data (MZG – RHM).

Figure 44 – Distribution of time in intensive care services for inpatient stays by region and hospital type or bed size (licensed C, D, E and G beds), 2022



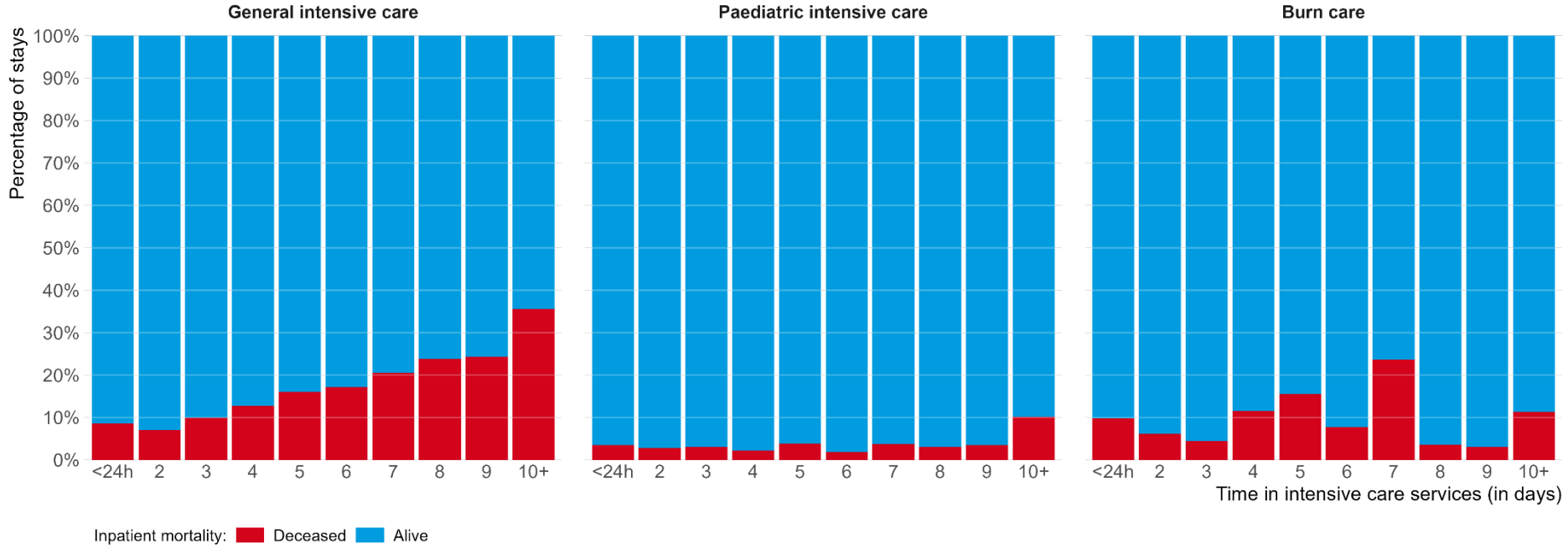
Note: Boxes are drawn from first quartile to third quartile with the median as inside line, whiskers are drawn from the 5th to the 95the percentile
Source: Minimal Hospital Data (MZG – RHM).

Figure 45 – Share of urgent or planned admissions by type of unit and time in intensive care services for inpatient stays in Belgium, 2022



Source: Minimal Hospital Data (MZG – RHM).

Figure 46 – Inpatient mortality by type of unit and time in intensive care services for inpatient stays in Belgium, 2022



Source: Minimal Hospital Data (MZG – RHM).

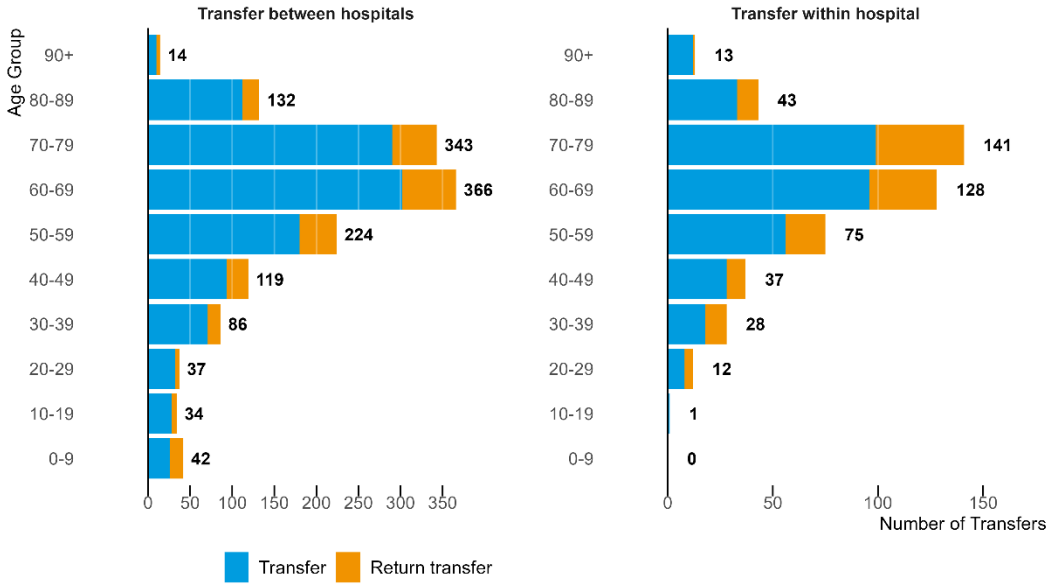
4.1.2.7 Transfers between intensive care services

In 2022 there were 1 875 transfers between intensive care services of different hospital sites. About 75%, or 1 397 transfers took place between hospital sites of different hospitals, while one quarter or 478 transfers took place between sites within the same hospital. A distinction was made between a first transfer between sites and a potential second or higher order return transfer. In total, there were 1 495 first order transfers and 380 return transfers, with a slightly higher percentage of first order transfers in case of a transfer between different hospitals, i.e. 82% (1 144 out of 1 397 transfers) compared to 73% (351 out of 478 transfers) between hospital sites within the same hospital.

TRANSFERS MOST FREQUENT IN 60-79 AGE GROUPS

Figure 47 presents the number of transfers between and within hospitals by age group. Transfers between hospitals (left panel) are most frequent in the 60-69 and 70-79 age groups, with 366 and 343 transfers, respectively. These are followed by the 50-59, 80-89, and 40-49 age groups, in that order. Transfers within hospitals (right panel) are less frequent overall and follow a similar age distribution, except in the youngest age groups (0-20 years), where transfers nearly exclusively occur between hospitals. Return transfers account for a substantial proportion of transfers in the 50-79 age groups. In comparison to the general age distribution of intensive care stays shown in Figure 30, transfers between and within hospitals (Figure 47) occur relatively less frequently in the oldest age groups (80 years and older) – and even in the 70-79 age group – and relatively more frequently in patients aged 30–59 years.

Figure 47 – Number of transfers between and within hospitals by age group, 2022



Source: Minimal Hospital Data (MZG – RHM).

TRANSFERS DRIVEN BY SPECIALISED SURGICAL AND COMPLEX MEDICAL CARE

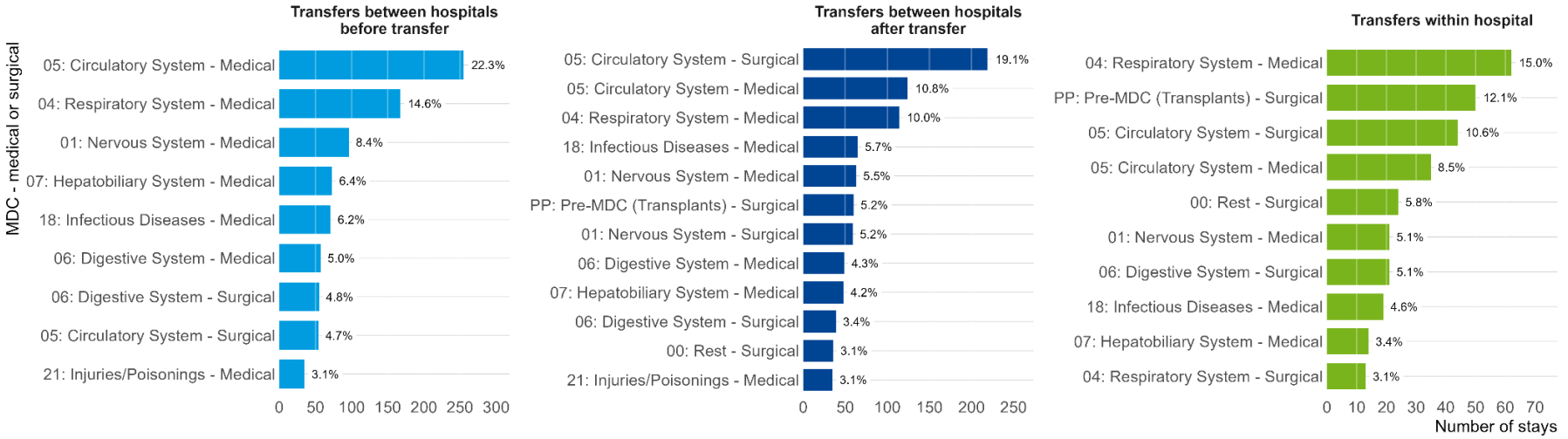
Figure 48 presents the distribution of first transfers (excluding return transfers) between and within hospitals by MDC, distinguishing between medical and surgical admissions. Only combinations representing more than 3% of transfers are shown.

For transfers within the same hospital (right panel), there is a single registration, which results in one MDC being recorded. These transfers most frequently involve patients treated for respiratory system conditions (medical, 15.0%), followed by transplant cases (Pre-MDC, surgical, 12.1%) and circulatory system conditions (surgical, 10.6% and medical, 8.5%).

For transfers between hospitals, there are two separate registrations: one at the sending hospital (‘before transfer’, left panel) and one at the receiving hospital (‘after transfer’, middle panel). The MDC recorded at the receiving hospital (‘after transfer’) is considered the most relevant, as it likely reflects the underlying reason for the transfer. Before transfer, the majority of admissions are classified as medical, with circulatory system conditions (medical, 22.3%), respiratory system conditions (medical, 14.6%), and nervous system conditions (medical, 8.4%) comprising the top three categories. After transfer, a higher proportion of admissions is classified as surgical. Circulatory system conditions (surgical, 19.1%) stand out as the most common MDC, representing almost double the share of the next two categories: circulatory system medical cases (10.8%) and respiratory system medical cases (10.0%).

This distribution highlights that many transfers between hospitals appear to be driven by the need for specialised surgical interventions (cardiac, transplants) or more complex medical care, particularly for circulatory and respiratory conditions.

Figure 48 – Most frequent MDCs (3% activity share or more) for first transfers between and within hospitals, ordered by activity share, 2022



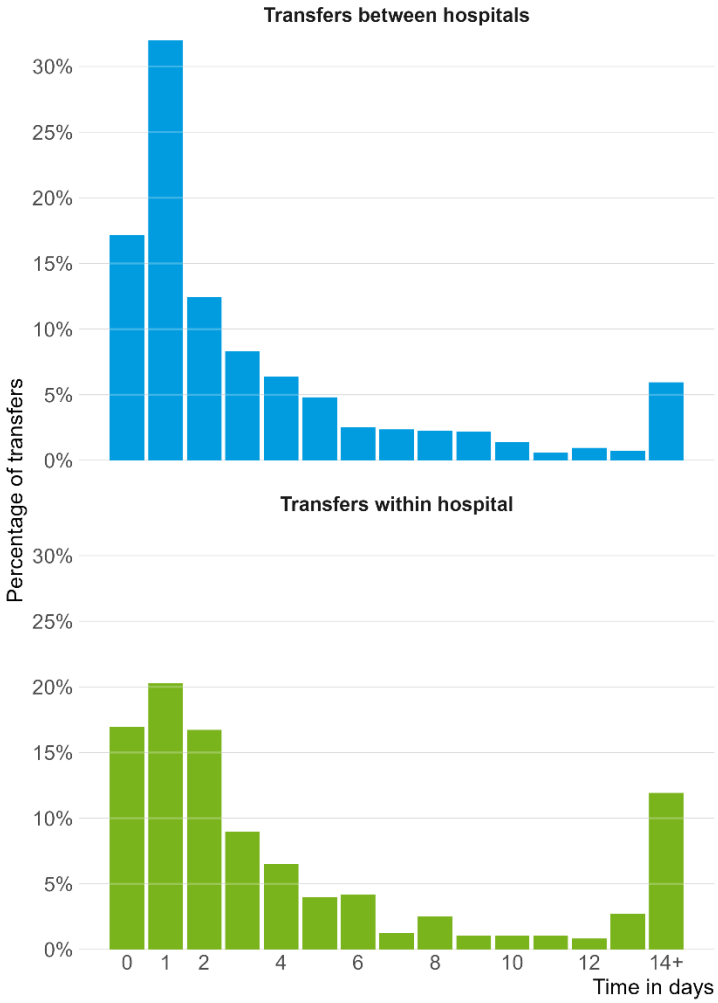
Source: Minimal Hospital Data (MZG – RHM).

MOST INTENSIVE CARE TRANSFERS OCCUR EARLY AFTER ADMISSION

Figure 49 illustrates the distribution of time (in days) from admission to an intensive care service in the sending hospital to the point of transfer to intensive care services in the receiving unit. Only first transfers are considered. The top panel represents transfers between sites of different hospitals, while the bottom panel shows transfers between sites within the same hospital.

Most transfers occur within the first few days of admission to intensive care, with over 15% taking place on the same day and a peak on day 1 – particularly for inter-hospital transfers, where more than 30% occur on this day. Transfers within the same hospital follow a similar pattern but are more evenly spread across the initial days of the stay. A substantial share of transfers happens after a prolonged stay. Specifically, 5% of inter-hospital transfers and over 10% of intra-hospital transfers take place after 14 days or more in intensive care services of the sending hospital.

Figure 49 – Distribution in time between admission in intensive care service and transfer for transfer between and within hospital, 2022



Source: Minimal Hospital Data (MZG – RHM).

INTER-HOSPITAL TRANSFERS ORIGINATE FROM SMALLER HOSPITALS AND MIXED UNITS, OFTEN DIRECTED TOWARDS LARGER AND UNIVERSITY HOSPITALS AND NON-MIXED UNITS

Figure 56 provides insight into the flow of transfers and referral patterns between intensive care units in hospital sites from different hospitals. The figures distinguish transfers by site type (Panels A and B), unit type (Panel C), and region (Panel D) of both the sending and receiving hospital sites. The data concern 1 144 first transfers (Panels A, C, and D) and 253 return transfers (Panel B). Flows representing 3% or more of all transfers are labelled in the figures.

Panel A indicates that most transfers originate from smaller hospital sites, with those having ≤200 licensed C/D/E/G beds accounting for 31% of outgoing first transfers and sites with 200-300 beds for 27%. A substantial proportion of these transfers are directed towards larger hospital sites, particularly those with >450 beds (22%) and primary sites of university hospitals (51%). Notably, primary university hospital sites receive patients from all types of sending sites, including other large hospitals, suggesting an additional layer of specialisation. The reverse, however, is rare. Mid-sized hospital sites (300-450 beds) operate both as sending (22%) and receiving (16%) sites. Overall, only a small share of transfers involve a receiving hospital site with fewer beds than the sending site. This may occur in specific cases, for example, when a patient receives (planned) specialised treatment at a larger site and is subsequently transferred to a smaller local hospital.

Panel B shows an opposite pattern for return transfers.

Panel C presents transfer flows between unit types. The majority of transfers originate from mixed general intensive care units (87%) and are directed towards non-mixed general intensive care units, i.e. specialised (MDC) and surgical units and to a lesser extent medical units. Smaller proportions involve transfers from mixed general intensive care units to paediatric intensive care and burn care units and from medical to mixed units. This distribution suggests that transfers are often driven by the need for specialised care unavailable in the sending unit.

Finally, Panel D highlights limited inter-regional transfers, with the exception of transfers from hospital sites in Wallonia to hospital sites in Brussels, which account for 11% of transfers.

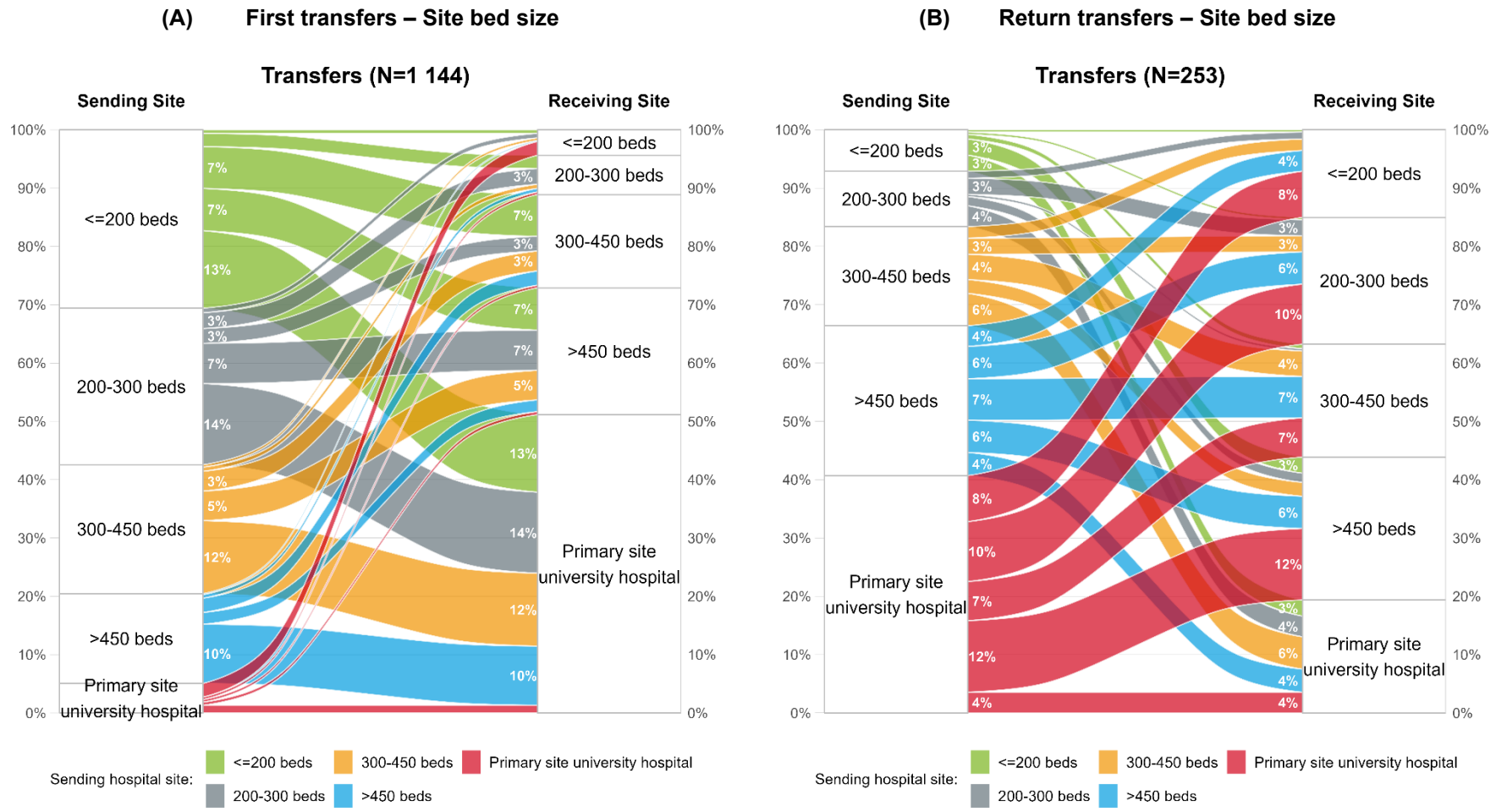
WITHIN-HOSPITAL TRANSFERS MORE CONCENTRATED IN SMALLER SITES, WITH A LOWER PROPORTION INVOLVING SPECIALISED UNITS

Figure 50 details the flow of transfers and referral patterns between intensive care units from different hospital sites of the same hospital. The figures differentiate transfers by site type (Panels A, B, and D) and unit type (Panel C) for both the sending and receiving hospital sites. The data include 351 first transfers (Panels A, C, and D) and 127 return transfers (Panel B). Transfers representing 3% or more of all cases are labelled in the figures. The general trends are similar to those observed in Figure 51, but notable differences exist in the relative proportions.

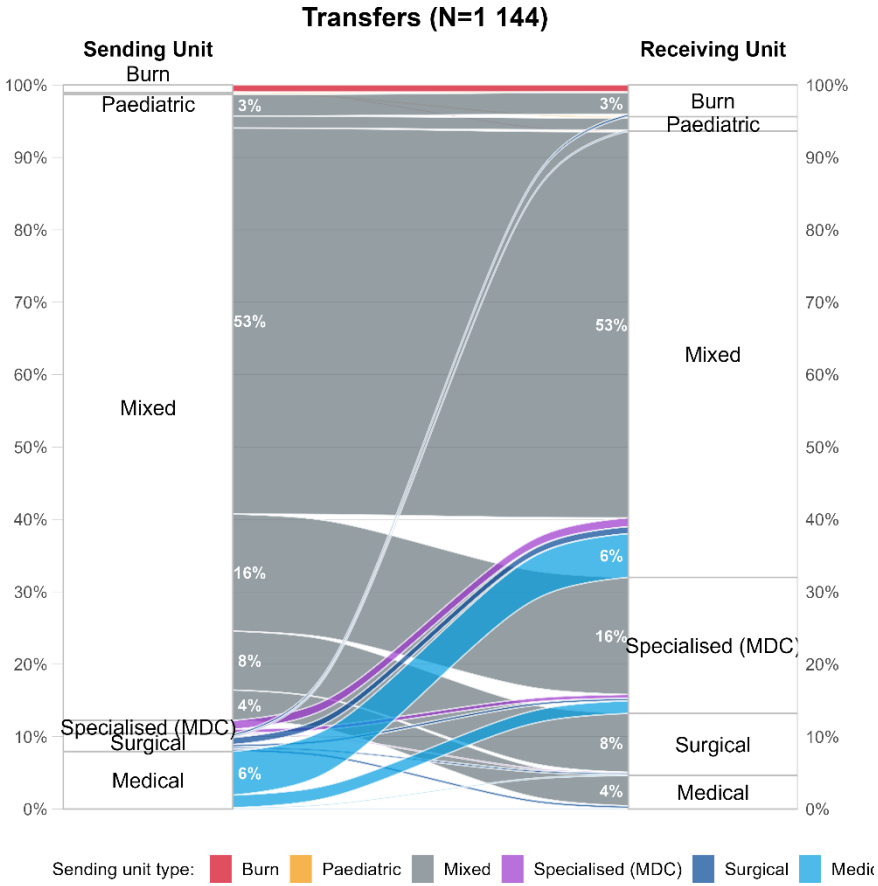
Panel A shows that outgoing transfers are substantially more concentrated in small-sized sites, with those having ≤200 licensed C/D/E/G beds accounting for 52% of outgoing first transfers and sites with 200–300 beds for 38%. The majority of these sites are secondary sites within the hospital (Panel D). On the receiving end, the concentration of transfers to larger hospital sites with >450 beds is lower (34%) compared to inter-hospital transfers, while smaller hospital sites with fewer than 300 beds account for 60% of incoming transfers. Panel B again demonstrates the opposite pattern for return transfers.

The flow of transfers between units also differs slightly. A lower proportion of outgoing transfers originate from mixed general intensive care units (80%) and transfers to non-mixed general intensive care units are less frequent. This suggests that transfers related to specific surgical treatments occur more often across hospitals than within hospitals. Conversely, medical general intensive care units account for a larger share of sending (and receiving) units, with an important flow towards mixed units (14%).

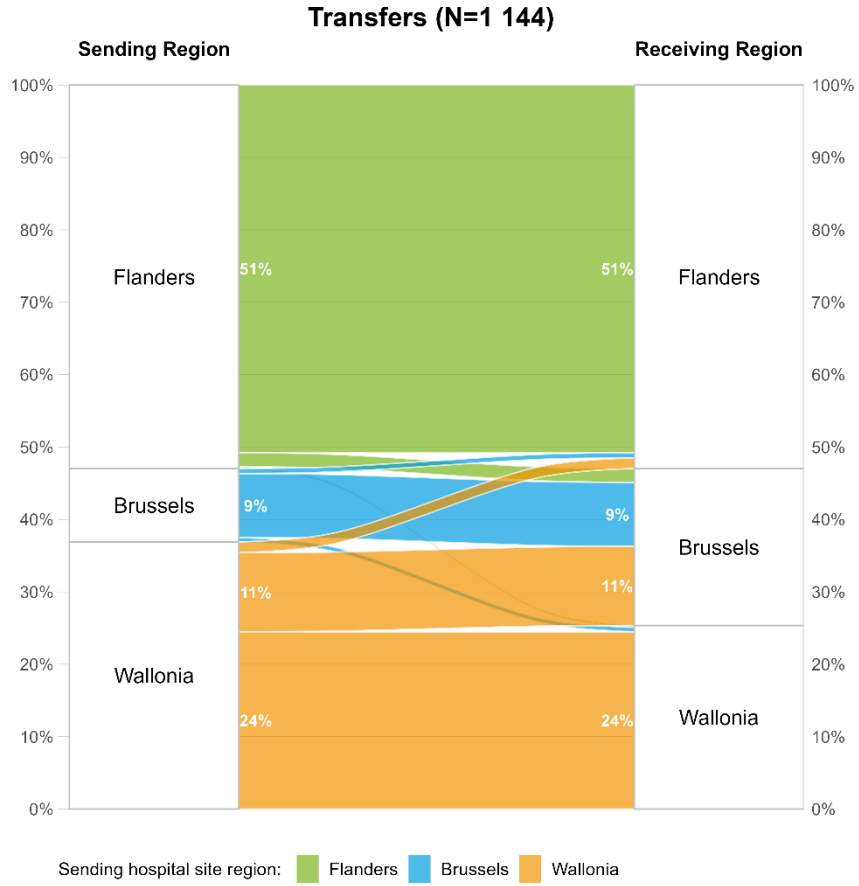
Figure 50 – Flow of transfers between intensive care units from different hospitals, 2022



(C) First transfers – Unit type



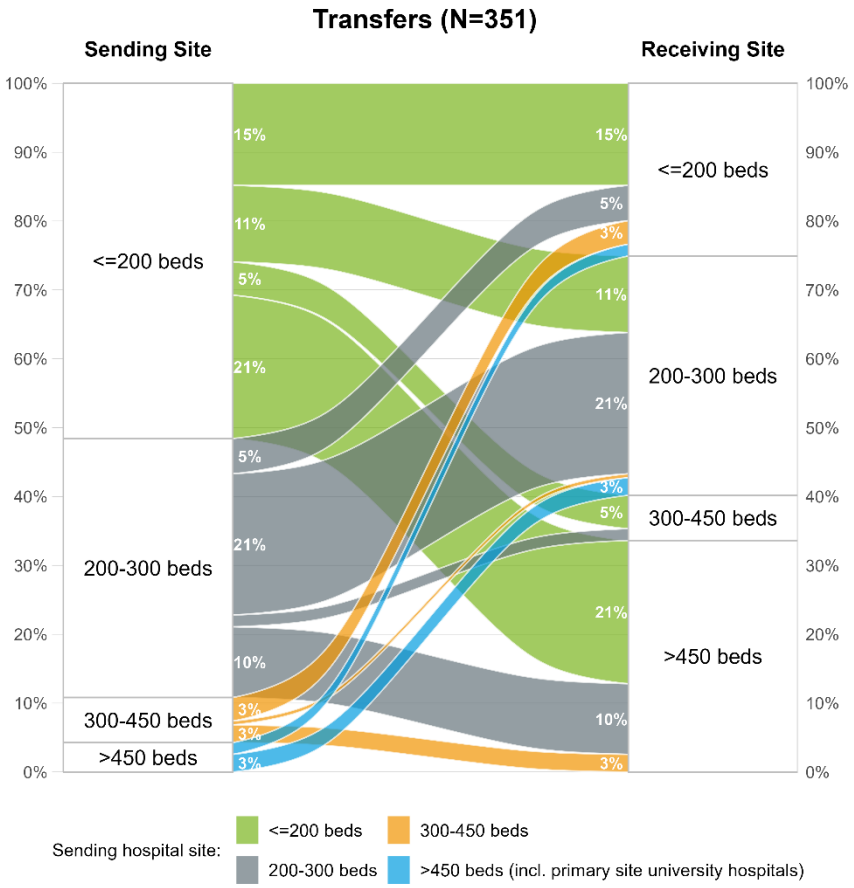
(D) First transfers – Site region



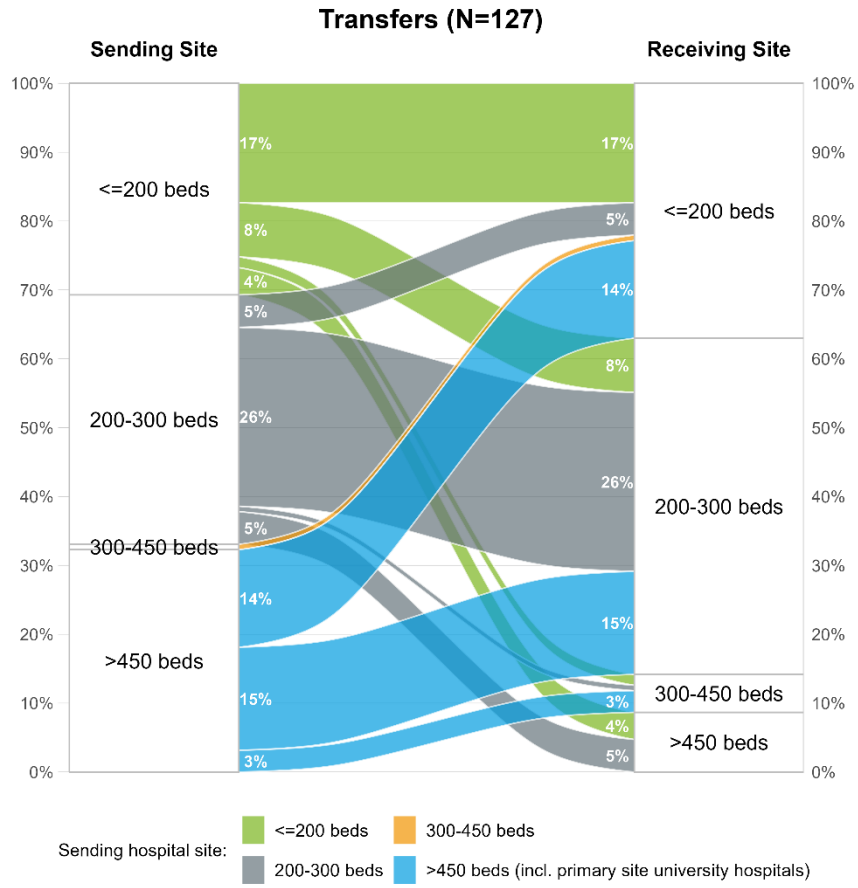
Source: Minimal Hospital Data (MZG – RHM).

Figure 51 – Flow of transfers between intensive care units from different hospital sites within the same hospital, 2022

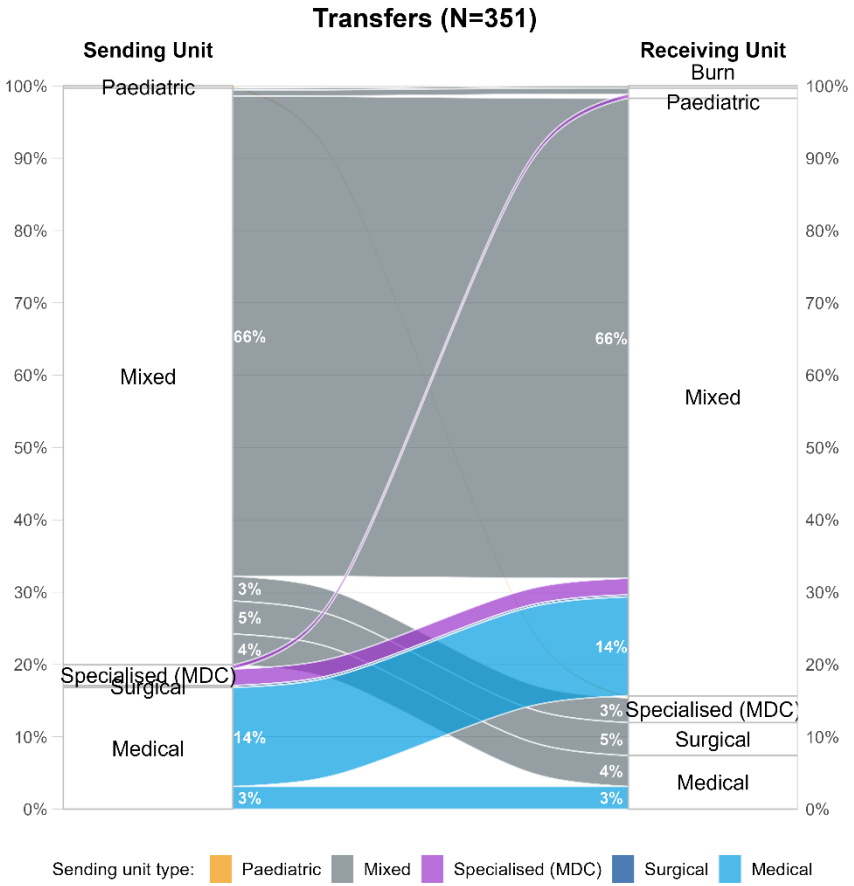
(A) First transfers – Site bed size



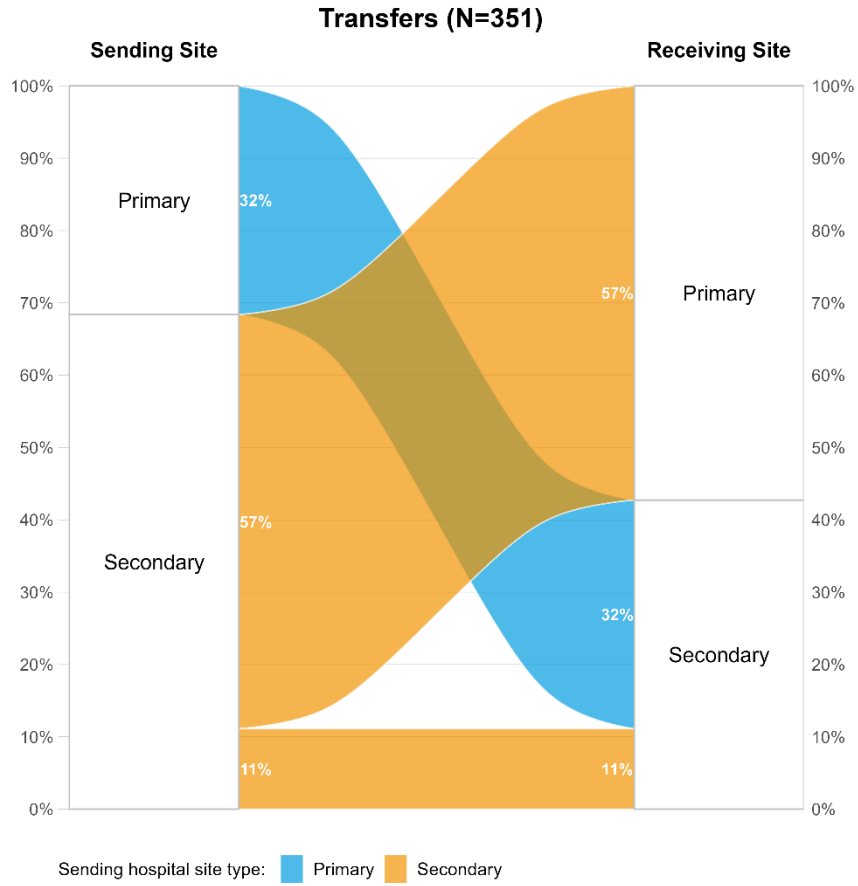
(B) Return transfers – Site bed size



(C) First transfers – Unit type



(D) First transfers – Site type

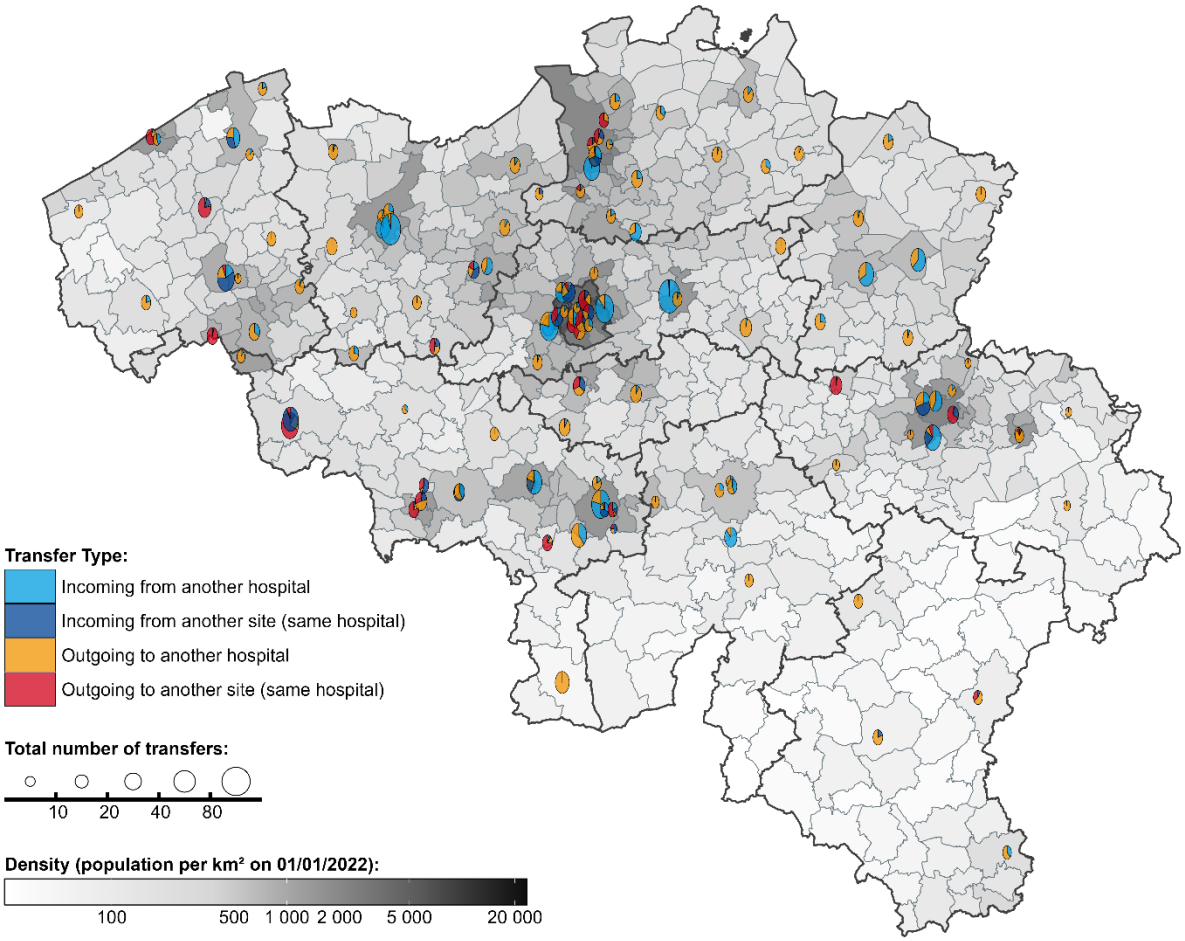


Source: Minimal Hospital Data (MZG – RHM).

TRANSFER FLOWS FROM LESS DENSELY POPULATED AREAS AND SMALLER CITY HOSPITALS TO LARGER SITES IN URBAN CENTRES

Figure 52 illustrates the geographical distribution of transfer flows in intensive care services in 2022. The size of the pie charts indicates the total number of incoming and outgoing transfers, while the colours represent the proportion of incoming (cyan and blue) and outgoing (red and orange) transfers. In combination with the geographical distribution of activity in Figure 26, a clear pattern emerges, with outgoing transfers predominantly originating from sites in less densely populated areas (rural or suburban) or smaller sites in urban centres, while incoming transfers are concentrated in larger hospital sites and university hospitals in urban centres.

Figure 52 – Geographical distribution of first transfer flows in intensive care services in Belgium, 2022



Source: Minimal Hospital Data (MZG – RHM).

4.2 Nursing activity profile

This section explores the variation in nursing care intensity within Belgian hospitals, focusing on intensive care services (general intensive care, paediatric intensive care and burn care) and general care units with high levels of technical care. The analysis addresses three key research questions. First, we assess the variation in care intensity between different intensive and burn care units, accounting for the diversity in care profiles and patient characteristics across these units. Second, we examine the variation in care intensity within individual intensive and burn care units, recognising the potential differences in care levels for patients within the same unit. Lastly, we investigate whether general care units exhibit nursing care intensity levels and technical demands comparable to intensive or burn care units. This may be observed in nursing units associated with specific pathologies (e.g. stroke, cardiac, haematology, or urology) or in intermediate care units, which are used for patients transitioning before or after ICU stays, requiring more care and monitoring than in general care units, but less than in intensive care services.

4.2.1 Data and methodology

4.2.1.1 Nursing Minimum Data Set

The Nursing Minimum Data Set (VG-MZG / DI-RHM) for the year 2019 was used. The VG-MZG / DI-RHM serves as a basis for the Belgian hospital financing system and provides detailed insights into the nursing activities performed in Belgian acute hospitals. Data are collected mandatorily during four registration periods each year, covering the first 15 days of March, June, September, and December, across all Belgian acute hospital nursing units, except psychiatric nursing units, operating and emergency rooms.[11, 27] The VG-MZG / DI-RHM data was linked to the MZG – RHM data (see section 4.1.1.1) containing patient-level information, such as comorbidity scores and age, as well as hospital-level characteristics, such as the number of beds, single-site status, and teaching status.

CARE EPISODES

The VG-MZG / DI-RHM data are recorded at the level of a care episode, rather than patient-days. A care episode is defined as a period that begins or ends with a transfer between nursing units or at midnight.[11, 28] Hence, during a single day, a patient may have one or more care episodes. If a patient remains in the same unit from midnight to midnight, there is only one care episode, corresponding to the patient day. In case of a transfer between nursing units, there are multiple care episodes on the same day and even in the same unit, e.g. a pre- and post-surgery care episode.

This granularity aims to capture the variable nature of a patient's condition and the corresponding nursing care provided during his/her stay. For example, nursing interventions before surgery can differ significantly from those after surgery.[28]

DIRECT NURSING CARE ACTIVITIES

Following the American Nursing Interventions Classification (NIC), registered nursing activities are organised into six domains: (1) Basic physiological functions; (2) Complex physiological functions; (3) Behaviour; (4) Safety; (5) Family and relatives; and (6) Healthcare management. These domains are further divided into 19 classes and 62 items. Items specific to intensive care units are found mainly in domain 2.[28]

The response categories of the registered items are binary (yes/no), categorical (multiple different categories), or frequency-based as defined by Coding Manual version 2.1 which is in use since 2018.[28, 29]

It is important to note that the VG-MZG / DI-RHM measures the nursing activities actually performed, not the care that is required. This distinction introduces the possibility of both underprovision of care (e.g. tasks left undone due to high workload) and overprovision of care (e.g. unnecessary tasks performed).[11] As such, the data do not allow a direct assessment of whether the observed care intensity is adequate or optimal.

4.2.1.2 Data selection

For this study, data from all general and paediatric intensive care units and burn care units were included, alongside general care units that handle patients requiring technical interventions such as sedation, dialysis, arterial blood sampling, intracranial pressure measurement, thermoregulation, respiratory or circulatory support, and continuous monitoring of vital parameters. Neonatal and maternal intensive care units were excluded.

4.2.1.3 Care intensity and complexity in the Nursing Minimum Data Set

Several elements in or based on the VG-MZG / DI-RHM were used to derive information on care intensity and complexity.

First, a direct measure of care intensity and complexity was developed by the research team based on the registration of specific high-technical nursing activities, particularly from domain 2, such as cardiocirculatory or respiratory support or arterial blood sampling (detailed in section 4.2.1.4).

Second, each item in the VG-MZG / DI-RHM was assigned both time points and competency points. Time points reflect the time required to perform a nursing activity, and different versions of these points exist and are currently undergoing an update.[11, 30] We applied the points currently used by the Federal Public Service (FPS) Public Health in the hospital financing system. Competency points capture the level of nursing expertise needed to perform a nursing activity. The product of these two values is referred to as time-competency points or total points, which offer a combined measure of both the workload and the complexity of the care provided.[28] The sum of total points at the level of a care episode was used to evaluate the intensity of nursing care performed, with higher values indicative of more time or expertise required to treat the patient.

Third, information on care intensity was derived from the Nursing Related Groups (NRGs), which classify care episodes into homogeneous groups with similar levels of nursing care requirements.[28] NRGs are used for hospital financing (see Chapter 3) and are awarded based on the duration of a care episode, the composition of registered items and time-competency points. Based on the registered items, care episodes receive a score on **two dimensions**:[28]

- Technical Score (ranging from 0 to 10): reflects the intensity of technical nursing activities (e.g. items in domain 2, such as respiratory or cardiocirculatory support);
- Basic Care Score (ranging from 0 to 10): reflects the intensity of basic nursing care activities (e.g. items in domain 1, such as hygiene or feeding assistance).

Based on these scores care episodes can be classified into **5 care groups**:[28]

- High-technical care: episodes with a technical score ≥ 7;
- Medium-technical care: episodes with a technical score ≥ 4 and < 7;
- High-basic care: episodes with a technical score < 4 and a basic care score ≥ 6;
- Medium-basic care: episodes with a technical score < 4 and a basic care score ≥ 3 and < 6;
- Low-basic care: episodes with both a technical score < 4 and a basic care score < 3.

Furthermore, NRGs allowed for a classification into *intensive* and *non-intensive* care episodes. The classification of an episode as intensive is based on the registration of high-technical items in domain 2 and the probability that a care episode will fall into the high-technical care group.[28]

4.2.1.4 Measures and descriptive analysis

To address the first research question – assessing variation in care intensity between different intensive care service units – we aggregated information from care episodes to provide unit-level summary statistics on

- Percentage of care episodes shorter than 24 hours;

- Percentage of intensive NRGs;
- Percentage of intensive NRGs (with duration of 24 hours) per patient;
- Percentage of care episodes classified as High-Technical (HT), Medium-Technical (MT), High-Basic (HB), and Low or Medium-Basic (LMB);
- Percentage of High and Medium-Technical (HT and MT) care episodes combined;
- Mean technical score;
- Mean basic care score;
- Mean time-competency points;
- Mean Elixhauser composite mortality risk score (see also Chapter 6). The Elixhauser composite mortality risk score sums up all 38 individual comorbidities identified through the AHRQ Elixhauser algorithm (see section 4.1.1.3), using pre-defined weights that reflect the association between each comorbidity and in-hospital mortality. The mortality risk weights, provided by AHRQ, were derived from logistic regression coefficients based on US hospital data, with in-hospital mortality as dependent variable and the individual comorbidities as explanatory variables.[22, 23, 31]
- Percentage of care episodes involving specific registered items (hereafter referred to as flagged care episodes). The identification strategy was developed by three Health Services Researchers with backgrounds in ICU nursing, intensive care medicine, and general nursing. It includes care episodes with:
    - Continuous or frequent monitoring of vital parameters (V400≥1 or V300>4) alongside one or more of the following activities: arterial blood sampling (N400≥1), intracranial pressure monitoring (I200=1 or 2), dialysis lasting more than 8 hours (G500=3), mechanical ventilation (K300=1 and K200=1; K200=3), or cardiocirculatory support monitoring (N600=1);
    - Artificial ventilation through tracheostomy, endotracheal tube, or laryngeal mask (K300=1 and K200=3; K200=2);
    - Mechanical cardiocirculatory or respiratory support (e.g. ECMO) (N700=1 or 2 or 3).

To address the second research question – assessing variation in care intensity within intensive care services – we examined the distribution of care episodes within hospital sites and calculate site-level descriptive statistics such as the ratio of percentile values (P90/P50) on the

- Technical score;
- Basic care score;
- Time-competency points;
- Elixhauser composite mortality risk score;
- Percentage of intensive NRGs (with duration of 24 hours) per patient.

To address the third research question – examining nursing intensity in general care units and comparing it to that in intensive care service units – a subset of the analyses conducted for the previous research questions was applied to general care units and compared to general and paediatric intensive care and burn care units. Higher-intensity general care units were identified based on their share of flagged care episodes (see above). The underlying premise is that a greater proportion of care episodes involving frequent monitoring and respiratory support suggests the presence of intermediate care units. A detailed analysis of these units may offer insights complementary to those obtained from the survey (see Chapter 7). Additionally, based on pathological information, recorded care items, episode duration, patient age profiles and survey information (see Chapter 7), these higher-intensity general care units were categorised.

4.2.2 Results

4.2.2.1 Sample descriptives

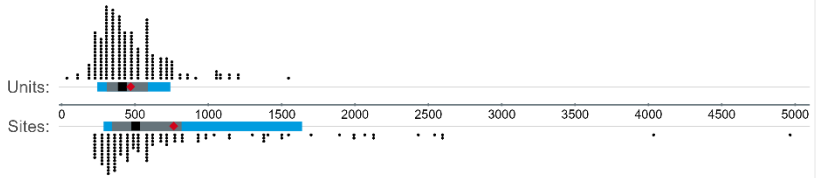
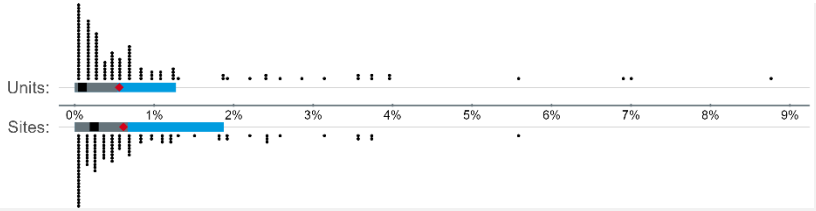
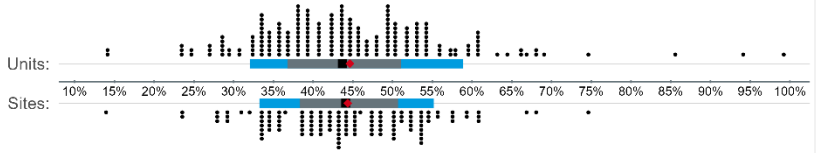
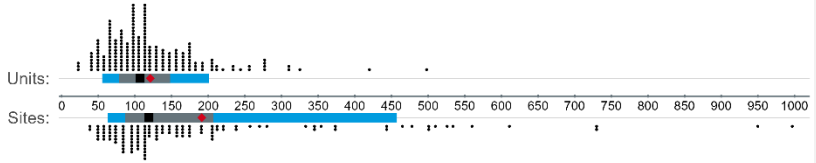
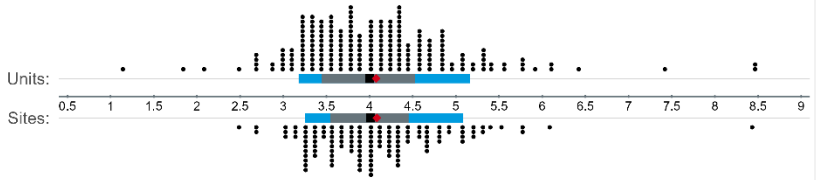
The data include information from 95 401 care episodes across 23 822 stays in 203 general and paediatric intensive care and burn care units within 125 hospital sites and 99 hospitals. As reported in Table 12, there is substantial variation in activity levels per unit and site, with an average of 470 care episodes per unit (median: 413, P25-P75: 306-588) and 121 stays per unit (median: 107, P25-P75: 78-148). At the site level, the average number of care episodes is 763 (median: 504, P25-P75: 342-817), with 191 stays per site (median: 119, P25-P75: 87-207). The distribution of activity levels is right-skewed, with a greater range across sites than across units, as larger sites typically operate multiple intensive care service units. The average number of care episodes per stay is 4.0.

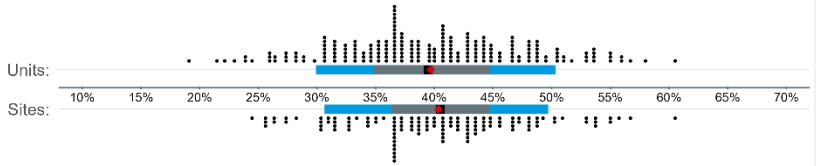
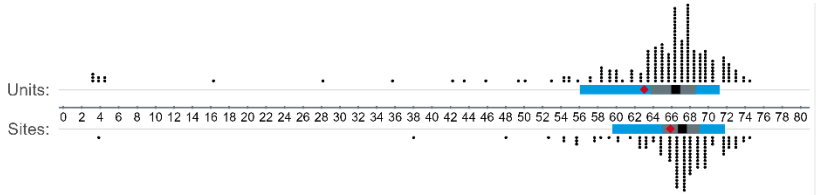
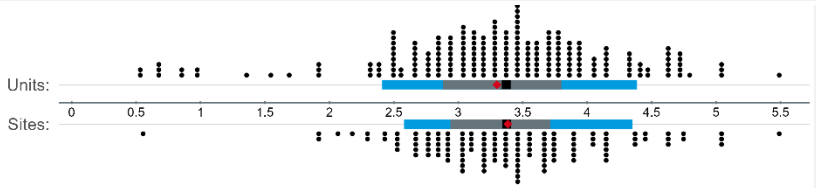
Only a small proportion of care episodes in intensive or burn care units are related to day-care stays (0.6%), although in approximately 10% of units and sites, the share exceeds 1% and 2%, respectively. Care episodes shorter than 24 hours account for 44.7% of all care episodes, with a similar distribution in units (median: 43.7%, P25-P75: 36.8%-51.1%) and sites (median: 44.1%, P25-P75: 38.4%-50.7%).

OLDER AND PREDOMINANTLY MALE PATIENT POPULATION

Female patients account for 39.2% of care episodes, representing less than half of ICU activity. The average patient age, weighted by care episodes to better capture the impact of age on the activity in the unit, is 63.5 years. The distribution exhibits some divergence, with a number of paediatric units, one dedicated paediatric site (HUDERF), two sites with a mean age below 50 years, and ten sites with a mean age between 50 and 60 years. The average number of comorbidities per patient is 3.3, with both units and sites having a median of 3.4 (P25-P75: 2.9-3.8 for units, 2.9-3.7 for sites). Outlier units and sites in this respect are the paediatric intensive care units, burn care units, and the dedicated paediatric site, which treat patients with significantly fewer comorbidities.

Table 12 – Descriptive statistics

	Overall	Unit and site distribution: Mean | Median [P25 – P75]	
Number of care episodes	95 401	Units: 470 | 413 [306-588] Sites: 763 | 504 [342-817]	
Share of care episodes in day care	0.6%	Units: 0.6% | 0.1% [0.0%-0.5%] Sites: 0.6% | 0.2% [0.0%-0.7%]	
Share of care episodes shorter than 24h	44.7%	Units: 44.6% | 43.7% [36.8%-51.1%] Sites: 44.4% | 44.1% [38.4%-50.7%]	
Number of stays	23 822	Units: 121 | 107 [78-148] Sites: 191 | 119 [87-207]	
Average number of care episodes per stay	4.0	Units: 4.1 | 4.0 [3.4-4.5] Sites: 4.1 | 4.0 [3.5-4.5]	

Share of care episodes by female patients	39.2%	Units: 39.7% | 39.5% [34.8%-44.8%] Sites: 40.4% | 40.5% [36.3%-44.7%]	
Average age of patients (weighted by care episodes)	63.5	Units: 63.0 | 66.4 [63.7-68.6] Sites: 65.9 | 67.2 [65.0-69.0]	
Average number of comorbidities of patients (weighted by care episodes)	3.3	Units: 3.3 | 3.4 [2.9-3.8] Sites: 3.4 | 3.4 [2.9-3.7]	

Note: Figures represent the distribution at the unit or site level. The blue range corresponds to the P10-P90 interval, the grey range to the P25-P75 interval, the black square indicates the median, and the red diamond represents the mean. Above or below the linerange, dots depict the density of the underlying observed values, with each dot representing a unit or site.

4.2.2.2 *Variation in care intensity between intensive care service units*

SINGLE MEASURES

Using various measures of care intensity, Figure 53 highlights substantial heterogeneity in care intensity, technical complexity, and severity of illness across general (mixed, surgical, medical, specialised) and paediatric intensive care and burn care units. This variation indicates that the care delivered and patient characteristics may differ significantly between units. Several key observations can be drawn from Figure 53.

First, there are clear differences between unit types. In *paediatric intensive care units* (indicated in orange), mortality risk is generally lower, and the level of high-technical care is also lower, as reflected in lower technical scores and smaller shares of high-technical care and intensive NRGs. Conversely, basic care is more prominent, as indicated by higher basic care scores and a greater proportion of high-basic care episodes. *Burn care units* (indicated in red) consistently deviate from the overall pattern observed in general intensive care units, reflecting their specialised focus on burn-related treatments rather than general intensive care (see section 4.1.2.5). These units exhibit lower technical and basic care scores, lower shares of intensive NRGs and high-technical care, a higher share of low and medium-basic care, and lower mean time-competence points per care episode. They also have a lower proportion of flagged care episodes, i.e. episodes involving continuous or frequent monitoring of vital parameters, artificial ventilation, or mechanical cardiocirculatory or respiratory support (see section 4.2.1.4). Additionally, patients in burn care units tend to have a lower mortality risk based on comorbidity burden. Differences also exist between types of general intensive care units, although they are less pronounced. *Medical intensive care units* (indicated in light blue) have a level of high-technical care comparable to paediatric intensive care units, reflected in lower technical scores and smaller proportions of high-technical care and intensive NRGs. They also have lower mean time-competence points but, on the other hand, treat patients with a higher comorbidity burden. *Surgical intensive care units* (indicated in black) are among those with the highest levels of technical care, particularly in terms of high-technical care, intensive NRGs, and flagged care episodes. This is also reflected in higher mean time-competence points. *Specialised intensive care units* (indicated in purple) exhibit the greatest variability in care intensity measures. While most units focus on cardiac surgery, there are units with both the highest and lowest levels of technical and basic care, short care episodes, and comorbidity burden. *Mixed general care units* (indicated in grey) constitute the largest group and exhibit a similar degree of variability as specialised units. They tend to have more medium-technical care than specialised and surgical intensive care units.

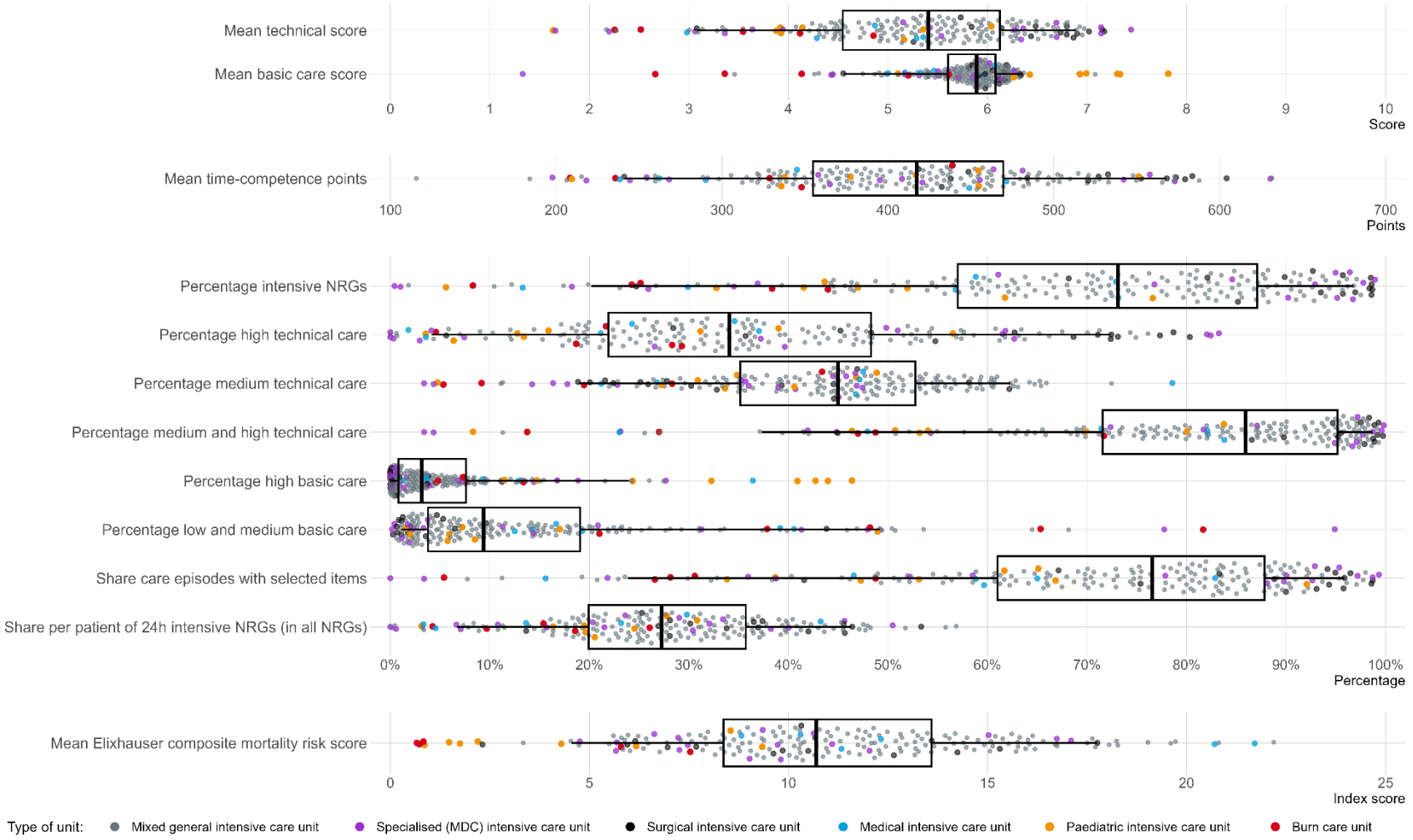
Second, the mean technical score exhibits considerable variability, with most units clustering between 4.5 and 6.5. A similarly broad dispersion is observed in other indicators of technical complexity, such as the proportion of intensive NRGs (median: 73%, P25-P75: 57%-87%), the proportion of medium or high-technical care (median: 86%, P25-P75: 72%-95%), and the proportion of flagged care episodes (median: 77%, P25-P75: 61%-88%). Moreover, the distributions of these three indicators are left-skewed, indicating that most units cluster at higher proportions, with a long tail of units displaying lower proportions.

Third, variation in the mean basic care score is much less pronounced, underscoring the more uniform distribution of (high) basic care requirements across intensive care patients. Similarly, the proportions of high-basic care NRGs and low and medium-basic care NRGs remain relatively small. For both indicators, the distributions are right-skewed, with most units concentrated in a narrow range, while a few units exhibit significantly higher proportions.

Fourth, the mean time-competence points per care episode in intensive care services show substantial variability, with an average unit-level value of 411 and a median of 417. The distribution ranges widely, with the 25th percentile value (355 points) being 25% lower than the 75th percentile value (469 points).

Finally, the mean Elixhauser composite mortality risk score, representing patient comorbidity burden, varies widely (median: 10.7, P25-P75: 8.4-13.6), highlighting significant differences in patient populations regarding mortality risk across intensive care units.

Figure 53 – Measure of care intensity



Note: Every dot represents a unit. The whiskers of the boxplot correspond to the P10-P90 interval.
Source: Minimal Hospital Data (MZG – RHM).



MEASURES OF CARE INTENSITY ARE RELATED

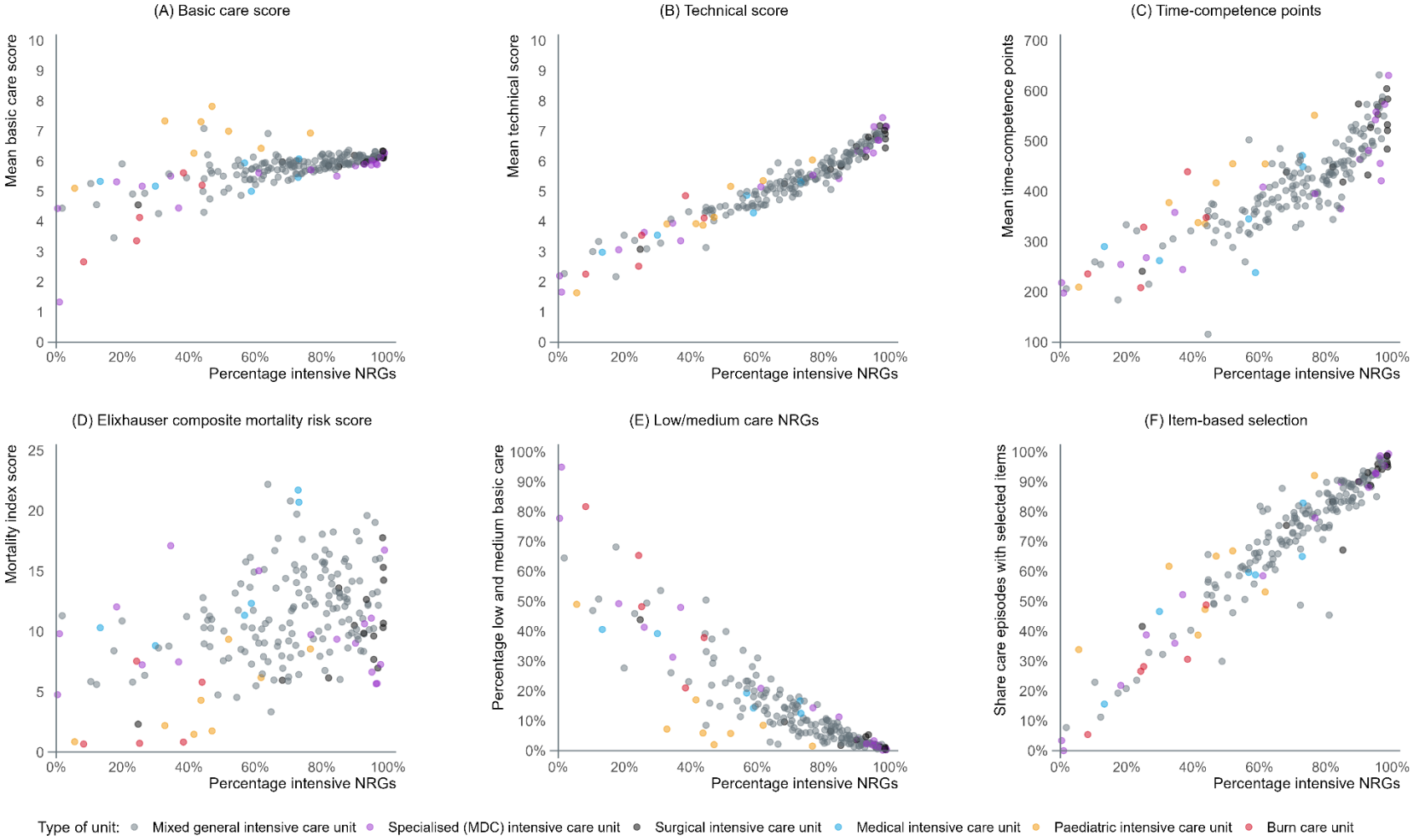
Figure 54 shows the relationship between the percentage of intensive NRGs and six other measures of care intensity. Figure 55 illustrates the relationship between the mean technical score and the mean basic care score at the unit level, across different unit types (left panel), the dominant NRG type in the unit (middle panel), and patient comorbidity burden as measured by the Elixhauser composite mortality risk score (right panel).

A main finding is the correlation between different measures of care intensity. There is a strong positive correlation between the percentage of intensive NRGs and the mean technical score (Figure 54, panel B), mean time-competency points (Figure 54, panel C), and the proportion of flagged care episodes (Figure 54, panel F). Conversely, a strong negative correlation is observed between the percentage of intensive NRGs and the proportion of low and medium-basic care NRGs (Figure 54, panel E). Excluding paediatric intensive care units, we also observe a positive correlation between the percentage of intensive NRGs and the mean basic care score (Figure 54, panel A), as well as between the mean technical score and the mean basic care score (Figure 55, left panel), indicating that units providing more technical care also tend to have higher basic care scores. As highlighted in Figure 53 and reaffirmed in Figure 54 and the left panel of Figure 55, burn care units and some paediatric intensive care units exhibit profiles that deviate in several aspects from those of general intensive care units, reflecting their specialised patient populations and treatment focus. The distinct patterns among surgical and medical intensive care units are also evident, with surgical units exhibiting higher levels of technical care, flagged care episodes, mean time-competence points, and intensive NRGs, while medical units show lower levels of these care intensity measures. Additionally, specialised intensive care units display considerable variability in care intensity measures.

The middle panel of Figure 55 shows distinct clusters of units based on the dominant NRG type. Units performing predominantly high-technical care exhibit the highest technical scores, while those primarily engaged in medium-technical care occupy the middle range of the distribution. In contrast, units focused on low or medium-basic care are grouped in the lower range of both technical and basic care scores. Units with a mixed profile, i.e. where no single NRG type accounts for more than 50% of all care episodes, are largely positioned alongside units with either medium-technical care or basic care profiles. In total, of the 203 units analysed, 83 units (41%) have a mixed NRG profile, 9 units (4%) predominantly provide low or medium-basic care, 63 units (31%) predominantly provide medium-technical care, and 48 (24%) predominantly provide high-technical care. Units predominantly delivering high-technical care are concentrated in primary sites of university hospitals and larger hospital sites with more than 450 licensed C/D/E/G beds. Specifically, university hospitals account for 17 out of 48 such units (35%). In contrast, units with a mixed profile are more common in smaller hospital sites with 200 or fewer licensed C/D/E/G beds. Units predominantly providing medium-technical care are less frequent in primary sites of university hospitals, suggesting a relative focus on either high-technical care or a broader, mixed NRG profile.

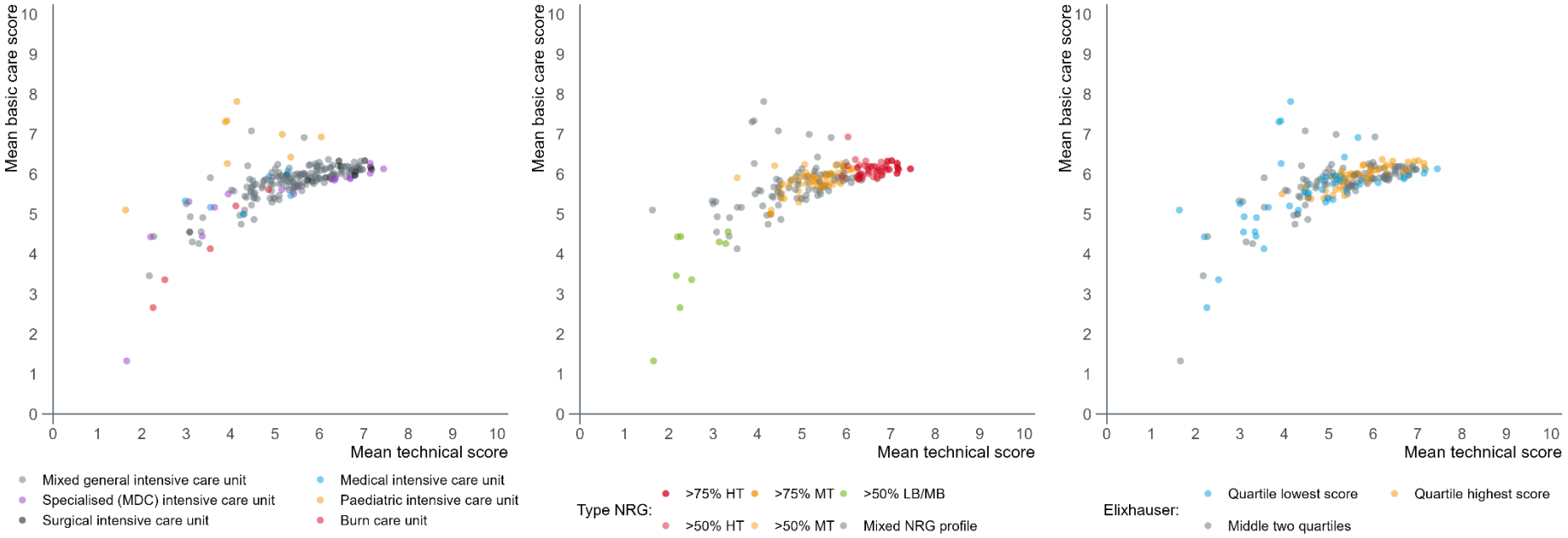
Panel D of Figure 54 reveals a weak positive association between patient comorbidity burden and the percentage of intensive NRGs. Similarly, the right panel of Figure 55 shows a weak association between patient comorbidity burden and the distribution of technical and basic care scores. Units in the lowest quartile of comorbidity burden are dispersed across the entire spectrum of technical and basic care scores, whereas units in the highest quartile of comorbidity burden are more concentrated within a narrower range, with a mean technical score above 4 and a mean basic care score above 5.

Figure 54 – Correlation between percentage intensive NRGs and other measures of care intensity at unit level



Note: Every dot represents a unit.
Source: Minimal Hospital Data (MZG – RHM).

Figure 55 – Correlation between mean technical score and basic care score at unit level, with different subdivisions

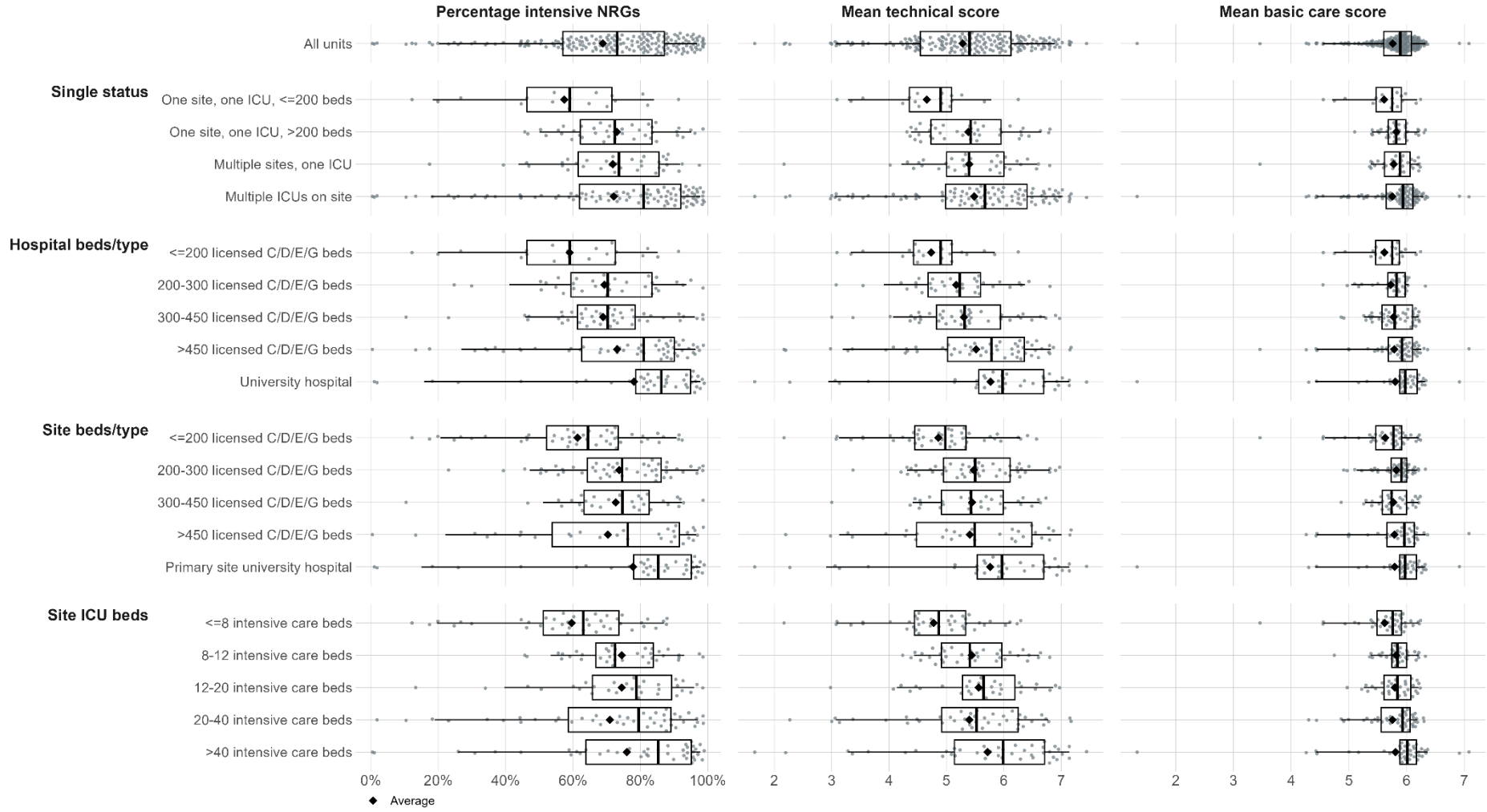


Note: Every dot represents a unit.
Source: Minimal Hospital Data (MZG – RHM).

DIFFERENCES BY HOSPITAL TYPE AND BED SIZE

Figure 56 presents the distribution of the percentage of intensive NRGs, mean technical score, and mean basic care score across hospital (site) type and bed size. The findings indicate that units in hospitals and hospital sites with a smaller number of ICU beds on-site (≤ 8 beds) or licensed C, D, E, or G beds (≤ 200 beds) tend to have a lower percentage of intensive NRGs and lower mean technical scores. Similarly, single-site hospitals with a single intensive care unit exhibit lower technical intensity compared to other units. In contrast, units in university hospitals or those in the highest bed size category tend to have a higher percentage of intensive NRGs and higher mean technical scores, suggesting that larger and more specialised hospitals provide more technical care. Additionally, larger hospitals and university hospitals typically have multiple intensive care service units on-site, leading to greater variation in technical scores, which may reflect differences in specialisation and patient case-mix. Finally, the right column in Figure 56 indicates that the mean basic care score remains relatively stable across all categories, implying that the level of basic care does not vary substantially with hospital size or ICU bed capacity.

Figure 56 – Distribution of percentage intensive NRGs, mean technical and basic care score by hospital or site type



Note: Every dot represents a unit. The whiskers of the boxplot correspond to the P10-P90 interval.
Source: Minimal Hospital Data (MZG – RHM).

4.2.2.3 *Variation in care intensity within intensive care services*

There is not only substantial variation in average care intensity across intensive care service units, but also significant variation within units in terms of patient care needs and patient profiles. This is illustrated in Figure 57 to Figure 59, which present the distribution of care episodes and patients within hospital sites, aggregating data across the different units at each site. In these figures, higher-intensity patients or care episodes are indicated in orange and red, while lower-intensity patients or episodes are represented in grey, green, or blue. Overall, all sites treat a mix of patients with varying levels of care needs and severity of illness. Although case-mix differences are not strongly related to intensive care service bed size, there are indications that the relative share of higher-intensity patients is somewhat lower in smaller sites (in terms of bed size) and higher in mid-sized sites, whereas the largest sites fall in between, accommodating both highly technical care patients and those requiring high-basic care due to unit specialisation (e.g. paediatric intensive care, burn care, and other specialised units). A higher proportion of lower-intensity patients may indicate the presence or potential for (further) development of intermediate care units.

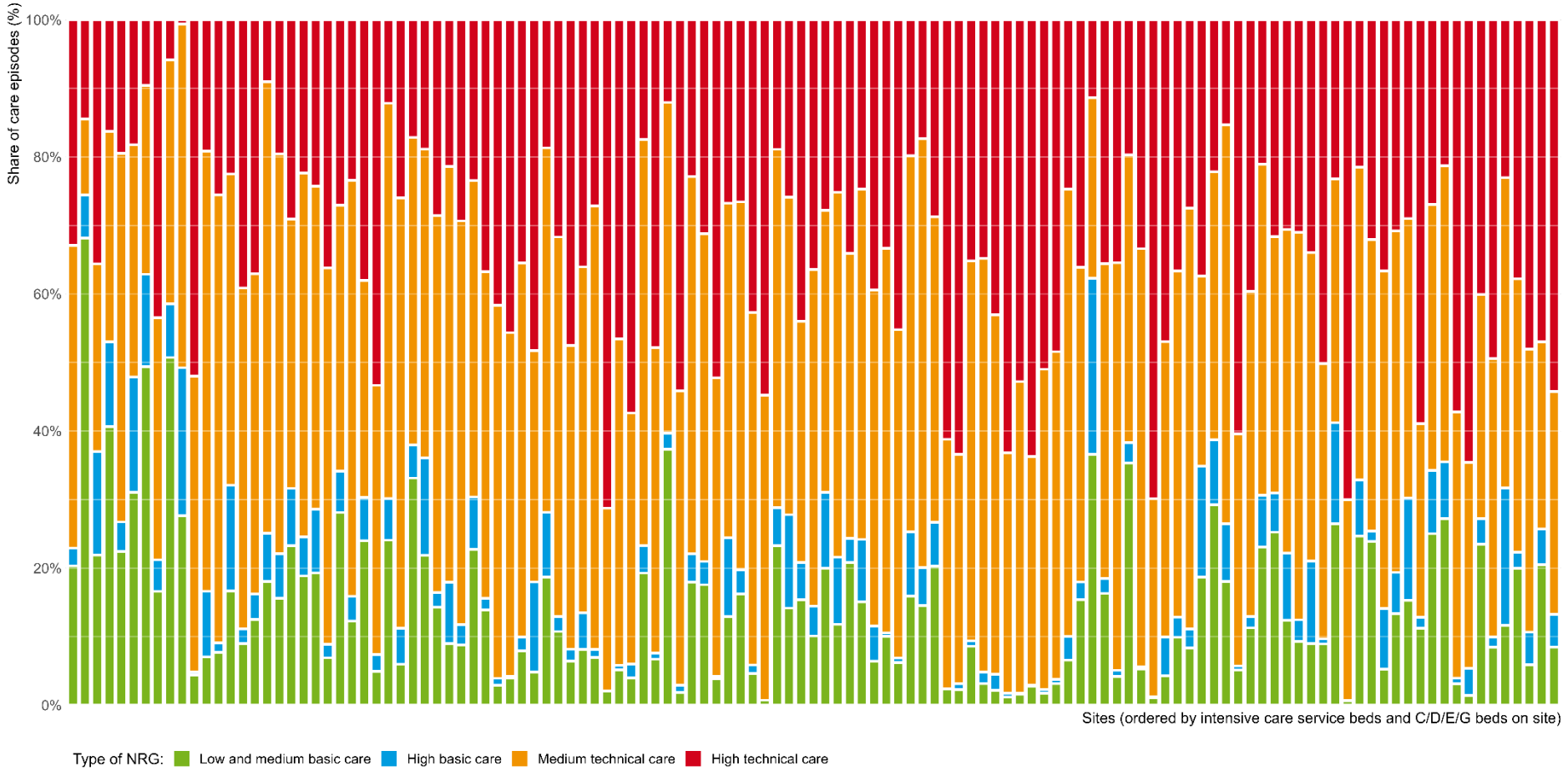
Figure 57 shows the distribution of NRGs within hospital sites, with sites ordered by intensive care service bed size and, in cases where the number of intensive care service beds is the same, by the total number of licensed C, D, E, or G beds. Figure 57 highlights substantial variation in care intensity both across and within sites. Mid-sized and larger hospital sites tend to have a higher proportion of high-technical care episodes (ranging from 30% to over 50%), compared to smaller sites (approximately 10% to 20%). Smaller sites display a more heterogeneous profile, with a greater proportion of low and medium-basic care episodes (10% to 20%), whereas some mid-sized sites have a basic care share below 5%.

Figure 58 reveals substantial variation in the distribution of patients according to their share of 24-hour intensive NRGs. Notably, approximately 30% to 60% of ICU patients did not have any 24-hour intensive NRG recorded. This may be due to the absence of 24-hour care episodes (e.g. if the ICU is used for postoperative monitoring or short-term care) or the absence of NRGs with an intensive profile. Patients with a high share of 24-hour intensive NRGs (>60%) typically represent between 10% and 40% of the patient population. Sites with few intensive care service beds tend to have a higher proportion of patients with no or a low share of 24-hour intensive NRGs.

Figure 59 presents the variation in patients' comorbidity burden within each site, as indicated by the Elixhauser composite mortality risk score. The distribution of scores varies, with some sites having a relatively even spread across quartiles, while others are more skewed towards specific risk categories. No clear pattern emerges in relation to bed size.

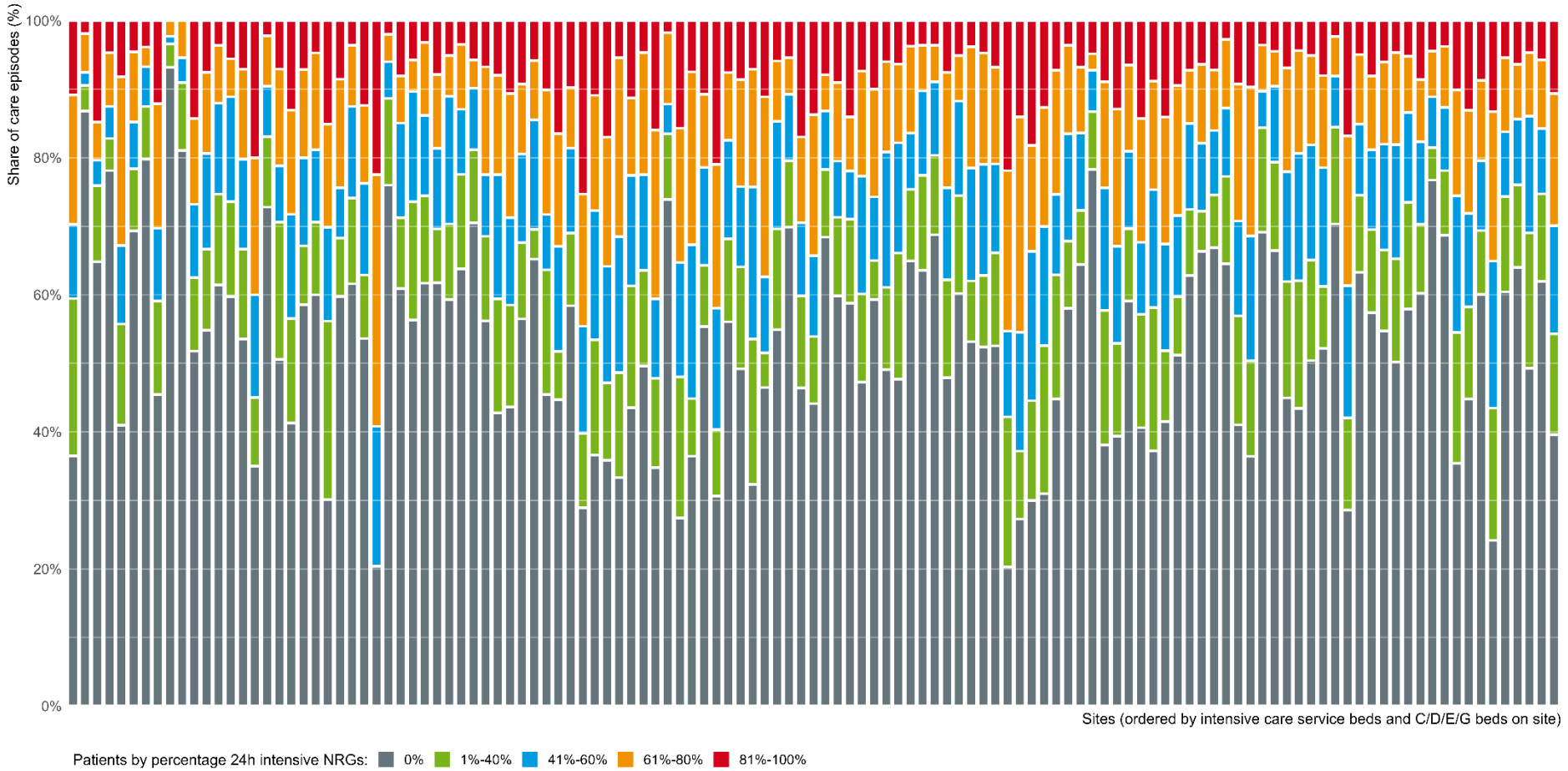
Figure 60 examines the correlation between the percentage of intensive NRGs and the ratio of the highest-intensity care episodes (95th percentile, P95) to the median within a site for time-competency points, technical scores, and basic care scores. A ratio of 1 indicates that the P95 care episode has a similar value to the median, while a ratio of 2 indicates that the P95 care episode has twice the value of the median. For time-competency points (Panel A) and technical scores (Panel B), the ratio ranges from approximately 2.5 to 1 and decreases as the percentage of intensive NRGs increases. In other words, in sites with a more pronounced intensive profile, the difference in care intensity between a top (P95) and median intensive patient is smaller. In contrast, in sites with a lower intensive profile, care intensity is more variable, suggesting that these units may be less accustomed to treating high-intensity patients. ICU bed size is represented in Figure 60 by the size of the circles, but no clear pattern emerges. Similarly, the ratios vary considerably among university hospitals. The variability in basic care scores (Panel C) remains relatively stable across sites, confirming earlier results that basic care provision is relatively uniform both across and within sites.

Figure 57 – Distribution within sites of NRGs by type, sites ordered by number of intensive care service beds



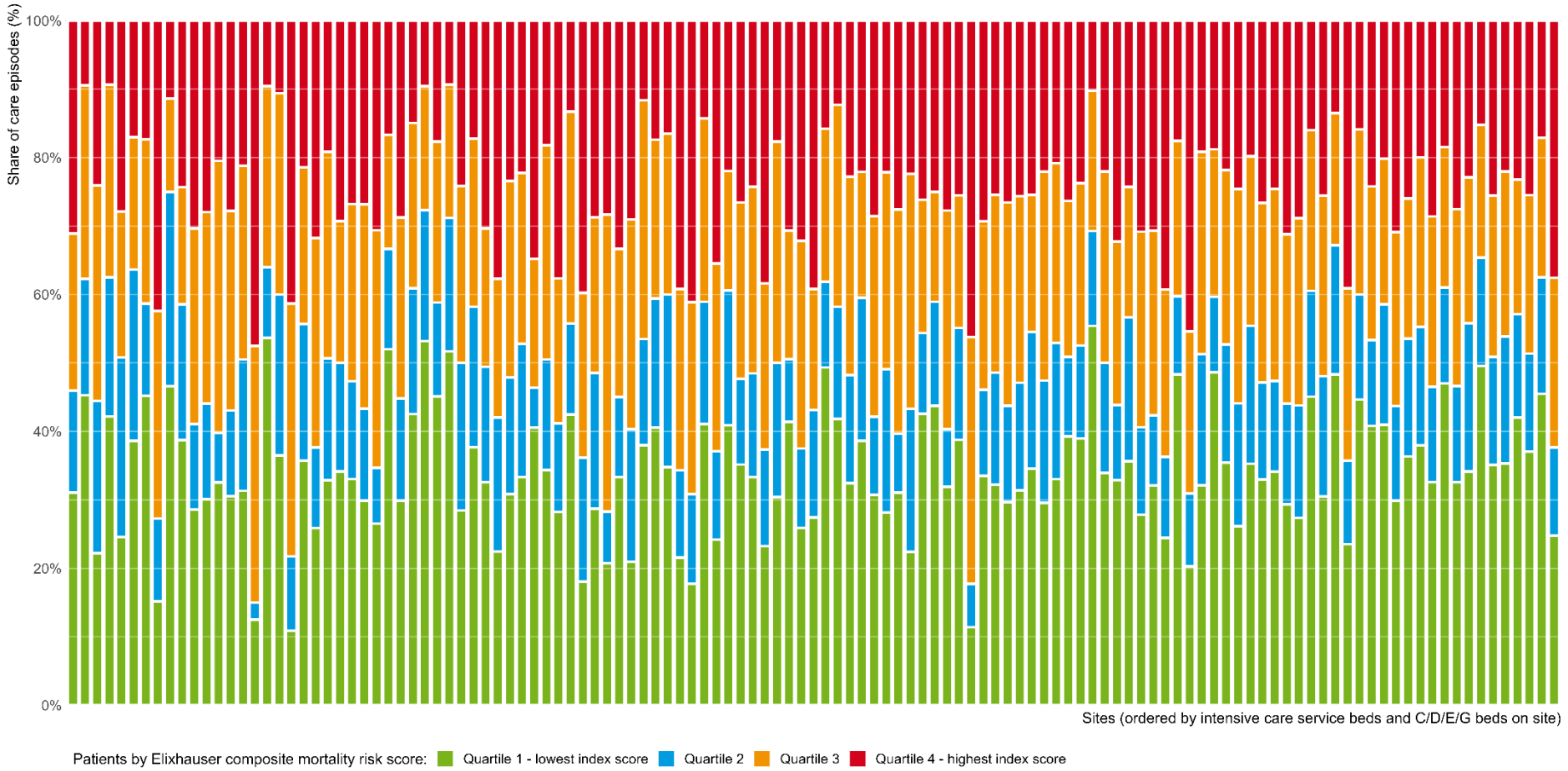
Note: Every bar represents a hospital site.
Source: Minimal Hospital Data (MZG – RHM).

Figure 58 – Distribution within sites of patients by share of 24h intensive NRGs, sites ordered by number of intensive care service beds



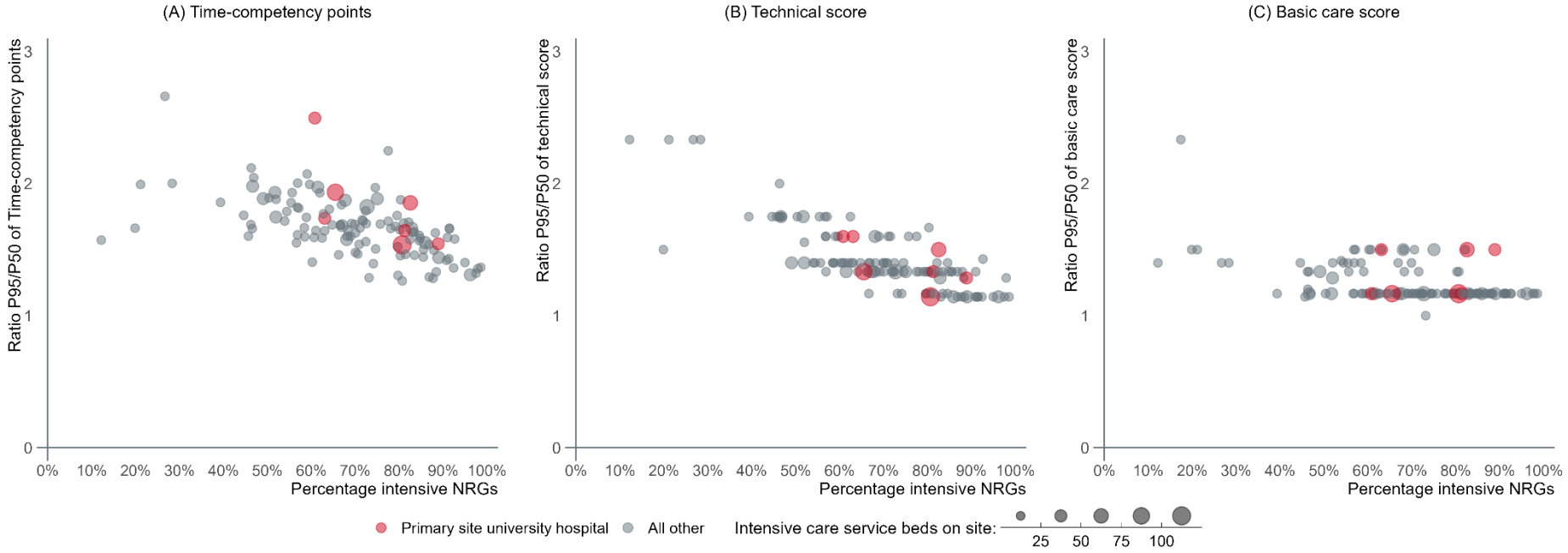
Note: Every bar represents a hospital site.
Source: Minimal Hospital Data (MZG – RHM).

Figure 59 – Distribution within sites of patients by Elixhauser composite mortality risk score, sites ordered by number of intensive care service beds



Note: Every bar represents a hospital site.
Source: Minimal Hospital Data (MZG – RHM).

Figure 60 – Correlation between percentage intensive NRGs and ratio (percentile 95 to median) of different measures at site level



Note: Every dot represents a hospital site.
Source: Minimal Hospital Data (MZG – RHM).

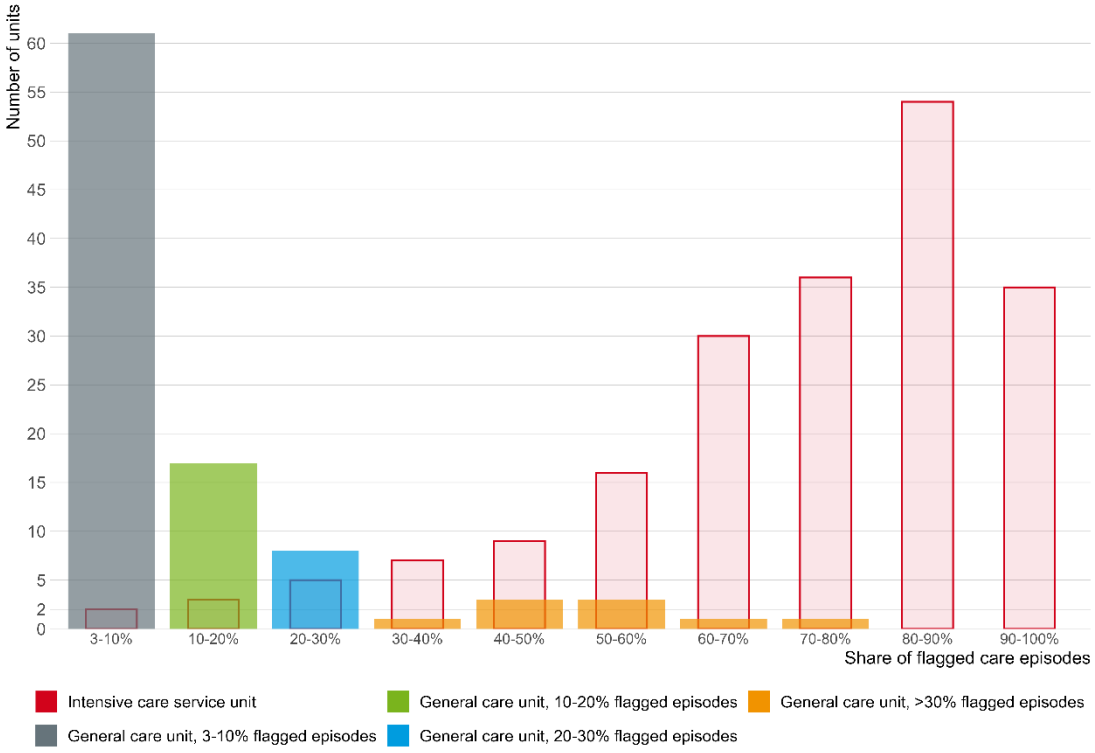
4.2.2.4 *Nursing intensity in general care units, towards identifying intermediate care units*

To identify general care units, i.e. units with a MZG – RHM unit code starting with *DIV*, that exhibit higher care intensity and may serve as intermediate care units, we examined the share of flagged care episodes. Flagged episodes involve continuous or frequent monitoring of vital parameters, artificial ventilation, or mechanical cardiocirculatory or respiratory support (see section 4.2.1.4).

As shown in Figure 56, all but one intensive care unit have flagged care episodes, with most intensive care services exceeding 60% flagged episodes (Figure 61). A smaller subset of general and paediatric intensive care and burn care units operates with a share between 3% and 60% (Figure 61). In contrast, the majority of general care units either have no flagged episodes (295 units) or a very low proportion (604 units below 3%). Among general care units with more than 3% flagged episodes, 61 units fall between 3% and 10%, 17 units between 10% and 20%, 8 units between 20% and 30%, and 9 units exceed 30% (Figure 61). For further analysis, an arbitrarily chosen threshold of 10% flagged care episodes was applied, leaving 34 units. Among these, 3 sleep units were initially included, due to the high frequency of monitoring. However, as these units are not considered potential intermediate care units, they were excluded from further analysis.

Table 13 compares the descriptive statistics of general and paediatric intensive care and burn care units (from Table 12) with general care units having more than 10% flagged care episodes. Intensive care service units manage fewer care episodes per unit (470 compared to 631) and have fewer patient stays (121 compared to 173). However, intensive care patients have more care episodes per stay (4.1 compared to 3.4). Intensive care service units also have a lower proportion of short care episodes (<24h) (44.6% compared to 64.6%) and day-care episodes (0.6% compared to 1.8%), indicating a focus on longer periods of care in intensive care services. Finally, intensive care patients are on average somewhat younger (63.0 compared to 65.9) and exhibit a higher comorbidity burden (3.3 compared to 3.0 conditions on average).

Figure 61 – Number of intensive care service units and general care units by share of flagged care episodes



Source: Minimal Hospital Data (MZG – RHM).

Table 13 – Comparison descriptive statistics intensive care service units and general care units with 10% or more flagged care episodes

	Intensive care service units Mean | Median [P25 – P75]	General units with ≥10% flagged care episodes Mean | Median [P25 – P75]
Number of care episodes	470 | 413 [306-588]	631 | 392 [186 - 1 061]
Share of care episodes in day care	0.6% | 0.1% [0.0%-0.5%]	1.8% | 0.1% [0.0% - 0.6%]
Share of care episodes shorter than 24h	44.6% | 43.7% [36.8%-51.1%]	64.6% | 66.7% [47.0% - 79.3%]
Number of stays	121 | 107 [78-148]	173 | 145 [90 - 260]
Average number of care episodes per stay	4.1 | 4.0 [3.4-4.5]	3.4 | 2.8 [2.5 - 4.2]
Share of care episodes by female patients	39.7% | 39.5% [34.8%-44.8%]	43.3% | 45.0% [36.8% - 47.9%]
Average age of patients (weighted by care episodes)	63.0 | 66.4 [63.7-68.6]	65.9 | 68.7 [65.6 - 71.2]
Average number of comorbidities of patients (weighted by care episodes)	3.3 | 3.4 [2.9-3.8]	3.0 | 3.0 [2.6 - 3.5]

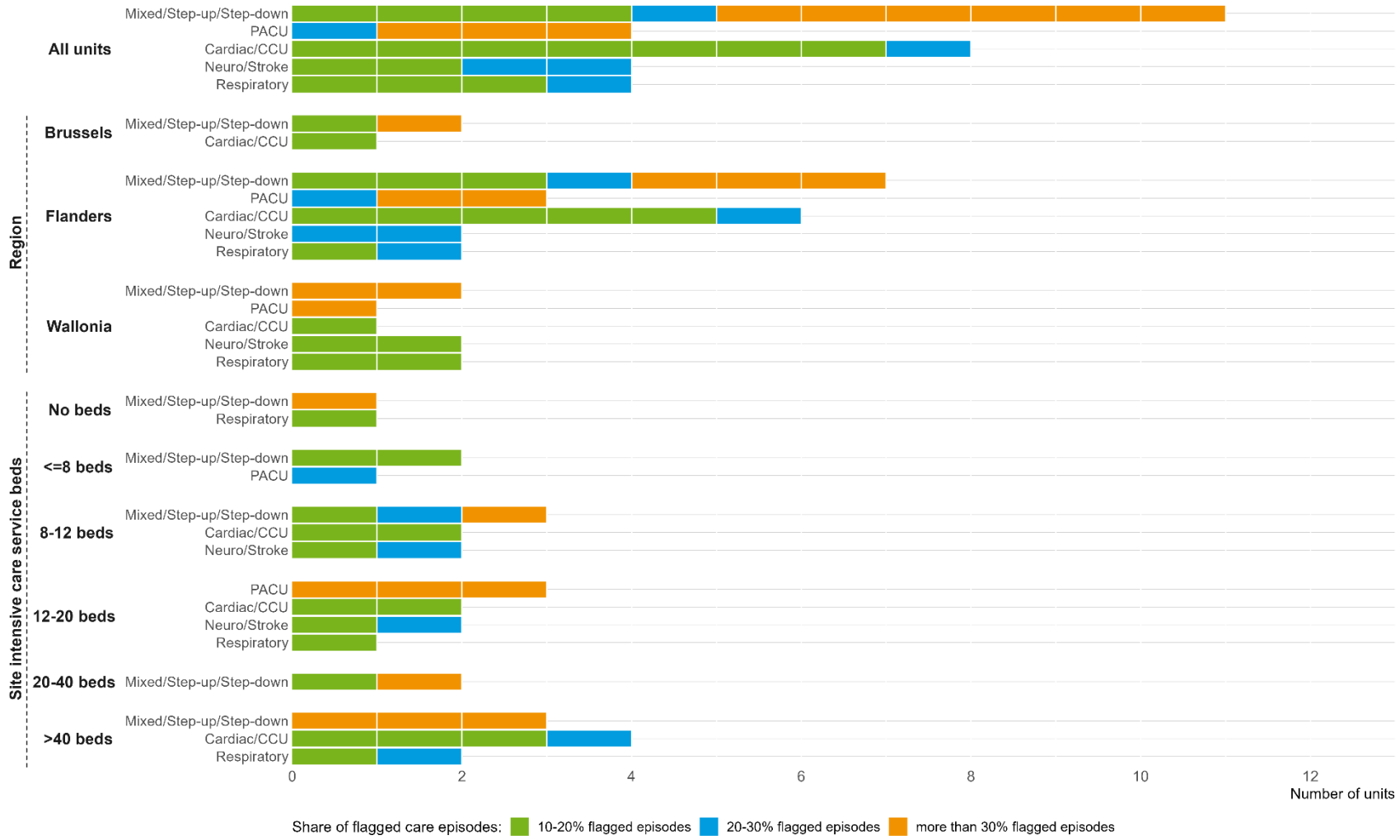
Based on pathological data (MDC, DRG, and diagnostic information), registered care items, episode duration, patient age profiles, and survey information (see Chapter 7), a classification of the selected general care units was made.

Figure 62 shows that among the 31 identified units, 8 specialised in cardiac care, 4 in neurological disorders and stroke, 4 in respiratory conditions, including one focused on paediatric patients, and 4 post-anaesthesia care units (PACUs), primarily managing short-stay surgical patients. Additionally, 11 mixed units combined cardiac, neurological, and respiratory care, with 5 labelled as step-up or step-down units in the survey. Mixed units and PACUs are the categories containing most units with high shares of flagged care episodes.

Regional differences are evident: Flanders has the highest number of selected units (20), a broader unit type distribution, and a greater prevalence of units with high shares of flagged care episodes compared to Brussels (3 units) and Wallonia (8 units).

When categorised by intensive care service bed availability on site, hospital sites without ICU beds or with fewer than 8 beds primarily contain mixed and PACU units, generally with lower proportions of flagged care episodes. In contrast, hospital sites with 12 to 20 beds or more than 40 ICU beds feature a greater diversity of unit types and a higher proportion of units exceeding 30% flagged episodes.

Figure 62 – Subdivision of selected general care units by unit type, region and intensive care service beds on site

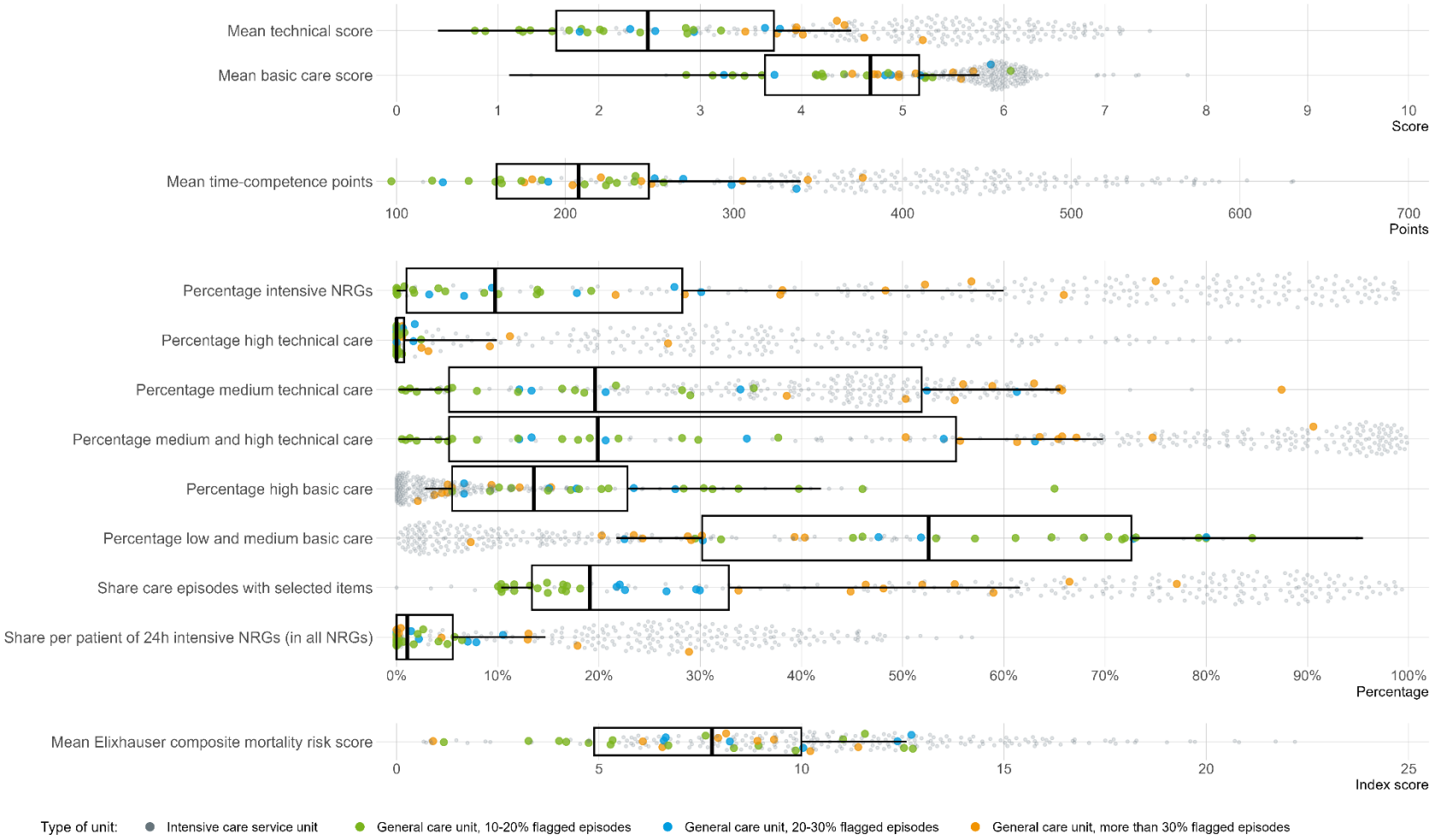


Source: Minimal Hospital Data (MZG – RHM).

Figure 63 illustrates the heterogeneity in various measures of care intensity, technical complexity, and severity of illness across general care units with different shares of flagged care episodes. The distribution of intensive care service units (see Figure 53) is included as a benchmark. We can draw a number of conclusions. First, most indicators of care intensity, such as the technical score, percentage of intensive NRGs, percentage of high-technical care, mean time-competence points, and percentage of low and medium-basic care, show that the selected general care units generally have lower care intensity than the majority of intensive care service units. However, their scores are similar to those of intensive care service units in the lower distribution tails. Second, there is greater overlap between general care units and intensive care service units regarding the percentage of medium-technical care, percentage of high-basic care, and the comorbidity burden of patients. Third, the mean basic care score is significantly lower in the selected general care units compared to intensive care service units. Fourth, general care units with a higher share of flagged care episodes tend to have greater care intensity across several indicators, including the mean technical score, percentage of intensive NRGs, percentage of high and medium-technical care, and percentage of low and medium-basic care. Notably, general care units with over 30% flagged care episodes exhibit characteristics more comparable to intensive care service units, particularly in terms of technical care intensity, which may be indicative of intermediate care. For other indicators, such as mean time-competence points and comorbidity burden, the distribution appears less correlated with the share of flagged care episodes. Fifth, substantial variation exists among general care units, particularly in the mean technical and basic care scores, percentage of intensive NRGs, percentage of medium-technical care, and percentage of low and medium-technical care. The variation in basic care scores is notably more pronounced than in intensive care service units.

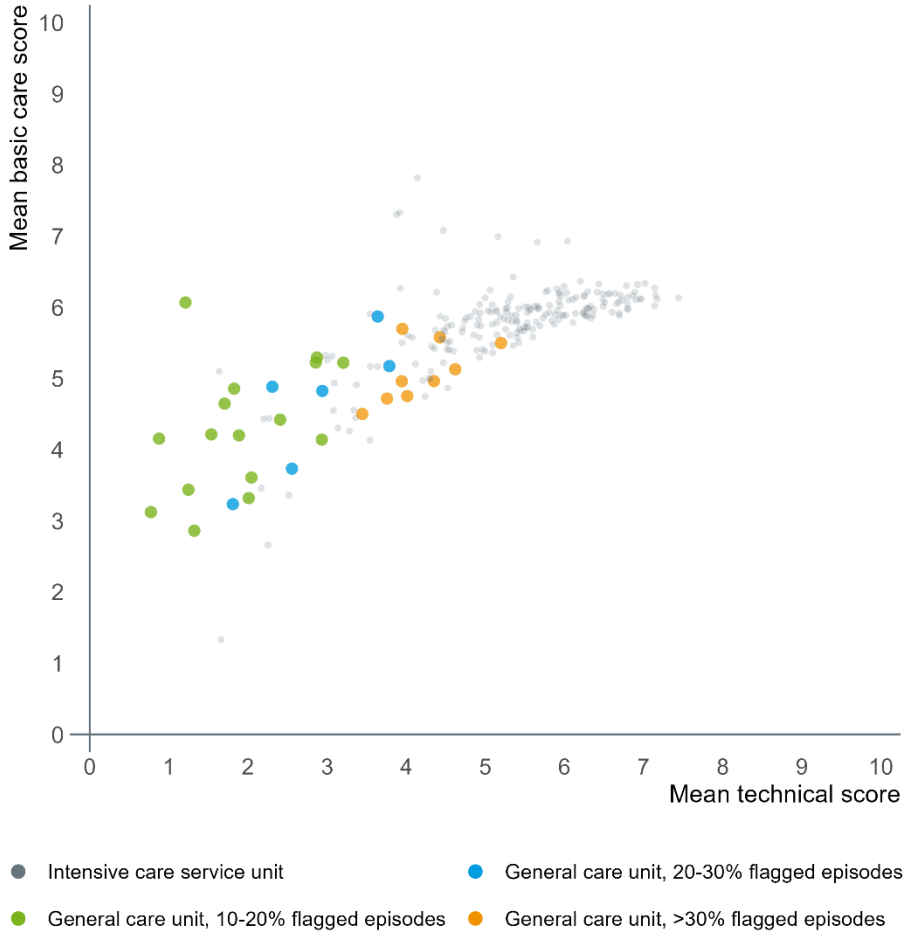
This is further supported by Figure 64, which depicts the relationship between the mean technical care score and the mean basic care score for general care units with different shares of flagged care episodes. While there is substantial variation, units with a higher share of flagged episodes tend to have higher technical and basic care scores, with those exceeding 30% (in orange) clustering closer to intensive care service units. The positive correlation between technical and basic care scores suggests that general care units providing more intensive technical care also tend to deliver more basic care, albeit to varying degrees.

Figure 63 – Measure of care intensity in selected general care units



Note: Every dot represents a unit. The whiskers of the boxplot correspond to the P10-P90 interval.
Source: Minimal Hospital Data (MZG – RHM).

Figure 64 – Correlation between mean technical score and basic care score for selected general care units



Note: Every dot represents a unit.
Source: Minimal Hospital Data (MZG – RHM).

5 COMPARISON OF THE NURSING ACTIVITIES SCORE (NAS) AND THE NURSING MINIMUM DATA SET FOR WORKLOAD MEASUREMENT

KEY POINTS

- In this chapter the ICU-specific Nursing Activities Score used in some Belgian hospitals and the general Nursing Minimum Data Set (VG-MZG / DI-RHM) used in all Belgian nursing units are compared to evaluate the association between workload measures of both systems as well as to evaluate if VG-MZG / DI-RHM can be improved in measuring ICU workload by adding specific items of the NAS. After all, the NAS was, in the literature, identified as the best-performing workload instrument for ICUs.
- The NAS usage in Belgian hospitals is rather scarce, with implementation challenges such as insufficient training, electronic data extraction difficulties, and resource constraints post-COVID-19. Only 8 hospitals provided usable data while based on an initial call, it was expected to retrieve data from at least 20 hospitals.
- The correspondence between the workload scores is limited, especially at lower aggregation levels, potentially due to differences in coding practices, over-/under-reporting, and mismatched shift definitions.
- Some NAS and VG-MZG / DI-RHM items measure similar activities (e.g. intracranial pressure, enteral feeding). Others require indirect derivations (e.g. respiratory support, lab tests). The correspondence between these items is generally higher compared to other items. Improving scores by machine learning for NAS-items that do not correspond (directly or via clinical meaningful indirect derivations) with the VG-MZG / DI-RHM, is limited and difficult in interpretation.
- Both systems are imperfect. It is clear that also the NAS has weaknesses such as the inclusion of items with poor discriminative power (e.g. overly frequent items like ‘Laboratory, biochemical investigations’ or rare activities like ‘Cardiopulmonary resuscitation after arrest’) and items that group several more specific nursing activities (e.g. hygiene procedures). Moreover, it is relatively old and potentially lacks adaptability to recent ICU practices. The limitations of VG-MZG / DI-RHM to use as an instrument to measure workload on ICUs are related to its generic nature (e.g. adding ICU-specific items that are both relatively frequent and have discriminative power might help to resolve this) and to the fact that it is registered per care episode (of 24 hours or shorter) and not per shift. Shift level information might be more accurate for staffing decisions but is not required to be used in payment systems that aim to differentiate budget allocations based on patient acuity. There is no silver bullet as neither system is perfect. However, both are useful for introducing objectivity into workload assessment when combined with qualitative inputs from head nurses and staff.

5.1 Introduction

This chapter focuses on the measurement of nursing workload within Belgian intensive care units (ICUs). Initially intended as an integral component of KCE report 353[32] on ‘Nurse staffing on Belgian intensive care units’, its inclusion was deferred due to the distinctive influence of COVID-19 on ICU nursing dynamics. The data collection pertaining to workload, originally part of the report, was subsequently postponed to not burden the nurses with extra work. The outcomes of the survey of nurses, which was executed as planned, were published in May 2022. Survey data were collected from December 2021 to February 2022 for 2 321 of the 4 851 nurses (47.8%) working in one of the 83 participating hospitals out of 100 Belgian hospitals with an ICU. To set the context, we start by presenting a brief overview of the principal findings from KCE report 353.[33]

A HIGHLY SKILLED NURSING WORKFORCE

The nursing staff in Belgian ICUs is characterised by a high level of expertise. Almost all nurses possess a Bachelor's level of education. Furthermore, a majority (77%) of these nurses have undergone advanced education in ICU care, either at the Bachelor or postgraduate level. The significance of having a nursing workforce equipped with specialised expertise in ICU care was underscored by the challenges posed by the COVID-19 pandemic. The work of ICU nurses is intricate and multifaceted, necessitating a blend of competencies and skills, including medical knowledge, psychosocial and relational qualities, a clinical perspective, adept medication management, and resilience to stress. ICU nurses are required to execute a diverse array of tasks simultaneously, shouldering significant responsibilities with potentially profound consequences.[33]

WELLBEING OF NURSES UNDER STRAIN AND PROBLEMS WITH QUALITY OF CARE REPORTED

KCE report 353 included an assessment of the repercussions of the two-year-long COVID-19 pandemic on nursing staff operating in Belgian ICUs. The study revealed a notable and disparate impact on the wellbeing of ICU nurses and the perceived quality of nursing care across various hospitals. Emotional burnout risk averaged at 43.1%, displaying considerable discrepancies among hospitals (25th percentile: 30.8%, 50th percentile: 42.9%, 75th percentile: 55.8%). The study reported a widespread perception of a decline in the quality of care, with 60.8% of nurses (67.1% in Flanders, 74.2% in Wallonia, and 69.5% in Brussels) expressing dissatisfaction compared to the pre-COVID-19 era. Moreover, a significant number of care activities were left undone during the last shift, on average 1.6 out of 5 planning and communication activities and 1.8 out of 9 clinical activities. Notably, key clinical activities such as frequent position changing (35.1%) and timely medication administration (29.1%) were frequently reported as required but left undone. Surprisingly, 24.5% of nurses noted that 'patient surveillance,' a critical responsibility of ICU nurses, was left undone during their last shift. Among planning and communication activities, emotional support for patients and family (49.2%) and multidisciplinary consultation meetings (38.8%) were most commonly reported as left undone. This comprehensive evaluation underscores the considerable challenges faced by ICU nurses during the prolonged COVID-19 crisis, with variations in impact observed across different hospitals and regions in Belgium.[33]

HOSPITALS WITH A BETTER NURSE WORKING ENVIRONMENT HAVE BETTER NURSE OUTCOMES AND HIGHER PERCEIVED QUALITY OF CARE

There is a solid evidence base illustrating that hospitals with a more favourable nurse working environment exhibit superior nurse outcomes and a heightened perception of care quality.[34-37] Also KCE report 353 included an evaluation of the nurse working environment within Belgian ICUs utilising the 32-item Nursing Work Index (NWI). An analysis of the five subdimensions of the NWI revealed positive outcomes for ‘physician-nurse relationships' and 'foundations for quality of care'. However, results for the 'leadership and management' dimensions presented a nuanced picture, with commendable scores for certain items juxtaposed with suboptimal scores, particularly on aspects such as 'praise and recognition.' The NWI dimensions exhibiting subpar results include ‘staffing & resource adequacy' and 'nurse participation in hospital affairs'. Our study underscores the imperative of investing in an optimal nurse working environment, aligning with findings in the existing literature. Hospitals demonstrating a superior work environment consistently outperformed counterparts in nurse-related outcomes. In essence, hospitals fostering an excellent work environment successfully mitigated the impact on the wellbeing of ICU staff, even amid the challenges posed by the COVID-19 crisis.[33]

PATIENT-TO-NURSE RATIOS REVEAL LITTLE VARIATION AT THE SURFACE ALTHOUGH CONSIDERABLE VARIATION EXISTS UNDERNEATH THE SURFACE

Based on the results published in KCE report 353, patient-to-nurse ratios in Belgian ICUs may appear relatively consistent on the surface. The survey included in KCE report 353 indicated an average patient-to-nurse ratio of 2.3 (2.2 during day shifts and 2.7 during night shifts). The interquartile range (IQR) for variation across hospitals is limited at 0.5. Yet, beneath this lies substantial variation. When

translating Belgian nurse staffing licensing standards for ICUs to patient-to-nurse ratios, a maximum of 3:1 is implied. While pre-pandemic perceptions of patient-to-nurse ratios for ICUs were not universally deemed inadequate, the COVID-19 crisis brought latent issues to the forefront. Concerns raised during focus groups included the default use of a 3:1 ratio, especially during nights, and insufficient compensation for staff absenteeism, leading to higher patient-to-nurse ratios. Head nurses often allocate part of their time to direct patient care to meet predefined ratios, hindering their management and leadership roles. Furthermore, the lack of a formal organisational system to differentiate ICUs by levels of care with adapted patient-to-nurse ratios for each level, was pointed out as a problem. As a consequence, according to the interviewed stakeholders, the patient-to-nurse ratios in Belgian ICUs are insufficiently tailored to case-mix and patient acuity differences across Belgian ICUs. Moreover, an objective measurement of patient acuity adapted to the ICU-specific context was clearly voiced as one of the missing elements to differentiate staffing levels across ICUs in an adequate way (both across and within hospitals). Nonetheless, Belgium has, with the Nursing Minimum Data Set (as part of the Minimal Hospital Data Set), data about nursing activities performed on all Belgian ICUs during the first 15 days of March, June, September and December of each year.[33] Adequate staffing of ICUs is of utmost importance as imbalances between staffing and caseload might impact patient outcomes.[38, 39]

COMPARISON OF WORKLOAD MEASURED BY THE ROUTINELY COLLECTED NURSING DATA AND AN ICU-SPECIFIC PATIENT CLASSIFICATION SYSTEM

An objective measurement of workload can guide an accurate nurse staffing allocation across ICUs based on objective criteria and avoid over- and understaffing.[40] Therefore, in the current chapter we will compare workload measurement based on two measurement systems: the Nursing Activities Score (NAS) and the Nursing Minimum Data Set (VG-MZG / DI-RHM), which was already done before in small-scale studies.[41-44] The VG-MZG / DI-RHM has the objective to adjust the allocation of budgets via the Belgian hospital payment system for differences in intensity of nursing care. In addition, it was also designed to guide staffing decisions based on the measurement of 'intensity of care'. Since these data are routinely collected (4*15 days a year), we wanted to study if they can be used to guide staffing decisions on ICU, or if adjustments to the VG-MZG / DI-RHM items are required to make it more suitable to be used in the ICU context.

5.2 Research questions

This chapter has the following research questions:

- What is the association between workload as measured by the VG-MZG / DI-RHM compared to the NAS in a selection of Belgian ICUs (at the level of the nursing unit, hospital stay and registration day)?
- Which NAS-items are captured by information in the VG-MZG / DI-RHM?
- To what extent are nurse staffing levels of ICUs associated with the workload as measured by the NAS and VG-MZG / DI-RHM?

5.3 Methods

5.3.1 Recruitment of hospitals and nursing units

To evaluate if the VG-MZG / DI-RHM can be used to support staffing policies in ICUs it is compared with the NAS, which is according to the literature the best-performing scoring system.[40] This involves studying the association between the VG-MZG / DI-RHM profiles and NAS-scores in a selection of units.

In September 2021, as part of KCE report 353, all general acute and university hospitals received an invitation to participate in the study including two parts: part I (survey of nurses – published in May 2022); part II (retrospective analysis of NAS and VG-MZG / DI-RHM – subject of the current study). All hospitals that were interested were asked to participate with all ICUs of the hospital (hospitals with

various sites could decide to participate with one or more hospital sites). A total of 83 hospitals participated in the first part and 20 expressed interest to participate in the second part. A prerequisite to participate in part II was to have previous experience with the NAS and the ability to extract these data from the electronic patient records. Every hospital had to appoint within its staff (e.g. nurse manager) a single point of contact (field manager) to communicate with the research team. The research team evaluated in collaboration with the hospital field manager if the hospital was able to submit the data in time (e.g. staff is used or trained to work with NAS; IT-facilities allow automatic data extraction, have resources to submit the data in the required formats and with the appropriate identifiers). KCE concluded a 'data processing protocol agreement' with each hospital. After first consultation rounds with the 20 hospitals that expressed their interest to participate in this part of the study, a Data Transfer Agreement was concluded with 10 hospitals. Reasons for not participating were lack of experience with the NAS-instrument, no automatic data extraction, other priorities in the aftermath of the COVID-19 pandemic (June 2022), etc.

5.3.2 Instruments and measures

In this study two instruments to measure the workload in the ICU (i.e. NAS and VG-MZG / DI-RHM) are used.

NURSING ACTIVITIES SCORE (NAS)

- The NAS is one of the various ICU-specific patient classification systems that are used to objectivise patient acuity. Over time, different scoring systems have been developed aiming to quantify the nursing workload (e.g. TISS-74, TISS-28, NEMS).[45, 46] The NAS quantifies the need for nursing care by assigning a score to each patient based on the performed nursing tasks. The NAS consists of 23 items (both direct and indirect nursing care activities, including hygiene, mobilisation, administrative activities, psychologic support for patient and family), with dichotomous or ordinal response categories. The unit of measurement is the patient level and can be encoded per shift or per 24h period. When data are coded per shift, the highest NAS per item is taken to calculate the score per day.
- The NAS is reported to explain 81% of nursing activities.[45] Each of the 23 items and subitems of the NAS are attributed a score reflecting the time spent per task. The total score per patient can vary from 0 to 170 points. One NAS point corresponds to a nursing workload equivalent of 4.8 minutes. It is, based on the initial validation studies, considered that the workload of one nurse should not exceed 100 NAS points.[47] Recent research suggests that applying '100 points per nurse' as a general rule of thumb in practice might be contraindicated. After all, Margadent et al. (2020)[39] demonstrated that a NAS greater than 61 points per nurse was associated with higher in-hospital mortality.
- A systematic review of Hoogendoorn et al. (2020)[40] showed that the NAS was superior when compared to other ICU scoring systems in measuring ICU nursing workload. Moreover, the NAS has been validated in at least 15 countries and in various types of ICUs (organ-specific, general surgical, general medical, mixed, large and medium sized). To date, the NAS is the most commonly used instrument to measure nursing workload in ICUs. Also in Belgium it is widely supported by the (French-speaking) professional organisation of ICU nurses[48m] and also several Flemish hospitals[49,50] register the NAS systematically on their ICU.[51, 52] Although the NAS outperforms other ICU-specific nursing workload instruments, it also has its limitations. A recent review confirmed that it is the best-performing nursing workload instrument based on an assessment of psychometric properties.[53] Yet, the NAS was also criticised as not covering all dimensions of the complexity of care, nor taking into account aspects like years of experience, level of nursing competencies, mentoring new staff or nurses. Moreover, an update to incorporate recent changes in clinical practice might be needed to increase its content validity.[53] Therefore,

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m http://www.siznursing.be/nas/

when the NAS is referred to as the 'gold standard' in the rest of the chapter, the reader should consider it as the 'best-performing' nursing workload instrument with inherent limitations.

THE BELGIAN NURSING MINIMUM DATA SET (VG-MZG / DI-RHM)

- The Nursing Minimum Data Set (VG-MZG / DI-RHM) is a coding system that is used in the context of the Belgian hospital payment system and is registered 4 times a year during 15 days on all Belgian acute hospital wards. Since 2008, the VG-MZG / DI-RHM has been updated and expanded with more items that are specific to the care provided in ICUs. Nevertheless, the VG-MZG / DI-RHM is rarely used by hospitals to guide their ICU staffing allocation decisions. The VG-MZG / DI-RHM includes 62 items (direct nursing care activities)[29] with dichotomous, nominal, ordinal or continuous (frequencies) response categories. Each response category corresponds to a number of points which are used to calibrate nursing resource groups or NRGs (i.e. groups of nursing activities that characterise a certain nursing profile that is used in the hospital payment system) . These 'relative points' were constructed based on a Delphi-approach to assess what the required nursing time and competency level for each item/response category was. Each point corresponds to a required nursing time of five minutes. Several versions of these points (see KCE report 325)[11] exist and are currently undergoing an update.[30] For the current study, we use the time-competency points applied by the Federal Public Service of Public Health in the payment system.[28] It should be noted that the correlation between the different point systems is very high,[11] as also confirmed by preliminary analyses testing the different point systems on the data in the current study. The unit of measurement is the patient level per 24 hours period or care episode (i.e. each time a patient changes from nursing unit during a day, a new care episode starts and amounts to the time the patient actually stays in that nursing unit on that day). Hence, during a single day, a patient can have multiple care episodes, even multiple care episodes on the same nursing unit. If a patient remains on the same nursing unit from midnight to midnight, there is only one care episode.
- Within the Belgian Hospital Discharge Data Set (MZG / RHM) there is a module (i.e. EMPLODAY) to encode nurse staffing per nursing unit per registration day of the VG-MZG / DI-RHM (i.e. the first 15 days of March, June, September and December). Worked hours and minutes for staff members who actually provide nursing care or support are recorded. If a staff member is absent for a period of more than half a day (e.g. for training), his/her hours of work are not recorded. An absence of less than half a day (e.g. for a meeting) is recorded as working time. Hours worked by nurses and caregivers in float teams are also registered when this staff replaces or reinforces the nursing team of the care unit. Working time is recoded by category: i.e. CAT1 nurse or midwife with university degree; CAT2 nurse or midwife with higher education degree; CAT3 nurse with secondary education degree; CAT4 caregiver staff; CAT5 support staff; CAT6 students. Although it has not been a compulsory registration since 2017, the module still exists.[11] Participating hospitals were asked to extract these data from their data warehouse for the June 2022 period.

5.3.3 Databases

Hospitals were asked to transmit the data to the research team. Prior to submitting the data, the hospital data information departments had to generate the following 5 key identifiers to enable a link between the NAS and the VG-MZG / DI-RHM (see also Appendix 1.2 in the Supplement): (1) hospital licence number, (2) site code, (3) nursing unit code, (4) pseudonymised stay ID, (5) pseudonymised patient ID (unique for each patient in the same hospital). Key identifiers (1) to (3) can be readily extracted from the VG-MZG / DI-RHM data collection, while key identifiers (4) and (5) are unique for this study to ensure privacy and impede linkage with other data sources. Key identifiers (4) and (5) replace the original hospital stay identifier (staynum) and hospital patient identifier (patnum) in the VG-MZG / DI-RHM. The correspondence table between the pseudonymised stay ID and the original hospital stay identifier is only known to the hospital staff.

The research team conducted a data quality check (e.g. format, missing data, linkage, etc.). In case of data quality problems, the research team liaised with the hospital field manager to improve the quality of the submitted data. This was a cumbersome process, suggesting either that the experience

with the NAS is more limited than was indicated in the letters of intention to participate or that due to the aftermath of the COVID-19 pandemic the study was not given priority.

The data are stored on a secured server of the KCE for a period of 10 years. The following data sources were collected:

- NAS data (item-level) per patient, stay, day and shift, for all patients admitted to the participating ICUs during the period 1-15 June 2022. This database includes the registration date and identifiers for the hospital, hospital site, as well as a pseudonymised hospital stay and patient ID. There are two data templates depending on the software package used by the hospital (Epimed or Medtronic).
- Patient level data include data that are available via the Hospital Discharge Data Set (MZG / RHM) including year of birth, gender and verified admission diagnosis. This database includes the identifiers for the hospital as well as a pseudonymised hospital stay and patient ID. Due to incompleteness of the variable 'verified admission diagnosis' in the delivered data of several hospitals, this variable was dropped from the analysis.
- VG-MZG / DI-RHM data (item-level per care episode, i.e. per nursing unit, patient, stay and day) for the period 1-15 June 2022. This database includes the registration date and identifiers for the hospital and the nursing unit as well as a pseudonymised hospital stay ID.
- Staffing data for the participating ICUs as encoded in EMPLODAY (hours and minutes per staffing category: CAT1-CAT6) per registration day for the period 1-15 June 2022. This database includes identifiers for the hospital, hospital site and nursing unit. Since EMPLODAY is no longer a compulsory registration in the VG-MZG / DI-RHM, only 1 hospital could submit these data. Therefore it was decided to exclude the third research question from the analysis.

5.3.4 Data analysis

DATA QUALITY CHECKS

This is a descriptive study that makes use of databases that include information at the hospital level (type of hospital/size, etc.), nursing unit level (number of beds, etc.), registration day per nursing unit (workload measure per nursing unit for each of the 15 registration days, etc.), shift per nursing unit per registration day (NAS-scores), etc.

First, data quality was checked in particular with regard to missing values in the NAS registration. As the VG-MZG / DI-RHM is a compulsory registration, it can be assumed to be complete. Next, for the item level analysis, observations with missing values or low data quality were removed. For the nursing unit/hospital analysis (see below), hospitals with major data issues (e.g. NAS-items that were not coded or for which the descriptive statistics indicated major coding issues) were removed from the analysis.

Prior to data analysis, we evaluated the validity of the data. Given the lack of perfect alignment between a 24-hour period based on NAS shifts (comprising two or three shifts) and VG-MZG / DI-RHM care episodes, we verified the correspondence of selected NAS-items recorded during the night shift of day T with VG-MZG / DI-RHM items recorded during care episodes of both day T and day T+1. If a significantly better match was observed between the night shift of day T and the care episodes of day T+1, the date of the night shift was adjusted to enhance the accuracy of the comparative analysis. This adjustment was made for data from three hospitals, based on our assessment.

Hospital stays from patients with VG-MZG / DI-RHM but without a NAS-registration (e.g. due to registration issue with NAS, due to very short passage in INT-unit or due to the potential mismatch in date of registration for the night shift (see above)) were removed to keep the sample balanced (99 stays in 3 hospitals).

Second, we performed descriptive analyses separately for the VG-MZG / DI-RHM and the NAS.

CORRELATION BETWEEN NAS AND VG-MZG / DI-RHM SCORES

To assess if the level of intensity measured by the VG-MZG / DI-RHM is associated with that measured by the NAS, we performed a correlation analysis at the level of the stay, per registration day and unit. Both a correlation between sum-scores (total NAS-points and total VG-MZG / DI-RHM-points) and average scores per observation were calculated by means of Pearson's correlation coefficient statistics.[11, 54]

CORRESPONDENCE OF VG-MZG / DI-RHM- AND NAS-ITEMS THAT ARE MAPPED BASED ON A CONTENT ANALYSIS

A Health Services Researcher with a background as ICU nurse mapped the items of the NAS and the VG-MZG / DI-RHM based on content (see Appendix 1.2 in the Supplement). The mapping was reviewed by another Health Services Researcher with a general nursing background. For the analysis, we converted both the VG-MZG / DI-RHM- and the NAS-items into binary format: registered or not during a period of 24 hours in a specific unit and for a specific stay (level of observation: unit-day-stay).

Based on the confusion matrix below, the following metrics were calculated to assess the correspondence between binary variables:[54, 55]

		VG-MZG / DI-RHM-item	
		Not registered	Registered
NAS-item	Not registered	N00	N01
	Registered	N10	N11

1. **Phi coefficient**: statistical measure to assess the strength of association between two dichotomous variables on a scale from -1 to 1, where 0 means no association. It is the equivalent for Pearson correlation in case of binary variables.

$$\varphi = \frac{N_{11}N_{00} - N_{10}N_{01}}{\sqrt{(N_{11} + N_{10})(N_{01} + N_{00})(N_{11} + N_{01})(N_{10} + N_{00})}}$$

2. **Accuracy (percentage correct):** the proportion of correct matches varying from 0% to 100%. The higher the value, the better the correspondence.

$$Accuracy = \frac{N_{11} + N_{00}}{N_{11} + N_{00} + N_{10} + N_{01}}$$

3. **Sensitivity**: measures how good the VG-MZG / DI-RHM is able to detect the coding of a NAS-item, calculated as the number of correct identified NAS- items that were coded varying from 0% to 100%.

$$Sensitivity = \frac{N_{11}}{N_{11} + N_{10}}$$

4. **Specificity**: measures how good the VG-MZG / DI-RHM is able to detect the absence of the coding of a NAS-item, calculated as the number of correct identified absent NAS-items varying from 0% to 100%.

$$Specificity = \frac{N_{00}}{N_{00} + N_{01}}$$

MACHINE LEARNING: WHICH VG-MZG / DI-RHM-ITEMS DETERMINE NAS-SCORES?

To discover patterns in the data between NAS-items and VG-MZG / DI-RHM-items, machine learning was used. Machine learning encompasses a wide range of algorithms and techniques including both traditional statistical methods and more modern techniques like deep learning or ensemble learning.[55-

[58] By learning patterns from data, these models can make predictions, recognise patterns, and make decisions. It is a powerful tool in data-analysis and predictive modelling across various fields.

Machine learning can be broadly classified into three categories: supervised learning, unsupervised learning, and reinforcement learning.[56, 57, 59] We used techniques from supervised learning.[55-57] It involves training a model on a labelled dataset, where the input data (VG-MZG / DI-RHM) is paired with the correct output (NAS). The model learns to map inputs to outputs by minimising the error between its predictions and the actual values. Supervised learning is widely used in various applications, including classification, regression, and anomaly detection.[55-57]

We applied three commonly used techniques in supervised learning techniques, that are not too complex and allow to interpret the association between input variables and the output variable: rule-based models, decision trees and logistic regression.[55] Each of these methods has strengths and weaknesses. Note that more complex methods exist that allow for more accurate predictions based on the data at hand, such as ensemble methods, support vector machine or neural networks.[55-57] These methods, however, are difficult to interpret and to understand the relation between the VG-MZG / DI-RHM on the one hand and the NAS on the other hand, and were therefore not applied in the analysis. The analysis was performed using R version 4.4.1.

- **Rule-based models**.[55, 58] Rule-based models use a set of 'if-then' rules to make predictions. Rule-based systems are interpretable and straightforward to implement, making them suitable for scenarios where transparency and simplicity are crucial.
    - *Advantages*: Easy to understand and interpret, transparent decision-making process.
    - *Disadvantages*: Can become complex and unmanageable with a large number of rules, may not generalise well to unseen data. Yet, we only use the simplified 1-rule model. This model is based on one input variable only.[55]
- **Decision tree models.**[55, 58] Decision trees are a type of model that splits the data into subsets based on the values of the input variables, forming a tree-like structure. Each internal node represents a decision based on an input variable, the branches represent the possible outcomes of the decision, and each leaf node or endpoint represents the final outcome based on the path taken through the tree.
    - *Advantages*: Easy to visualise and interpret, can handle both numerical and categorical data, requires little data preprocessing.
    - *Disadvantages*: Prone to overfitting, especially with deep trees, can be unstable with small variations in data.

We use the decision tree model with CART (Classification and Regression Trees) algorithm.[55] The CART algorithm recursively partitions the data into subsets based on the most significant attribute at each node, creating a binary tree structure that minimises impurity (in case of classification). It uses cost-complexity pruning to simplify the tree and avoid overfitting. To further prevent overfitting, we enforce that each internal node must cover at least 25 observations, that there are 10 observations in each leaf node and that the maximum depth of the tree is limited. We run models with a maximum depth of the tree limited to 3 and 5.

- **Logistic regressions**.[54, 55, 60] Logistic regression is a statistical method used for binary classification problems. It models the probability that a given input belongs to a particular class. The model uses a logistic function to map predicted values to probabilities between 0 and 1.
    - *Advantages*: Simple and efficient, works well for linearly separable data, provides probabilities for class membership.
    - *Disadvantages*: Assumes a linear relationship between the input features and the log-odds of the outcome, can struggle with non-linear relationships.

To prevent overfitting and find a reasonable trade-off between goodness of fit and model parsimony, we applied stepwise selection to identify the most suitable subset of predictors for the model by iteratively adding and removing predictors based on the Bayesian Information Criterion (BIC).[60, 61]

PERFORMANCE

We measure performance by looking at the agreement between actual (registered NAS) values and predicted values based on the VG-MZG / DI-RHM, age (continuous variable in years) and shift information (all-day shifts available: an indicator for whether all shifts in the NAS were registered, a 24-hour registration). There are many different ways to measure how successful each algorithm is in predicting NAS-values, each with different perspectives, strengths and weaknesses. All measures (except the C-statistic) can be directly derived from the confusion matrix:[55]

		Predicted NAS-item	
		Not predicted	Predicted
Actual NAS-items	Not registered	N00	N01
	Registered	N10	N11

We used, next to accuracy, sensitivity and specificity (see above) the following performance measures.[54, 55, 60]

1. **Kappa Cohen Statistic.** Cohen's Kappa is a statistical measure that compares the observed accuracy with the expected accuracy (random chance) in classification problems. This is especially important for datasets with severe class imbalance because a classifier can obtain high accuracy simply by always guessing the most frequent class (the accuracy of such trivial model is called the no-information rate or NIR). The Kappa statistic will only reward the algorithm if it is correct more often than this simplistic strategy. In essence, the Kappa statistic adjusts the accuracy measure to account for the baseline accuracy captured by the NIR.
   It ranges from negative infinity to 100%, with higher values indicative of better agreement. As a rule of thumb, we can say that negative values indicate that agreement is less than chance, between 0% and 20% is poor agreement, between 20% and 40% fair agreement, between 40% and 60% is moderate agreement, between 60% and 80% is substantial agreement and between 80% and 100% is very good agreement.

$$\text{Kappa} = \kappa = \frac{p_o - p_e}{1 - p_e}$$

$$with\ p_o = \text{accuracy} = \frac{N_{00} + N_{11}}{N_{00} + N_{01} + N_{10} + N_{11}}$$

$$and\ p_e = \text{expected accuracy by chance} = \frac{(N_{00} + N_{01})(N_{00} + N_{10}) + (N_{10} + N_{11})(N_{01} + N_{11})}{(N_{00} + N_{01} + N_{10} + N_{11})^2}$$

2. **C-statistic (Area Under the ROC Curve).** The C-statistic, also known as the area under the ROC curve (AUC), measures the discriminative ability (how well a model distinguishes between positive and negative cases) of a binary classification model. It summarises the trade-off between sensitivity and specificity across all possible thresholds. The C-statistic can be interpreted as the probability that a randomly chosen positive instance (with NAS registration) has a higher chance of a predicted NAS registration than a randomly chosen negative instance (no NAS registration). It can be used in imbalanced datasets where one class may dominate.
   It varies between 0% and 100%, higher values indicate a better discriminative ability. A C-statistic of 50% indicates no discrimination ability, meaning the model's predictions are no better than random guessing. As a rule of thumb, we can say that values between 0 and 50% point to an unacceptable model, between 50% and 70% is poor discrimination, between 70% and 80% is acceptable discrimination, between 80% and 90% is good to excellent discrimination and between 90% and 100% is outstanding discrimination.

5.4 Results

Based on an evaluation of the descriptive statistics (e.g. frequency NAS-items per nursing unit; NAS-points per unit and VG-MZG / DI-RHM-points per unit) it was decided to exclude data from two hospitals. Identified problems were, for instance, implausibly low scores on NAS-items 'support care relatives patient'; 'administrative tasks'; 'respiratory support'; 'care artificial airways'; 'treatment improving lung function'; 'vasoactive medication'; 'IV replacement fluid losses' as well as low total NAS-scores. Also the non-ICU units were removed from the sample (3 units in the remaining 8 hospitals). In addition, initial data checks showed that two NAS-variables (i.e. 4. Hygiene and 7. Support) were not coded in two hospitals. For analyses that concern these variables, these two hospitals were excluded.

5.4.1 Study population

The sample (see Table 14) includes 8 hospitals of which 1 is a university hospital (4 from Flanders; 3 from Wallonia and 1 from Brussels) and 21 ICUs[n] with a total of 301 beds. All hospitals participated with 1 site, but several are organised in multiple nursing units. There are 4 hospitals with 1 ICU, 1 hospital with 2 ICUs, 1 hospital with 3 ICUs, 1 hospital with 5 ICUs and 1 hospital with 7 ICUs. The average patient-to-nurse ratios are 2.3 (SD ± 0.6) during a morning shift, 2.6 (SD ± 0.7) during an afternoon shift and 3.1 (SD ± 0.9) during the night.

Table 14 – Sample characteristics

Hospitals	8
Units	21
Beds available* in the ICUs on a typical weekday	301
Patient-to-nurse ratio morning shift on a typical weekday (mean ± SD)	2.3 ± 0.6
Patient-to-nurse ratio afternoon shift on a typical weekday (mean ± SD)	2.6 ± 0.7
Patient-to-nurse ratio night shift on a typical weekday (mean ± SD)	3.1 ± 0.9

**This concerns the beds that are usually 'operational' in the ICU; Source data (see Chapter 7)*

The sample includes 815 hospital stays (68% male patients; average age of 59.4 years (SD ± 21); median length of stay of 20 days [P25: 10 – P75: 39]), and 3 955 coupled VG-MZG / DI-RHM and NAS observations (of which 2 773 observations or 70% have a NAS registration in all three shifts) (see Table 15). There are 3 518 observations for a morning shift, 3 474 observations for an afternoon shift and 3 250 observations for a night shift.

[n] Burn units are included in the ICU count.

Table 15 – Number of coupled registrations (NAS and VG-MZG / DI-RHM) per shift and hospital

	Stays	Coupled observations	NAS all day observations: N (%)	NAS observations morning shift	NAS observations afternoon shift	NAS observations night shift
All	815	3 955	2 773 (70%)	3 518	3 474	3 250
Hospital A	116	696	541 (78%)	649	644	587
Hospital B	140	604	375 (62%)	534	529	441
Hospital C	29	111	82 (74%)	102	94	91
Hospital D	29	136	117 (86%)	121	131	132
Hospital E	32	197	106 (54%)	182	179	122
Hospital F	270	1 348	952 (71%)	1 149	1 123	1 177
Hospital G	137	540	351 (65%)	490	464	419
Hospital H	62	323	249 (77%)	291	310	281

5.4.2 NAS

Table 16 shows the count and percentage of NAS-items scored per shift and over 24h (maximum score per item over all shifts in a given day). There are 7 items with a very high frequency: 1. 'Monitoring and titration' (97%); 2. 'Laboratory, biochemical investigations' (90%); 3. 'Medication, vasoactive drugs excluded' (90%); 4. 'Hygiene procedures' (98%); 6. 'Mobilisation and positioning, including procedures' (96%); 8. 'Administrative and managerial tasks' (97%); 17. 'Quantitative urine output measurement' (87%). For most of these items (items 1, 4, 6 and 8), subcategories allow to differentiate in intensity. 'Monitoring and titration', for instance, is divided into hourly monitoring of vital signs (55%); present at the bedside and continuous observation for more than 2 hours in any shift (30%) and present at the bedside and active for 4 hours in any shift (12%).

A 'Cardiopulmonary resuscitation after arrest' (item 15) is very rare (15 shifts). Other low frequency items are 14. 'Left atrium monitoring: pulmonary artery catheter' (5%); 16. 'Hemofiltration techniques, dialysis techniques' (6%); 18. 'Measurement of intracranial pressure' (2%) and 19. 'Treatment of complicated metabolic acidosis/alkalosis' (7%). Also items 22. 'Specific intervention(s) in the intensive care unit (e.g. pacemaker introduction)' (11%); and 23. 'Specific interventions outside the intensive care unit: surgery or diagnostic procedures (e.g. discharge and decease; making patients ready for transport to investigations)' (10%) show low frequency.

As such, only 9 items have a frequency between very low and very high: 5. 'Care of drains, all (except gastric tube)' (48%); 7. 'Support and care of relatives and patient' (65%); 9. 'Respiratory support' (65%); 10. 'Care of artificial airways' (45%); 11. 'Treatment for improving lung function' (65%); 12. 'Vasoactive medication' (42%); 3. 'Intravenous replacement of large fluid losses' (23%); 20. 'Intravenous hyperalimentation' (16%) and 21. 'Enteral feeding through gastric tube' (30%). For some items, differences between shifts can be observed. Hygiene procedures are more often performed during morning shifts (97%) compared to afternoon and night shifts (both 77%). Emotional support during night shifts (47%) is lower than during the day shifts (56%). The item 'Intravenous replacement of large fluid losses' is performed more during the night (21%) compared to day shifts (9-10%). For all other NAS-items the results are comparable across shifts.



Table 16 – Description of NAS-scores

Items	Day (n=3 955)	Morning shift (n=3 518)	Afternoon shift (n=3 474)	Night shift (n=3 250)
1. Monitoring and titration	3 826 (97%)	3 279 (93%)	3 317 (95%)	3 098 (95%)
1a. Hourly vital signs, regular registration and calculation of fluid balance	2 194 (55%)	2 331 (66%)	2 388 (69%)	2 236 (69%)
1b. Present at bedside and continuous observation or active for 2 h or more in any shift	1 168 (30%)	753 (21%)	750 (22%)	680 (21%)
1c. Present at bedside and active for 4 h or more in any shift for reasons of safety	464 (12%)	195 (6%)	179 (5%)	182 (6%)
2. Laboratory, biochemical investigations	3 557 (90%)	2 824 (80%)	2 709 (78%)	2 852 (88%)
3. Medication, vasoactive drugs excluded	3 573 (90%)	2 804 (80%)	2 827 (81%)	2 530 (78%)
4. Hygiene procedures	3 557 (98%)	3 138 (97%)	2 429 (77%)	2 287 (77%)
4a. Performing hygiene procedures such as dressing of	2 239 (62%)	2 207 (68%)	1 665 (53%)	1 690 (57%)
4b. The performance of hygiene procedures took 2 h in any shift	1 092 (30%)	793 (25%)	681 (22%)	536 (18%)
4c. The performance of hygiene procedures took 4 h in any shift	226 (6%)	138 (4%)	83 (3%)	61 (2%)
5. Care of drains, all (except gastric tube)	1 882 (48%)	1 611 (46%)	1 532 (44%)	1 415 (44%)
6. Mobilisation and positioning, including procedures	3 816 (96%)	3 268 (93%)	3 287 (95%)	3 022 (93%)
6a. Performing procedure(s) up to three times per 24 h	637 (16%)	710 (20%)	743 (21%)	823 (25%)
6b. Performing procedure(s) more frequently than 3 times per 24 h, or with two nurses, any frequency	2 991 (76%)	2 459 (70%)	2 477 (71%)	2 150 (66%)
6c. Performing procedure with three or more nurses, any frequency	188 (5%)	99 (3%)	67 (2%)	49 (2%)
7. Support and care of relatives and patient	1 903 (65%)	1 449 (56%)	1 404 (56%)	1 119 (47%)
7a. Support and care of either relatives or patient requiring full dedication for about 1 h in any shift	1 477 (50%)	1 224 (47%)	1 184 (47%)	1 035 (43%)
7b. Support and care of either relatives or patient requiring full dedication for 3 h or more in any shift	426 (15%)	225 (9%)	220 (9%)	84 (4%)
8. Administrative and managerial tasks	3 821 (97%)	3 277 (93%)	3 310 (95%)	3 084 (95%)

8a. Performing in routine	2 713 (69%)	2 733 (78%)	2 834 (82%)	2 705 (83%)
8b. Performing administrative and managerial tasks requiring full dedication for about 2 h in any shift	923 (23%)	483 (14%)	413 (12%)	303 (9%)
8c. Performing administrative and managerial tasks requiring full dedication for about 4 h or more of the time in any shift	185 (5%)	61 (2%)	63 (2%)	76 (2%)
9. Respiratory support	2 571 (65%)	2 211 (63%)	2 038 (59%)	1 929 (59%)
10. Care of artificial airways	1 798 (45%)	1 555 (44%)	1 410 (41%)	1 296 (40%)
11. Treatment for improving lung function	2 562 (65%)	2 053 (58%)	1 994 (57%)	1 983 (61%)
12. Vasoactive medication	1 647 (42%)	1 297 (37%)	1 265 (36%)	1 069 (33%)
13. Intravenous replacement of large fluid losses	905 (23%)	339 (10%)	317 (9%)	690 (21%)
14. Left atrium monitoring: pulmonary artery catheter	183 (5%)	145 (4%)	143 (4%)	142 (4%)
15. Cardiopulmonary resuscitation after arrest	15 (0%)	7 (0%)	3 (0%)	5 (0%)
16. Hemofiltration techniques, dialysis techniques	225 (6%)	163 (5%)	180 (5%)	136 (4%)
17. Quantitative urine output measurement	3 452 (87%)	3 026 (86%)	2 902 (84%)	2 792 (86%)
18. Measurement of intracranial pressure	94 (2%)	79 (2%)	82 (2%)	79 (2%)
19. Treatment of complicated metabolic acidosis/alkalosis	269 (7%)	169 (5%)	158 (5%)	95 (3%)
20. Intravenous hyperalimentation	617 (16%)	568 (16%)	544 (16%)	481 (15%)
21. Enteral feeding through gastric tube	1 187 (30%)	1 071 (30%)	1 010 (29%)	973 (30%)
22. Specific intervention(s) in the intensive care unit	436 (11%)	261 (7%)	172 (5%)	121 (4%)
23. Specific interventions outside the intensive care unit: surgery or diagnostic procedures	392 (10%)	132 (4%)	201 (6%)	89 (3%)

Note that due to exclusions the number of observations is lower for support and care of relatives (2 936) and patient and hygiene procedures (3 632).

Table 17 shows the mean ± standard deviation for each NAS-item (when an item is not registered, a score of 0 is given). The score can be interpreted as the time spent by a nurse. This is a relative measure, where 100 equals to a full workload of a nurse (see section 5.3.2). It is clear that a limited set of items is responsible for the majority of time. The items 1. 'Monitoring (8.4)'; 3. 'Medication, vasoactive drugs excluded (5.1)'; 4. 'Hygiene procedures (8.7)', 6. 'Mobilisation (11.1)', 7. 'Support and care of relatives and patients (6.7)'; 8. 'Administrative support (9.6)', and 17. 'Quantitative urine output measurement (6.1)' take the most time in the daily care of a patient.

Table 17 – Average time per activity obtained according to item frequency and weighting of the original NAS scale (expressed as a percentage)

Items	Day (n=3 894)	Morning shift (n=3 457)	Afternoon shift (n=3 417)	Night shift (n=3 250)
1. Monitoring and titration	8.4 ± 5.5	6.6 ± 4.7	6.7 ± 4.5	6.7 ± 4.6
2. Laboratory, biochemical investigations	3.9 ± 1.3	3.4 ± 1.7	3.4 ± 1.8	3.8 ± 1.4
3. Medication, vasoactive drugs excluded	5.1 ± 1.7	4.4 ± 2.3	4.5 ± 2.2	4.4 ± 2.3
4. Hygiene procedures	8.7 ± 6.4	7.7 ± 6.0	6.2 ± 6.3	5.7 ± 5.8
5. Care of drains, all (except gastric tube)	0.8 ± 0.9	0.8 ± 0.9	0.8 ± 0.9	0.8 ± 0.9
6. Mobilisation and positioning, including procedures	11.1 ± 3.5	10.2 ± 4.1	10.4 ± 3.8	9.9 ± 4.1
7. Support and care of relatives and patient	6.7 ± 10.6	4.7 ± 8.7	4.8 ± 8.7	2.9 ± 5.9
8. Administrative and managerial tasks	9.6 ± 9.2	6.8 ± 7.3	6.7 ± 7.0	6.4 ± 6.7
9. Respiratory support	0.9 ± 0.7	0.9 ± 0.7	0.8 ± 0.7	0.8 ± 0.7
10. Care of artificial airways	0.8 ± 0.9	0.8 ± 0.9	0.7 ± 0.9	0.7 ± 0.9
11. Treatment for improving lung function	2.8 ± 2.1	2.6 ± 2.2	2.5 ± 2.2	2.7 ± 2.1
12. Vasoactive medication	0.5 ± 0.6	0.4 ± 0.6	0.4 ± 0.6	0.4 ± 0.6
13. Intravenous replacement of large fluid losses	0.6 ± 1.1	0.2 ± 0.7	0.2 ± 0.7	0.5 ± 1.0
14. Left atrium monitoring: pulmonary artery catheter	0.1 ± 0.4	0.1 ± 0.3	0.1 ± 0.3	0.1 ± 0.3
15. Cardiopulmonary resuscitation after arrest	0.0 ± 0.4	0.0 ± 0.3	0.0 ± 0.2	0.0 ± 0.3
16. Hemofiltration techniques, dialysis techniques	0.4 ± 1.8	0.4 ± 1.6	0.4 ± 1.7	0.3 ± 1.5
17. Quantitative urine output measurement	6.1 ± 2.3	6.0 ± 2.4	5.9 ± 2.6	6.0 ± 2.4
18. Measurement of intracranial pressure	0.0 ± 0.2	0.0 ± 0.2	0.0 ± 0.2	0.0 ± 0.2
19. Treatment of complicated metabolic acidosis/alkalosis	0.1 ± 0.3	0.1 ± 0.3	0.1 ± 0.3	0.0 ± 0.2
20. Intravenous hyperalimentation	0.4 ± 1.0	0.4 ± 1.0	0.4 ± 1.0	0.4 ± 1.0
21. Enteral feeding through gastric tube	0.4 ± 0.6	0.4 ± 0.6	0.4 ± 0.6	0.4 ± 0.6

22. Specific intervention(s) in the intensive care unit	0.3 ± 0.9	0.2 ± 0.7	0.1 ± 0.6	0.1 ± 0.5
23. Specific interventions outside the intensive care unit: surgery or diagnostic procedures	0.2 ± 0.6	0.1 ± 0.4	0.1 ± 0.4	0.1 ± 0.3

In the items 1, 4, 6, 7, and 8 only one subitem (a, b, or c) can be scored; the weights represent the percentage of time spent by one nurse on the activity mentioned in the item, if performed.[45]

Example: Monitoring and titration (4.5 in 1a, 12.1 in 1b, and 19.6 in 1c according to the original NAS scale) takes 8.4 of the nurse's time counted at day-level.

NAS registrations with two shifts instead of three are excluded (only weekends and holidays in 1 hospital)

Note that due to exclusions, the number observations is lower for support and care of relatives (2 875) and patient and hygiene procedures (3 571).

5.4.3 VG-MZG / DI-RHM

In Table 18 the VG-MZG / DI-RHM time-competency and NAS point values (mean-median, P25 and P75) are shown per hospital. The level of aggregation was the patient-unit-day, where the highest score per item was used in case of multiple registrations during that day for the same patient on the same unit. The average time-competency points for the entire sample was 516.4 (P25: 383 ; P75: 644) for the VG-MZG / DI-RHM and 65.7 (P25: 46.8 ; P75: 81.7) for the NAS. The average VG-MZG / DI-RHM points vary from 342 in hospital B to 630 in hospital E. For the NAS, the average per hospital varies from 43.9 (hospital H) to 83.4 (hospital E). At the level of the ICUs, VG-MZG / DI-RHM points vary from 258 in unit X in hospital Y to 633 in unit Z in hospital Z.

Table 18 – Distribution of VG-MZG / DI-RHM and NAS points per hospital

	NRG 24h time competence points				NAS 24h points*			
	Mean	P25	Median	P75	Mean	P25	Median	P75
All	516.4	383.3	525.2	644.2	65.7	46.8	59.9	81.7
Hospital A	568.7	496.0	597.1	669.4	46.9	42.1	47.8	52.1
Hospital B	341.9	264.9	322.9	406.8	68.1	48.5	62.2	82.0
Hospital C	368.6	307.5	350.8	420.5	52.5	39.2	43.6	60.3
Hospital D	514.5	428.5	518.1	621.1	68.5	59.6	66.2	76.9
Hospital E	629.6	521.4	609.2	726.0	83.4	69.4	83.4	95.0
Hospital F	548.5	435.7	563.8	669.7	70.1	53.1	69.8	86.2
Hospital G	486.0	372.7	476.0	589.0	84.6	62.2	81.4	104.2
Hospital H	628.7	556.7	635.4	719.1	43.9	38.0	44.9	50.9

NRG = Nursing Related Groups.
For VG-MZG / DI-RHM, the items that are used for the NRG model were retained and frequency items were rounded as in the NRG model.
** When hygiene and support variables were removed from the NAS, the overall average is 52.7 (P25: 41.2; P50:50.3; P75:63.2) and the mean per hospital varies from 36.4 (hospital C) to 68.1 (hospital E).*

5.4.4 Correlation VG-MZG / DI-RHM and NAS

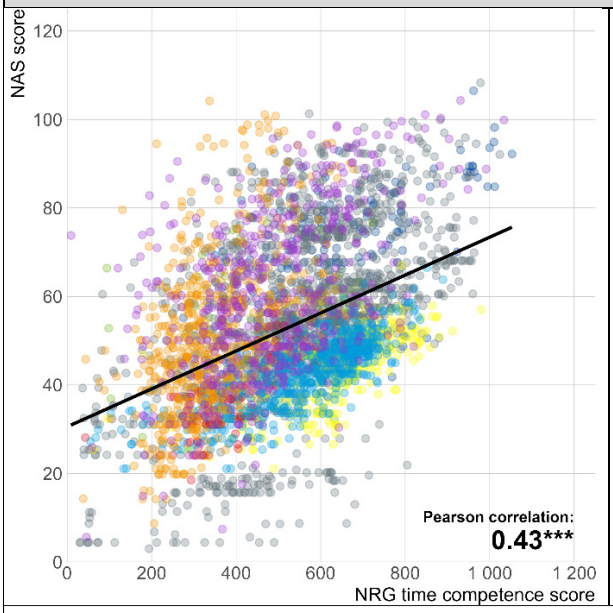
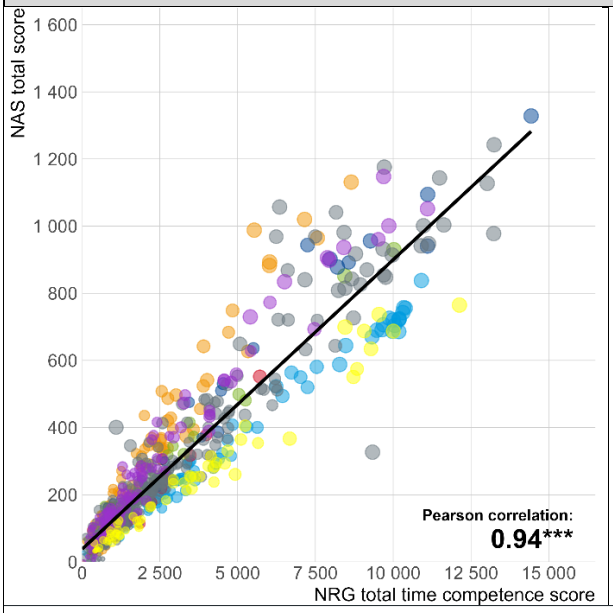
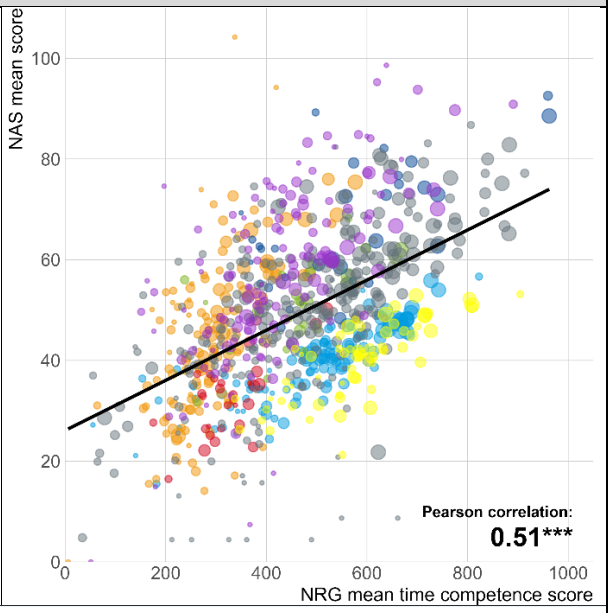
In Table 19 the Pearson correlation coefficients and scatter plots between the VG-MZG / DI-RHM points and NAS-scores are shown. For the VG-MZG / DI-RHM, we used the time-competency points for the items that are retained in the NRG model.[28] These points cover the time needed per activity (each point equals 5 minutes) with the required competency (multiplication of the time points by a factor ranging from 1 to 5). Thresholds of the NRG model (frequency items) were applied. For the NAS, we calculated the scores per patient, per unit per day with the highest NAS-score for patients with several registrations. Since an analysis of descriptive data showed that the coding of two NAS-items (item 4 Hygiene and item 7 Support) was problematic (i.e. not registered in some hospitals while registered for the large majority of patients in other hospitals), we calculated the NAS-scores without these two items°.

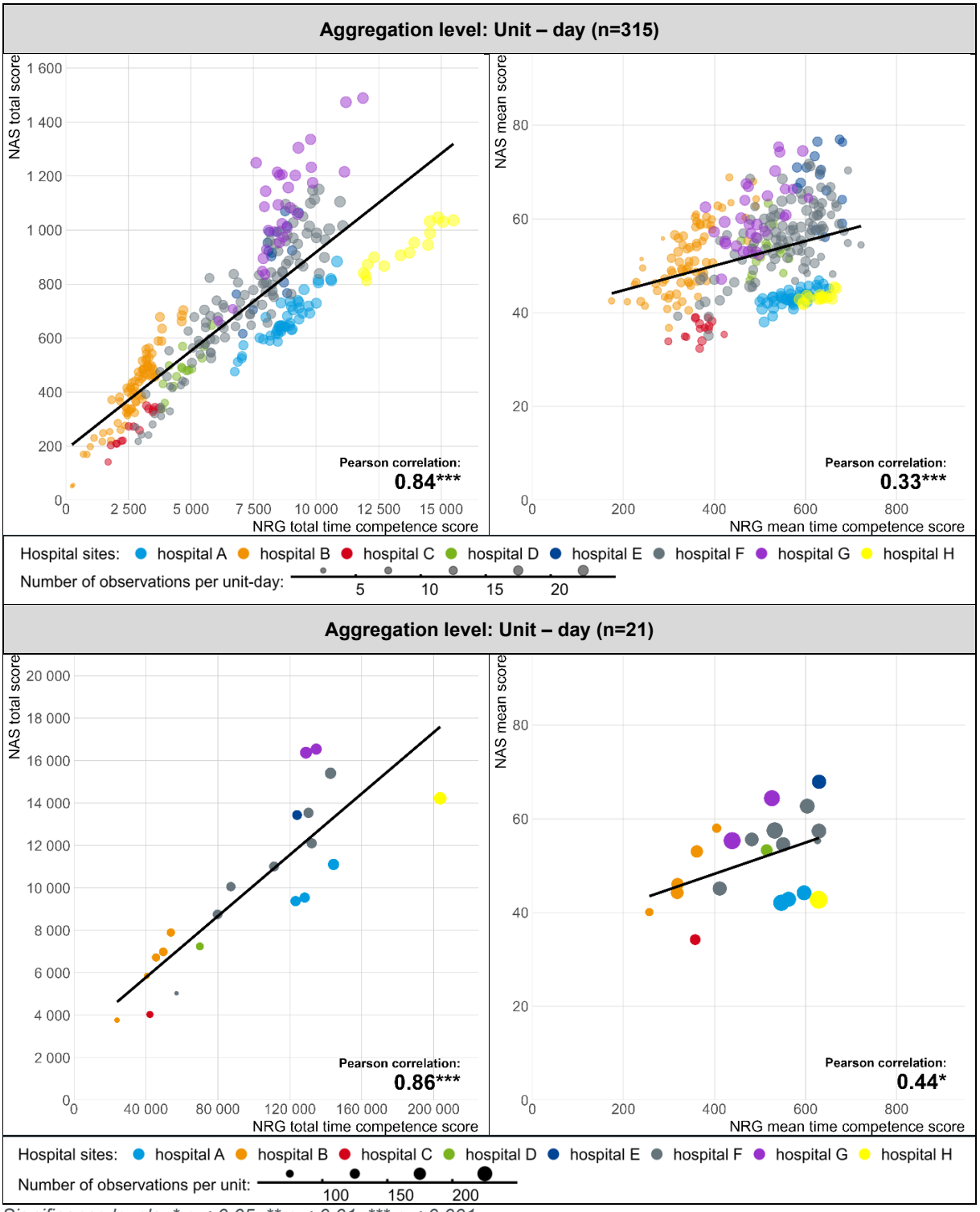
It is shown that the correlation increases when the aggregation level is higher and that correlation coefficients are higher for sum scores compared to average scores per observation. While the correlation coefficients of sum scores at the level of the patient per unit per day is rather low (0.43**), it increases to high values at the level of the unit (0.86**), the unit per day (0.84**) and hospital stay level (0.94**). The correlation coefficients for the average scores are much lower: hospital stay (0.51**); unit per day (0.33**); unit (0.44**). It should be noted that hospital A and H decrease the

° When item 4 and item 7 were included, the correlation coefficients were lower.

overall correlation coefficients due to higher VG-MZG / DI-RHM scores compared to the NAS-scores which can be due to over-coding of the VG-MZG / DI-RHM, or under-coding of the NAS.

Table 19 – Correlation between VG-MZG / DI-RHM points (total and mean) with NAS-points (total and mean) for different aggregation levels

Total VG-MZG / DI-RHM time-competency points versus total NAS-points	Mean VG-MZG / DI-RHM time-competency points versus mean NAS-points
Aggregation level: Patient – unit – day (n=3 955)	
	
Hospitals: hospital A hospital B hospital C hospital D hospital E hospital F hospital G hospital H	
Aggregation level: Hospital stay (n=845)	
	
Hospital sites: hospital A hospital B hospital C hospital D hospital E hospital F hospital G hospital H Number of observations per stay: 4 8 12	



*Significance levels: * p < 0.05; ** p < 0.01; *** p < 0.001*

5.4.5 *Correspondence of VG-MZG / DI-RHM and NAS-items that are mapped based on a content analysis*

CONTENT MAPPING

For only 16 of the 23 NAS-items a correspondence was found in the VG-MZG / DI-RHM based on the content mapping made by the researchers.

- For some NAS-items, a one-to-one mapping appeared to be possible to a certain extent:
  - 16. 'Hemofiltration techniques, dialysis techniques' – (M100 – Management thermoregulation – score 3. specific techniques: extracorporal heating - continuous veno-venous hemofiltration, heart-lung machine, etc.);
  - 18. 'Measurement of intracranial pressure' – (I200 – Monitoring intracranial pressure);
  - 20. 'Intravenous hyperalimentation' – (D400 – Care and monitoring of patients with total parenteral feeding – TPN) ;
  - 21. 'Enteral feeding through gastric tube' – (D300 – Administration of feeding via an enteral tube);
- For other NAS-items, a combination of VG-MZG / DI-RHM items seemed to result in a more or less similar content. Examples are:
  - 9. 'Respiratory support' – (K200 – Improvement of respiration: supportive measures; OR K300 – Improvement of ventilation: artificial ventilation);
  - 10. 'Care of artificial airways' – (K200 - Improvement of respiration: supportive measures; score 2. endotracheal tube or larynx mask; OR score 3. tracheal cannullas; OR K300 - Improvement of ventilation: artificial ventilation);
- For the following NAS-items, the presence of VG-MZG / DI-RHM items corresponds with the presence of NAS-items. Yet, the link is indirect. Examples are:
  - 2. 'Laboratory, biochemical investigations' – (N300 - Venous blood sample; OR N400 – arterial blood sample; OR N500 – capillary blood sample; OR V500 sample of organic material and tissue);
  - 11. 'Treatment for improving lung function' – (H400 – medication administration via inhalation; OR K100 aspiration of airways);
- For other NAS-items, the labels of VG-MZG / DI-RHM appear to be similar but, in fact, cover less activities than the NAS-item. Examples are:
  - 1. 'Monitoring and titration' which corresponds to V300 – Monitoring vital observations: discontinuous monitoring; V400 – Monitoring vital observations: continuous monitoring (number of different parameters, max 13); I100 – Monitoring neurological function. Yet, the NAS-item also refers to other activities than strictly monitoring vital observations like the use of other assessment scales.
  - 4. 'Hygiene procedures' corresponds to F100 – Hygiene care (support with bathing etc.). Yet, this only covers part of the NAS-items which also refer to wound care. Therefore, we use a narrow definition (based on the label of the items) and a broad definition (including wound care items such as L100-L500).



CORRESPONDENCE BETWEEN NAS-ITEMS AND MAPPED VG-MZG / DI-RHM ITEMS

Phi scores can range from -1 to 1. A score of 1 means a perfect match, a score of -1 means that the predicted score is the complete opposite of the actual score, a score of 0 means no association. The higher the value, the higher the association (positive or negative). From Table 20 it is clear that:

- A good (Phi ≥ 0.8) or a relative good match (Phi 0.6-0.8) is obtained for the following items: 10. 'Care of artificial airways' (0.731); 9. 'Respiratory support' (0.604); 18. 'Measurement of intracranial pressure' (0.880); 20. 'Intravenous hyperalimentation' (0.759) and 21. 'Enteral feeding though gastric tube' (0.903). All these items appear to have a good one-to-one match to a VG-MZG / DI-RHM item (see Appendix 1.2 in the Supplement). The exception is 'Care for artificial airways', which corresponds, according to the content mapping to K200 – Improving respiration: support via endotracheal tube or tracheal canulae; K300 – Improving ventilation: artificial ventilation.
- A mediocre match (040-0.60) was found for 2. 'Lab tests' (0.503) and 11. 'Treatment for improving lung function' (0.44; mapped to K100 – Aspiration of airways and H400 – Medication via inhalation airways). Lab tests were mapped to VG-MZG / DI-RHM items that correspond to activities such as arterial (N400), venous (N300) and capillary blood sampling (N500) as well as taking samples of organic material (V500).
- A low match (0.20-0.40) was found for 14. 'Pulmonary artery catheter' (0.373; mapped to N500 – Capillary blood sampling and N600 – Electric cardiocirculatory support) and 16. 'Dialysis' (0.368; M100 – score 3: thermoregulation via extracorporeal heating such as continuous veno-venous hemofiltration). Some of these items are also based on content only indirectly (e.g. pulmonary artery catheter and improving lung function) or partly (e.g. dialysis) mapped to the VG-MZG / DI-RHM.
- Very low matches (0.0-0.2) were found for 1. 'Monitoring' (0.039); 3. 'Medication' (0.097); 4. 'Hygiene' (small: 0.052; broad 0.116); 5. 'Drains' (0.061); 6. 'Mobilisation' (0.083); and 23. 'Specific interventions' (0.194). While these items were included in the content mapping, it is clear that this was already borderline. The NAS-item monitoring was, for instance, mapped to VG-MZG / DI-RHM items monitoring vital observations (V300, V400) and neurological function (I100) while the NAS also refers to the use of other assessment scales, assistance with feeding, etc. Another example is the hygiene item. While the mapping on label (with VG-MZG / DI-RHM item F100 – Hygiene care) was very low, it hardly improved by adding wound care items L100-L500.
- A negative Phi (worse than due to chance) was found for 17. 'Urine output measurement' (-0.011) which was mapped to G100 in-out balance.

Table 20 – Correspondence of NAS-scores and mapped VG-MZG / DI-RHM items

Label	Observations							
	All	NAS	VG-MZG / DI-RHM	Phi	Accuracy	Kappa	Sensitivity	Specificity
1. Monitoring and titration	3 955	3 826	3 951	0.039	96.7%	1.3%	99.9%	0.8%
2. Laboratory, biochemical investigations	3 955	3 557	3 720	0.503	92.3%	48.3%	98.0%	41.5%
3. Medication, vasoactive drugs excluded	3 955	3 573	3 818	0.097	88.6%	8.4%	97.1%	8.9%
4. Hygiene procedures small)*	3 632	3 557	1 810	0.052	50.6%	1.5%	50.2%	68.0%
4. Hygiene procedures (broad)**	3 632	3 557	2 812	0.116	77.7%	5.8%	78.1%	56.0%
5. Care of drains, all (except gastric tube)	3 955	1 882	3 818	0.061	48.9%	2.1%	97.7%	4.5%
6. Mobilisation and positioning, including procedures	3 955	3 816	3 409	0.083	84.7%	6.4%	86.7%	28.8%
9. Respiratory support	3 955	2 571	3 162	0.604	82.1%	56.3%	97.7%	53.0%
10. Care of artificial airways	3 955	1 798	2 045	0.731	86.2%	72.5%	91.7%	81.6%
11. Treatment for improving lung function	3 955	2 562	2 277	0.440	73.0%	43.5%	73.6%	71.9%
14. Left atrium monitoring: pulmonary artery catheter	3 955	183	145	0.373	95.0%	37.1%	35.5%	97.9%
16. Hemofiltration techniques, dialysis techniques	3 955	225	77	0.368	94.9%	31.8%	22.7%	99.3%
17. Quantitative urine output measurement	3 955	3 452	248	-0.011	17.2%	-0.2%	6.2%	93.0%
18. Measurement of intracranial pressure	3 955	94	94	0.880	99.4%	88.0%	88.3%	99.7%
20. Intravenous hyperalimentation	3 955	617	643	0.759	93.5%	75.8%	81.4%	95.8%
21. Enteral feeding through gastric tube	3 955	1 187	1 222	0.903	95.9%	90.3%	94.6%	96.4%
23. Specific interventions outside the intensive care unit: surgery or diagnostic procedures	3 955	436	445	0.194	84.0%	19.4%	28.7%	90.9%

**: Mapped on label only (VG-MZG / DI-RHM item hygiene care; ** Mapped on label and content (e.g. also including VG-MZG / DI-RHM items on wound care). A colour code was used based on the Phi statistic: ≤ 0.20 in red; between 0.20 and 0.40 in orange; between 0.40 and 0.60 no colour; between 0.60 and 0.80 in light green; between 0.8 and 1.00.*

5.4.6 Machine learning

GENERAL RESULTS

In Table 21 the performance measures are shown per NAS-item and model that was used. The colour coding used in Table 21 has the advantage to indicate for which items there is relevant information available in the VG-MZG / DI-RHM to predict (or reconstruct) NAS-items.

There seems to be a relatively good prediction for: 5. 'Care of drains'; 7. 'Support'; 9. 'Respiratory support'; 10. 'Care of artificial airways'; 11. 'Treatment for improving lung function'; 13. 'Intravenous replacement of large fluid losses'; 14. 'Pulmonary artery catheter'; 16. 'Hemofiltration and dialysis'; 17. 'Urine output measurement'; 18. 'Intracranial pressure'; 20. 'Intravenous hyperalimentation'; 21. 'Enteral feeding through gastric tube'.

The main reason for a good prediction seems to be the presence of clear corresponding VG-MZG / DI-RHM items (cf. content mapping with good performance in bold). For item 11 ('Lung function'), with a mediocre score in the content mapping, a relatively good Cohen's Kappa score was reached. Moreover, also for NAS-items that did not score well based on the content mapping, machine learning produced relatively good results: 5. 'Care of drains' (5-level decision tree and logistic regression); 6a. 'Mobilisation up to three times per 24h' (logistic regression); 7. 'Support' (all models); 13. 'Intravenous replacement of large fluid losses' (logistic regression and decision tree 5 levels); 14. 'Pulmonary artery catheter' (decision tree and logistic regression) 16. 'Hemofiltration and dialysis' (all models); 17. 'Urine output measurement' (decision trees).

There seems to be no accurate prediction for : 1. 'Monitoring and titration'; 3. 'Medication, vasoactive drugs excluded'; 4. 'Hygiene procedures'; 6. 'Mobilisation and positioning'; 8. 'Administrative task's; 15. 'Cardiopulmonary resuscitation'; 22. 'Specific intervention(s) in ICU'; 23. 'Specific interventions outside ICU'. The main reasons for the lack of accurate prediction seem to be: items that are registered too frequently, which gives no to low added value to VG-MZG / DI-RHM items (e.g. monitoring, administrative tasks, etc.) or which are extremely rare and therefore give no to low added value to VG-MZG / DI-RHM items (e.g. cardiopulmonary resuscitation) and finally no clear corresponding VG-MZG / DI-RHM items.

In the next section we describe some examples more in detail. The detailed results for all models are available upon request.

Table 21 – Performance of machine-learning models per NAS-item and model used

NAS item	Model	N_0_0	N_1_0	N_0_1	N_1_1	Cohen's Kappa statistic	C -statistic	Sensitivity (recall)	Specificity
1. Monitoring and titration	1 rule model	0	0	129	3826	0.0%	50.0%	100.0%	0.0%
1. Monitoring and titration	Decision tree (CART algorithm) - up to 5 levels	17	2	112	3824	22.3%	93.7%	99.9%	13.2%
1. Monitoring and titration	Decision tree (CART algorithm) - up to 3 levels	17	2	112	3824	22.3%	93.7%	99.9%	13.2%
1. Monitoring and titration	Logistic regression	24	8	105	3818	28.9%	96.5%	99.8%	18.6%
1a. Monitoring: hourly vital signs	1 rule model	1127	720	634	1474	31.0%	65.6%	67.2%	64.0%
1a. Monitoring: hourly vital signs	Decision tree (CART algorithm) - up to 5 levels	1303	500	458	1694	51.1%	81.8%	77.2%	74.0%
1a. Monitoring: hourly vital signs	Decision tree (CART algorithm) - up to 3 levels	1390	631	371	1563	49.5%	81.4%	71.2%	78.9%
1a. Monitoring: hourly vital signs	Logistic regression	1382	537	379	1657	53.5%	85.0%	75.5%	78.5%
1b. Monitoring: observation for 2h	1 rule model	2760	1118	27	50	4.5%	51.7%	4.3%	99.0%
1b. Monitoring: observation for 2h	Decision tree (CART algorithm) - up to 5 levels	2528	783	259	385	27.2%	74.4%	33.0%	90.7%
1b. Monitoring: observation for 2h	Decision tree (CART algorithm) - up to 3 levels	2787	1168	0	0	0.0%	50.0%	0.0%	100.0%
1b. Monitoring: observation for 2h	Logistic regression	2483	734	304	434	29.4%	77.7%	37.2%	89.1%
1c. Monitoring: observation for 4h or more	1 rule model	3490	454	1	10	3.7%	51.1%	2.2%	100.0%
1c. Monitoring: observation for 4h or more	Decision tree (CART algorithm) - up to 5 levels	3476	412	15	52	17.1%	58.3%	11.2%	99.6%
1c. Monitoring: observation for 4h or more	Decision tree (CART algorithm) - up to 3 levels	3487	437	4	27	9.6%	58.1%	5.8%	99.9%
1c. Monitoring: observation for 4h or more	Logistic regression	3443	378	48	86	24.8%	84.6%	18.5%	98.6%
2. Laboratory, biochemical investigations	1 rule model	34	23	364	3534	12.7%	53.9%	99.4%	8.5%
2. Laboratory, biochemical investigations	Decision tree (CART algorithm) - up to 5 levels	159	32	239	3525	50.8%	79.5%	99.1%	39.9%
2. Laboratory, biochemical investigations	Decision tree (CART algorithm) - up to 3 levels	194	92	204	3465	52.7%	79.1%	97.4%	48.7%
2. Laboratory, biochemical investigations	Logistic regression	185	83	213	3474	51.6%	92.3%	97.7%	46.5%
3. Medication, vasoactive drugs excluded	1 rule model	2	0	380	3573	0.9%	50.3%	100.0%	0.5%
3. Medication, vasoactive drugs excluded	Decision tree (CART algorithm) - up to 5 levels	128	71	254	3502	40.1%	82.5%	98.0%	33.5%
3. Medication, vasoactive drugs excluded	Decision tree (CART algorithm) - up to 3 levels	0	0	382	3573	0.0%	50.0%	100.0%	0.0%
3. Medication, vasoactive drugs excluded	Logistic regression	129	74	253	3499	40.1%	91.4%	97.9%	33.8%
4. Hygiene procedures	1 rule model	0	0	75	3557	0.0%	50.0%	100.0%	0.0%
4. Hygiene procedures	Decision tree (CART algorithm) - up to 5 levels	21	5	54	3552	41.0%	72.0%	99.9%	28.0%

NAS item	Model	N_0_0	N_1_0	N_0_1	N_1_1	Cohen's Kappa statistic	C -statistic	Sensitivity (recall)	Specificity
NAS item	Model	N_0_0	N_1_0	N_0_1	N_1_1	Cohen's Kappa statistic	C -statistic	Sensitivity (recall)	Specificity
4. Hygiene procedures	Decision tree (CART algorithm) - up to 3 levels	21	5	54	3552	41.0%	72.0%	99.9%	28.0%
4. Hygiene procedures	Logistic regression	23	5	52	3552	44.0%	96.3%	99.9%	30.7%
4a. Hygiene: basic	1 rule model	497	66	896	2173	36.9%	66.4%	97.1%	35.7%
4a. Hygiene: basic	Decision tree (CART algorithm) - up to 5 levels	671	142	722	2097	45.4%	72.9%	93.7%	48.2%
4a. Hygiene: basic	Decision tree (CART algorithm) - up to 3 levels	671	142	722	2097	45.4%	72.9%	93.7%	48.2%
4a. Hygiene: basic	Logistic regression	813	269	580	1970	48.4%	83.3%	88.0%	58.4%
4b. Hygiene: about 2h	1 rule model	2425	644	115	448	42.3%	68.2%	41.0%	95.5%
4b. Hygiene: about 2h	Decision tree (CART algorithm) - up to 5 levels	2451	646	89	446	43.7%	68.9%	40.8%	96.5%
4b. Hygiene: about 2h	Decision tree (CART algorithm) - up to 3 levels	2451	646	89	446	43.7%	68.9%	40.8%	96.5%
4b. Hygiene: about 2h	Logistic regression	2346	526	194	566	48.4%	84.1%	51.8%	92.4%
4c. Hygiene: 4h or more	1 rule model	3406	226	0	0	0.0%	50.0%	0.0%	100.0%
4c. Hygiene: 4h or more	Decision tree (CART algorithm) - up to 5 levels	3406	226	0	0	0.0%	50.0%	0.0%	100.0%
4c. Hygiene: 4h or more	Decision tree (CART algorithm) - up to 3 levels	3406	226	0	0	0.0%	50.0%	0.0%	100.0%
4c. Hygiene: 4h or more	Logistic regression	3404	222	2	4	3.1%	79.7%	1.8%	99.9%
5. Care of drains	1 rule model	1333	514	740	1368	36.8%	68.5%	72.7%	64.3%
5. Care of drains	Decision tree (CART algorithm) - up to 5 levels	1678	351	395	1531	62.2%	85.3%	81.3%	80.9%
5. Care of drains	Decision tree (CART algorithm) - up to 3 levels	1882	713	191	1169	53.6%	80.6%	62.1%	90.8%
5. Care of drains	Logistic regression	1744	415	329	1467	62.2%	89.0%	77.9%	84.1%
6. Mobilisation and positioning	1 rule model	0	0	139	3816	0.0%	50.0%	100.0%	0.0%
6. Mobilisation and positioning	Decision tree (CART algorithm) - up to 5 levels	17	2	122	3814	20.8%	91.7%	99.9%	12.2%
6. Mobilisation and positioning	Decision tree (CART algorithm) - up to 3 levels	17	2	122	3814	20.8%	91.7%	99.9%	12.2%
6. Mobilisation and positioning	Logistic regression	17	2	122	3814	20.8%	94.1%	99.9%	12.2%
6a. Mobilisation: up to three times per 24h	1 rule model	3214	493	104	144	25.8%	59.7%	22.6%	96.9%
6a. Mobilisation: up to three times per 24h	Decision tree (CART algorithm) - up to 5 levels	3212	329	106	308	52.6%	80.3%	48.4%	96.8%

NAS item	Model	N_0_0	N_1_0	N_0_1	N_1_1	Cohen's Kappa statistic	C -statistic	Sensitivity (recall)	Specificity
6a. Mobilisation: up to three times per 24h	Decision tree (CART algorithm) - up to 3 levels	3194	327	124	310	51.6%	79.9%	48.7%	96.3%
6a. Mobilisation: up to three times per 24h	Logistic regression	3159	230	159	407	61.9%	91.9%	63.9%	95.2%
NAS item	Model	N_0_0	N_1_0	N_0_1	N_1_1	Cohen's Kappa statistic	C -statistic	Sensitivity (recall)	Specificity
6b. Mobilisation: more frequently, or with two nurses	1 rule model	157	91	807	2900	17.7%	56.6%	97.0%	16.3%
6b. Mobilisation: more frequently, or with two nurses	Decision tree (CART algorithm) - up to 5 levels	418	141	546	2850	45.1%	72.5%	95.3%	43.4%
6b. Mobilisation: more frequently, or with two nurses	Decision tree (CART algorithm) - up to 3 levels	397	160	567	2831	41.8%	71.8%	94.7%	41.2%
6b. Mobilisation: more frequently, or with two nurses	Logistic regression	495	215	469	2776	48.5%	85.3%	92.8%	51.3%
6c. Mobilisation: with three or more nurses, any frequency	1 rule model	3758	172	9	16	14.1%	54.1%	8.5%	99.8%
6c. Mobilisation: with three or more nurses, any frequency	Decision tree (CART algorithm) - up to 5 levels	3766	178	1	10	9.6%	54.1%	5.3%	100.0%
6c. Mobilisation: with three or more nurses, any frequency	Decision tree (CART algorithm) - up to 3 levels	3766	178	1	10	9.6%	54.1%	5.3%	100.0%
6c. Mobilisation: with three or more nurses, any frequency	Logistic regression	3759	174	8	14	12.5%	79.0%	7.4%	99.8%
7. Support	1 rule model	954	461	79	1442	62.8%	84.1%	75.8%	92.4%
7. Support	Decision tree (CART algorithm) - up to 5 levels	952	397	81	1506	66.6%	85.7%	79.1%	92.2%
7. Support	Decision tree (CART algorithm) - up to 3 levels	952	397	81	1506	66.6%	85.7%	79.1%	92.2%
7. Support	Logistic regression	971	374	62	1529	69.5%	91.8%	80.3%	94.0%
7a. Support: about 1h	1 rule model	1073	342	386	1135	50.4%	75.2%	76.8%	73.5%
7a. Support: about 1h	Decision tree (CART algorithm) - up to 5 levels	1055	294	404	1183	52.4%	76.2%	80.1%	72.3%
7a. Support: about 1h	Decision tree (CART algorithm) - up to 3 levels	1055	294	404	1183	52.4%	76.2%	80.1%	72.3%
7a. Support: about 1h	Logistic regression	1097	299	362	1178	55.0%	82.4%	79.8%	75.2%
7b. Support: about 3h or more	1 rule model	2508	422	2	4	1.5%	50.4%	0.9%	99.9%
7b. Support: about 3h or more	Decision tree (CART algorithm) - up to 5 levels	2510	426	0	0	0.0%	50.0%	0.0%	100.0%

NAS item	Model	N_0_0	N_1_0	N_0_1	N_1_1	Cohen's Kappa statistic	C -statistic	Sensitivity (recall)	Specificity
7b. Support: about 3h or more	Decision tree (CART algorithm) - up to 3 levels	2510	426	0	0	0.0%	50.0%	0.0%	100.0%
7b. Support: about 3h or more	Logistic regression	2495	413	15	13	4.0%	74.6%	3.1%	99.4%
8. Administrative tasks	1 rule model	0	0	134	3821	0.0%	50.0%	100.0%	0.0%
8. Administrative tasks	Decision tree (CART algorithm) - up to 5 levels	17	2	117	3819	21.6%	92.9%	99.9%	12.7%
8. Administrative tasks	Decision tree (CART algorithm) - up to 3 levels	17	2	117	3819	21.6%	92.9%	99.9%	12.7%
8. Administrative tasks	Logistic regression	24	7	110	3814	28.2%	96.3%	99.8%	17.9%
8a. Administration: routine	1 rule model	86	19	1156	2694	8.3%	53.1%	99.3%	6.9%
8a. Administration: routine	Decision tree (CART algorithm) - up to 5 levels	231	70	1011	2643	20.2%	67.6%	97.4%	18.6%
8a. Administration: routine	Decision tree (CART algorithm) - up to 3 levels	81	14	1161	2699	8.0%	59.9%	99.5%	6.5%
8a. Administration: routine	Logistic regression	437	302	805	2411	27.0%	78.8%	88.9%	35.2%
8b. Administration: about 2h	1 rule model	3010	840	22	83	12.0%	54.1%	9.0%	99.3%
8b. Administration: about 2h	Decision tree (CART algorithm) - up to 5 levels	3010	840	22	83	12.0%	54.1%	9.0%	99.3%
8b. Administration: about 2h	Decision tree (CART algorithm) - up to 3 levels	3010	840	22	83	12.0%	54.1%	9.0%	99.3%
8b. Administration: about 2h	Logistic regression	2893	709	139	214	23.7%	77.1%	23.2%	95.4%
8c. Administration: about 4h	1 rule model	3770	184	0	1	1.0%	50.3%	0.5%	100.0%
8c. Administration: about 4h	Decision tree (CART algorithm) - up to 5 levels	3770	185	0	0	0.0%	50.0%	0.0%	100.0%
8c. Administration: about 4h	Decision tree (CART algorithm) - up to 3 levels	3770	185	0	0	0.0%	50.0%	0.0%	100.0%
8c. Administration: about 4h	Logistic regression	3765	182	5	3	2.7%	80.9%	1.6%	99.9%
9. Respiratory support	1 rule model	1193	904	191	1667	45.6%	75.5%	64.8%	86.2%
9. Respiratory support	Decision tree (CART algorithm) - up to 5 levels	1068	153	316	2418	73.2%	87.3%	94.0%	77.2%
9. Respiratory support	Decision tree (CART algorithm) - up to 3 levels	955	164	429	2407	65.5%	85.8%	93.6%	69.0%
9. Respiratory support	Logistic regression	1138	152	246	2419	77.5%	93.8%	94.1%	82.2%
10. Care of artificial airways	1 rule model	1903	390	254	1408	67.0%	83.3%	78.3%	88.2%
10. Care of artificial airways	Decision tree (CART algorithm) - up to 5 levels	2033	104	124	1694	88.4%	94.9%	94.2%	94.3%
10. Care of artificial airways	Decision tree (CART algorithm) - up to 3 levels	2053	275	104	1523	80.5%	90.3%	84.7%	95.2%
10. Care of artificial airways	Logistic regression	2077	113	80	1685	90.1%	97.4%	93.7%	96.3%
11. Treatment for improving lung function	1 rule model	880	474	513	2088	45.0%	72.3%	81.5%	63.2%

NAS item	Model	N_0_0	N_1_0	N_0_1	N_1_1	Cohen's Kappa statistic	C -statistic	Sensitivity (recall)	Specificity
11. Treatment for improving lung function	Decision tree (CART algorithm) - up to 5 levels	1173	131	220	2431	80.3%	93.2%	94.9%	84.2%
11. Treatment for improving lung function	Decision tree (CART algorithm) - up to 3 levels	1121	342	272	2220	66.4%	88.1%	86.7%	80.5%
11. Treatment for improving lung function	Logistic regression	1230	184	163	2378	80.8%	96.4%	92.8%	88.3%
12. Vasoactive medication	1 rule model	2058	825	250	822	41.1%	69.5%	49.9%	89.2%
12. Vasoactive medication	Decision tree (CART algorithm) - up to 5 levels	1963	503	345	1144	55.3%	79.0%	69.5%	85.1%
NAS item	Model	N_0_0	N_1_0	N_0_1	N_1_1	Cohen's Kappa statistic	C -statistic	Sensitivity (recall)	Specificity
12. Vasoactive medication	Decision tree (CART algorithm) - up to 3 levels	1933	491	375	1156	54.5%	78.8%	70.2%	83.8%
12. Vasoactive medication	Logistic regression	1941	483	367	1164	55.3%	85.4%	70.7%	84.1%
13. Intravenous replacement of large fluid losses	1 rule model	2789	583	261	322	30.9%	63.5%	35.6%	91.4%
13. Intravenous replacement of large fluid losses	Decision tree (CART algorithm) - up to 5 levels	2892	353	158	552	60.4%	85.5%	61.0%	94.8%
13. Intravenous replacement of large fluid losses	Decision tree (CART algorithm) - up to 3 levels	2922	438	128	467	53.9%	83.5%	51.6%	95.8%
13. Intravenous replacement of large fluid losses	Logistic regression	2851	291	199	614	63.6%	92.1%	67.8%	93.5%
14. pulmonary artery catheter	1 rule model	3750	131	22	52	38.8%	63.9%	28.4%	99.4%
14. pulmonary artery catheter	Decision tree (CART algorithm) - up to 5 levels	3740	55	32	128	73.5%	87.3%	69.9%	99.2%
14. pulmonary artery catheter	Decision tree (CART algorithm) - up to 3 levels	3749	80	23	103	65.4%	81.5%	56.3%	99.4%
14. pulmonary artery catheter	Logistic regression	3747	83	25	100	63.6%	96.0%	54.6%	99.3%
15. Cardiopulmonary resuscitation	1 rule model	3940	15	0	0	0.0%	50.0%	0.0%	100.0%
15. Cardiopulmonary resuscitation	Decision tree (CART algorithm) - up to 5 levels	3940	15	0	0	0.0%	50.0%	0.0%	100.0%
15. Cardiopulmonary resuscitation	Decision tree (CART algorithm) - up to 3 levels	3940	15	0	0	0.0%	50.0%	0.0%	100.0%
15. Cardiopulmonary resuscitation	Logistic regression	3940	15	0	0	0.0%	69.9%	0.0%	100.0%
16. Hemofiltration and dialysis	1 rule model	3719	100	11	125	67.9%	77.6%	55.6%	99.7%
16. Hemofiltration and dialysis	Decision tree (CART algorithm) - up to 5 levels	3714	34	16	191	87.8%	92.4%	84.9%	99.6%
16. Hemofiltration and dialysis	Decision tree (CART algorithm) - up to 3 levels	3714	34	16	191	87.8%	92.4%	84.9%	99.6%

NAS item	Model	N_0_0	N_1_0	N_0_1	N_1_1	Cohen's Kappa statistic	C -statistic	Sensitivity (recall)	Specificity
16. Hemofiltration and dialysis	Logistic regression	3714	37	16	188	86.9%	95.4%	83.6%	99.6%
17. Urine output measurement	1 rule model	95	32	408	3420	26.4%	59.0%	99.1%	18.9%
17. Urine output measurement	Decision tree (CART algorithm) - up to 5 levels	290	93	213	3359	61.2%	79.2%	97.3%	57.7%
17. Urine output measurement	Decision tree (CART algorithm) - up to 3 levels	296	106	207	3346	61.0%	79.1%	96.9%	58.8%
17. Urine output measurement	Logistic regression	275	98	228	3354	58.3%	92.2%	97.2%	54.7%
18. Intracranial pressure	1 rule model	3861	25	0	69	84.3%	86.7%	73.4%	100.0%
18. Intracranial pressure	Decision tree (CART algorithm) - up to 5 levels	3861	12	0	82	93.0%	94.1%	87.2%	100.0%
18. Intracranial pressure	Decision tree (CART algorithm) - up to 3 levels	3861	12	0	82	93.0%	94.1%	87.2%	100.0%
18. Intracranial pressure	Logistic regression	3860	5	1	89	96.7%	99.4%	94.7%	100.0%
19. Complicated metabolic acidosis/alkalosis	1 rule model	3642	177	44	92	42.8%	66.5%	34.2%	98.8%
19. Complicated metabolic acidosis/alkalosis	Decision tree (CART algorithm) - up to 5 levels	3665	181	21	88	44.4%	66.6%	32.7%	99.4%
19. Complicated metabolic acidosis/alkalosis	Decision tree (CART algorithm) - up to 3 levels	3665	181	21	88	44.4%	66.6%	32.7%	99.4%
19. Complicated metabolic acidosis/alkalosis	Logistic regression	3654	162	32	107	50.1%	90.5%	39.8%	99.1%
20. Intravenous hyperalimentation	1 rule model	3197	116	141	501	75.7%	88.5%	81.2%	95.8%
20. Intravenous hyperalimentation	Decision tree (CART algorithm) - up to 5 levels	3306	132	32	485	83.1%	89.8%	78.6%	99.0%
20. Intravenous hyperalimentation	Decision tree (CART algorithm) - up to 3 levels	3306	132	32	485	83.1%	89.8%	78.6%	99.0%
20. Intravenous hyperalimentation	Logistic regression	3304	109	34	508	85.6%	97.5%	82.3%	99.0%
21. Enteral feeding through gastric tube	1 rule model	2670	67	98	1120	90.1%	95.4%	94.4%	96.5%
21. Enteral feeding through gastric tube	Decision tree (CART algorithm) - up to 5 levels	2725	81	43	1106	92.5%	96.3%	93.2%	98.4%
21. Enteral feeding through gastric tube	Decision tree (CART algorithm) - up to 3 levels	2725	81	43	1106	92.5%	96.3%	93.2%	98.4%
21. Enteral feeding through gastric tube	Logistic regression	2700	70	68	1117	91.7%	98.3%	94.1%	97.5%
22. Specific intervention(s) in ICU	1 rule model	3516	409	3	27	10.3%	53.1%	6.2%	99.9%
22. Specific intervention(s) in ICU	Decision tree (CART algorithm) - up to 5 levels	3472	315	47	121	36.2%	63.7%	27.8%	98.7%
22. Specific intervention(s) in ICU	Decision tree (CART algorithm) - up to 3 levels	3476	329	43	107	32.7%	63.6%	24.5%	98.8%
22. Specific intervention(s) in ICU	Logistic regression	3494	345	25	91	29.7%	82.3%	20.9%	99.3%

NAS item	Model	N_0_0	N_1_0	N_0_1	N_1_1	Cohen's Kappa statistic	C -statistic	Sensitivity (recall)	Specificity
23. Specific interventions outside ICU	1 rule model	3562	386	1	6	2.7%	50.8%	1.5%	100.0%
23. Specific interventions outside ICU	Decision tree (CART algorithm) - up to 5 levels	3559	372	4	20	8.6%	52.8%	5.1%	99.9%
23. Specific interventions outside ICU	Decision tree (CART algorithm) - up to 3 levels	3559	372	4	20	8.6%	52.8%	5.1%	99.9%
23. Specific interventions outside ICU	Logistic regression	3561	383	2	9	3.9%	69.8%	2.3%	99.9%

A colour code was used based on the Kappa statistic: below or equal to 20% => in red; between 20% and 40% => in orange; between 40% and 60% => no colour; between 60% and 80% => in light green; between 80% and 100% => in green; N00= not predicted and not registered in NAS; N01= predicted but not registered in NAS; N10= registered in NAS but not predicted; N11= predicted and registered in NAS.

1-RULE BASED MODEL MATCHES WELL FOR NAS-ITEMS WITH A CLOSE LINK TO THE VG-MZG / DI-RHM CONTENT

Only for 6 NAS-items the performance measures are good for a 1-rule based model: 7. 'Support' (If Z100 'assessment of mental, psychosocial, functioning' not equal to 1 'Present' , then Yes, else No); 10. 'Artificial airways' (If K100 'aspiration of airways' equal to 1, then Yes, else No); 16. 'Hemofiltration and dialysis' (If G500 equal to 3 'Presence of renal function replacement therapy for more than 8 hours', then Yes, else No); 18. 'Intracranial pressure' (If I200 equal to 2 'Monitoring intracranial pressure with drainage cerebrospinal fluids', then Yes, else No); 20. 'Intravenous hyperalimentation' (If D400 equal to 1 'Presence of total parenteral nutrition', then Yes, else No); 21. 'Enteral feeding through gastric tube' (If D300 equal to 1 'Enteral feeding via gastric tube', then Yes, else No).

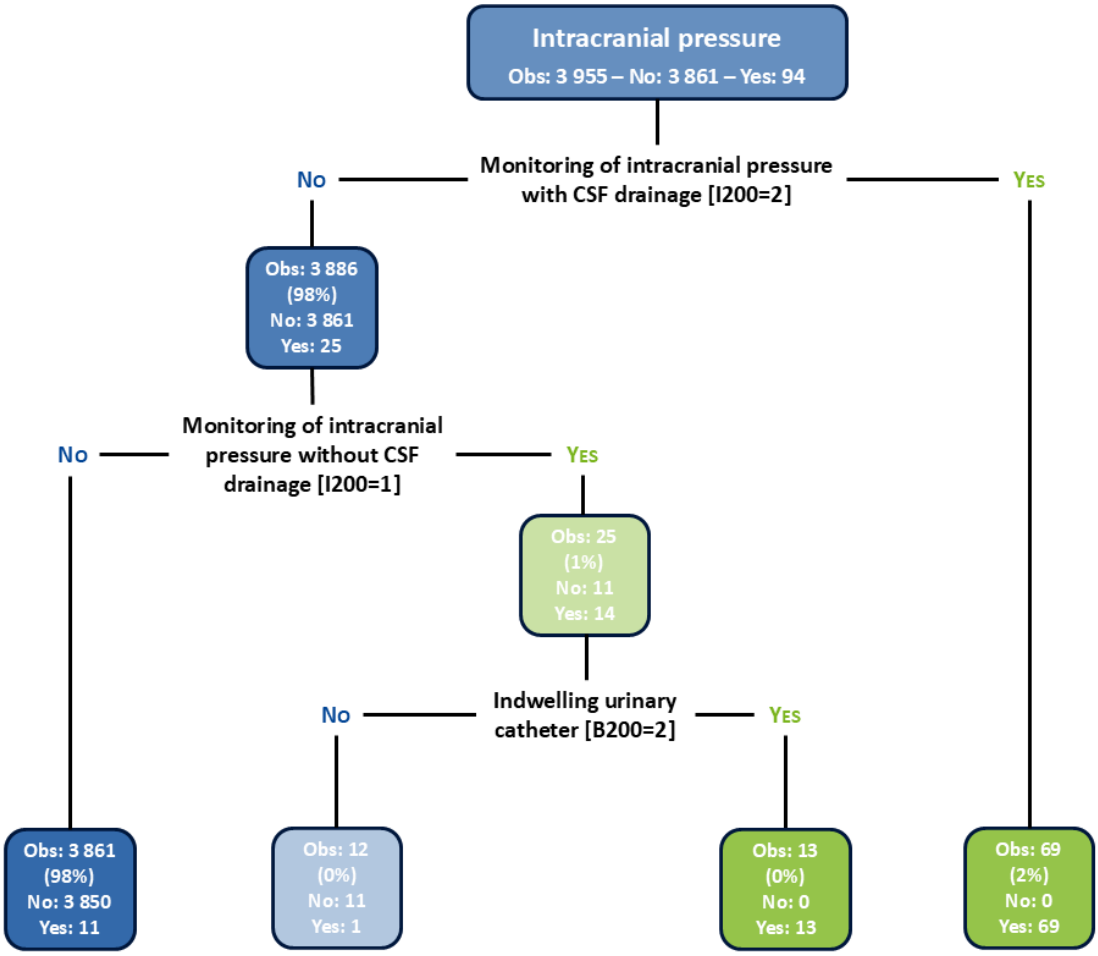
It is clear that nearly all of these items also performed well in the content-based mapping, indicating a closely linked content. Yet, for some items the link is more indirect. Item 10. 'Artificial airways', for instance, is in the 1-rule based model linked with K100 'Aspiration of airways' and not with K300 'Artificial ventilation'. This can be explained by the fact that 'Aspiration of artificial airways' is a more common nursing activity. The link in terms of content for item 7. 'Support' with the absence of an assessment (Z100=1) is less clear. For item 16. 'Hemofiltration', the machine learning improves the content mapping, since the content mappers seemed to have made the wrong choice. Indeed, while the content mappers related it to M100 – score 3 (Thermoregulation with extra corporal blood heating), the machine learning assigned it to score 3 of item G500 (Renal replacement therapy for >8 hours).

Yet, the match is never perfect. For an item like 20. 'Intravenous hyperalimentation' a perfect match with VG-MZG / DI-RHM item 'D400 presence of total parenteral nutrition' is expected. Yet, of the 617 NAS-observations with such an activity coded, only 501 can be retrieved in the VG-MZG / DI-RHM. Moreover, for 141 observations such a VG-MZG / DI-RHM item is coded while it was not the case in the NAS. This can be due to several reasons such as over- and underreporting in both systems, a different practice in coding night-time activities (e.g. next day in VG-MZG / DI-RHM while still counted on the same day in the NAS) or differences in coding guidelines.

DECISION TREE MODELS HAVE THE POTENTIAL TO IMPROVE PREDICTION OF 1-RULE BASED MODELS FOR CONTENT-RELATED VG-MZG / DI-RHM ITEMS WITH SEVERAL CATEGORIES

For some items, the 1-rule model is too restricted to match with the VG-MZG / DI-RHM. VG-MZG / DI-RHM item 'I200 Intracranial pressure monitoring', for instance, has two coding possibilities (monitoring intracranial pressure with and without drainage of cerebrospinal fluids). A 3-level decision tree model (see Figure 65) improves the Cohen's Kappa from 84.3% to 93.0%. The sensitivity increases from 73.4 % to 87.2% while the specificity remains 100% (if the model predicts that the NAS-item will be absent, it is absent). This is because of the addition of intracranial pressure without drainage in level 2 of the model (I100=1) and by adding 'B200 indwelling urinary catheter' in level 3. The latter is already less intuitive. It means that for observations with intracranial pressure monitoring without drainage in the VG-MZG / DI-RHM, the presence of an indwelling urinary catheter helps to predict the presence of the NAS-item intracranial pressure monitoring. In this three-level model still 12 observations have a score for the NAS-item while it was not predicted by the VG-MZG / DI-RHM model. It should be noted that the sample does not allow to generalise these results. It is possible that item 'B200' improves the model due to sample characteristics that cannot be repeated in a random sample. A similar picture is observed for NAS-items 9. 'Respiratory support'; 14. 'Left atrium monitoring: pulmonary catheter'; and 16. 'Continuous veno-venous hemofiltration.

Figure 65 – Three-level decision tree model for intracranial pressure



DECISION TREE MODELS HAVE THE POTENTIAL TO IMPROVE PREDICTION OF 1-RULE BASED MODELS THAT CAN BE INDIRECTLY DEDUCED FROM (SEVERAL) VG-MZG / DI-RHM ITEMS

An example in which several VG-MZG / DI-RHM items with only an indirect link to a NAS-item are combined in a decision tree model to predict the NAS-item is 14. 'Pulmonary artery catheter'. The 1-rule model assigned VG-MZG / DI-RHM item V400 a score of 8 or higher (different vital observations that are monitored in a continuous way), which is not completely illogical since these types of patients require close monitoring of several vital observations. Yet, the 3-level decision tree model adds also the following VG-MZG / DI-RHM items: N700 – score 3 (ECMO); F500 ('Special mouth care', score 2 or more) and age >52 years. While ECMO is expected and logical with a pulmonary catheter, special mouth care (i.e. is more frequently done in very critically ill patients) as well as age are not specific and only indirectly linked. Compared to the 1-level model, in the 3-level decision tree model the sensitivity increases from 28.4% to 56.3% while the specificity remains at 99.4% (it is an uncommon procedure). The sensitivity in the 5-level decision tree model even increases to 69.9%. Yet, the model becomes less intuitive since items like H200 (IV medication); K100 (Aspiration airways) and N600 (Monitoring electric cardiocirculatory support) are added. While these are also indirectly linked to the NAS-item, the readability of the model decreases and can also be the result of specific sample characteristics that will not yield the same results when a random sample of ICU patients is used.

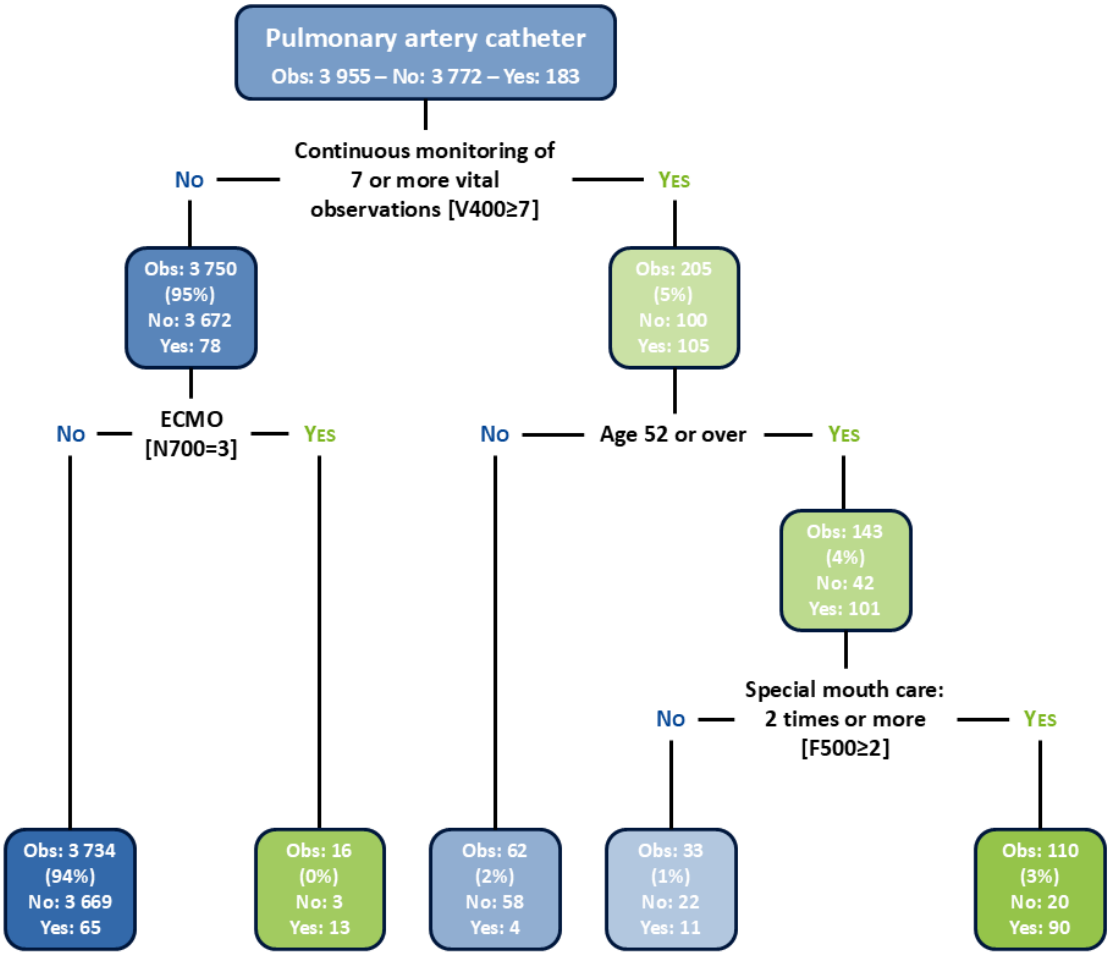
Also for NAS-item 13. 'IV fluids', the presence of VG-MZG / DI-RHM item H200 with a frequency of 10 or more is logical. Yet, the other items in the model (e.g. 3-level model: F100= 3 'Complete hygiene care' and Z100=1 'Assessment mental, psychosocial functioning') are not very specifically related to

this item. The same can be observed for NAS-item 17. 'Urine output measurement'. While item B200=2 'Indwelling catheter' (also result of 1-rule based model) is logical, the items in the decision tree models (e.g. V200 'Pressure ulcer prevention'; N300 'Venous blood sampling'; F500 'Special mouth care') are not specifically enough related to the NAS-activity to make the model readable. Also NAS-item 2. 'Lab testing' is indirectly linked to venous-arterial and capillary blood sampling (N300-N500).

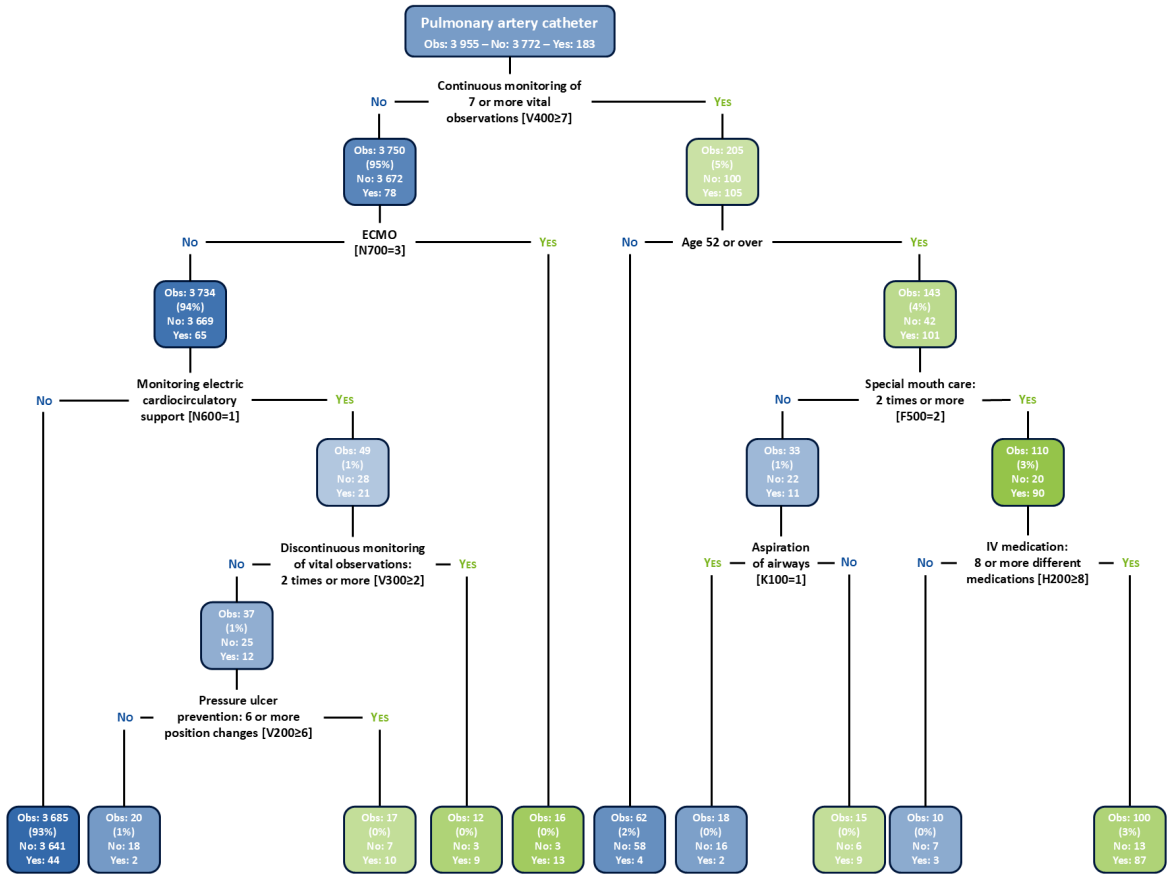
Also for NAS-items 3. 'Medication (vasoactive drugs excluded)'; 5. 'Drainage'; 11. 'Lung function'; 12. 'Vasoactive medication'; 17. 'Quantitative urine output measurement'; 19. 'Treatment of acidosis/alkalosis', the decision trees improve the performance scores while the results are not very intuitive.

Figure 66 – Decision tree model (3- and 5-levels) for NAS-item pulmonary artery catheter

3 level decision tree



5 level decision tree



MACHINE-LEARNING MODELS PERFORM BAD WHEN THERE IS NO CLEAR LINK BETWEEN THE CONTENT OF BOTH MEASUREMENT SYSTEMS

An example of bad-performance of the machine-learning models can be found for NAS-item 4. 'Hygiene procedures'. The 1-rule model predicts that this NAS-item is present when the frequency of arterial blood sampling is 11 or lower (N400). There is no clear content-related explanation for this. When looking at the output from the decision tree models we see that V300 (Discontinuous monitoring vital observations); V600 (Isolation measures) and Z100 (Assessment) are included in the 3-level model and that in the 5-level model F100 (Hygiene care) and D100 (Care with feeding) are added. These items probably depict a 'clinical profile' in which the NAS-item is scored or not scored. Yet, there is no obvious link and it can be dependent on the sample of the current study. In fact, only at the lowest level of the 5-level decision tree model item F100 (Complete assistance with hygiene care) has a content-related link with the NAS-item. VG-MZG / DI-RHM items related to wound care (which is part of this NAS-item), were not retained by the model. In the logistic regression model more items are added, including a wound care item L300 (Simple care for open wound). Yet, it does not improve readability.

The instability of this model can be illustrated when we apply the exclusion rule that we used in the other statistics above (i.e. one hospital was excluded for calculations regarding 'hygiene care' since the descriptive statistics showed data quality problems for this item). The application of these exclusions results in a different set of items: I100 (Monitoring neurological function); R100 (Emotional support) and 'all shifts'.

Moreover, the overall performance of these models is low with Cohen's Kappa values of 0.0% (1-rule model); 41.0% (5-level decision tree); 41.0% (3-level decision tree); and 44.0% (logistic regression) (see Table 21; item 4). Since NAS-item 4. 'Hygiene procedures' includes three subcategories, models

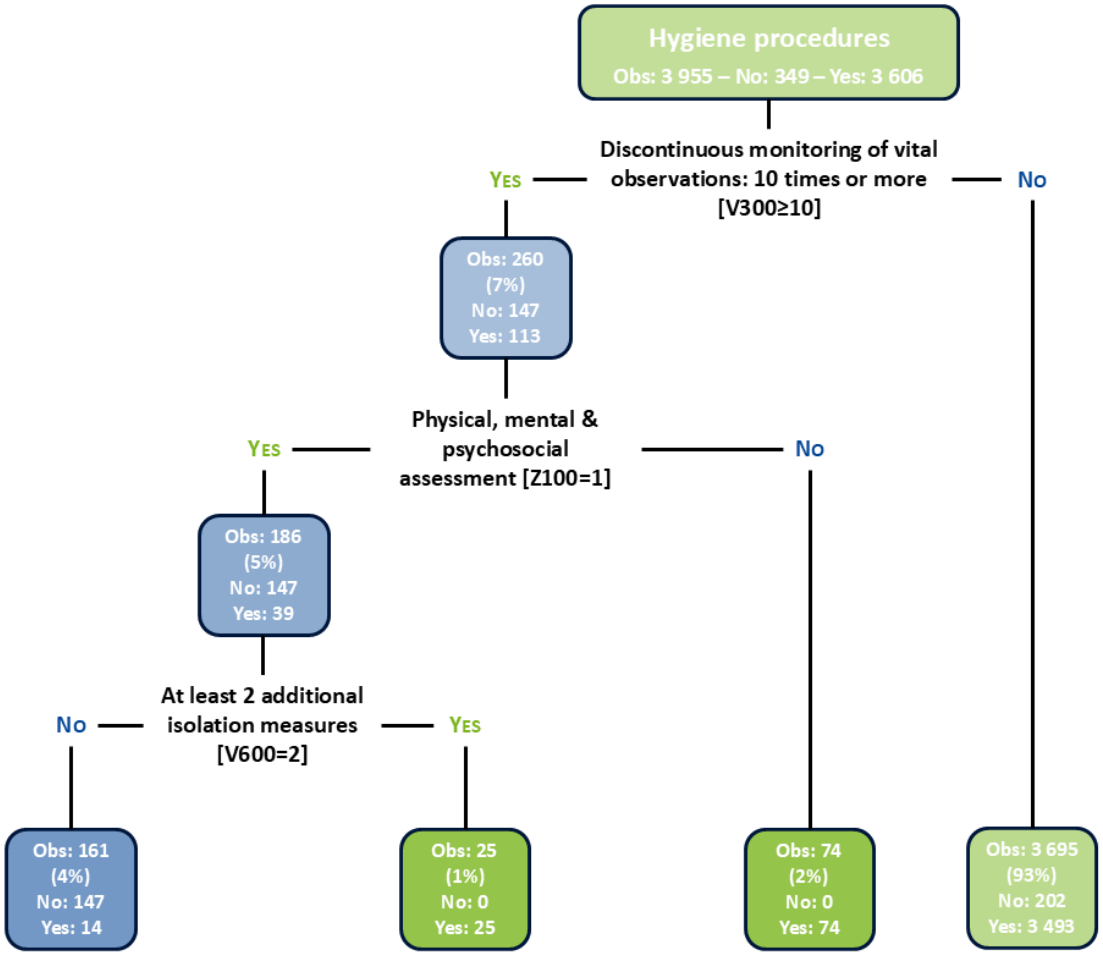
were also run at this level. If we consider the subcategories (e.g. 4a. 'Hygiene care: basic'; Cohen's Kappa between 36.9% and 48.4%) similar content-related conclusions about the models can be drawn (see Table 21; item 4.a).

A similar picture is observed for NAS-items 1. 'Monitoring and titration'; 6. 'Mobilisation'; 7. 'Support and care for patient and relatives'.

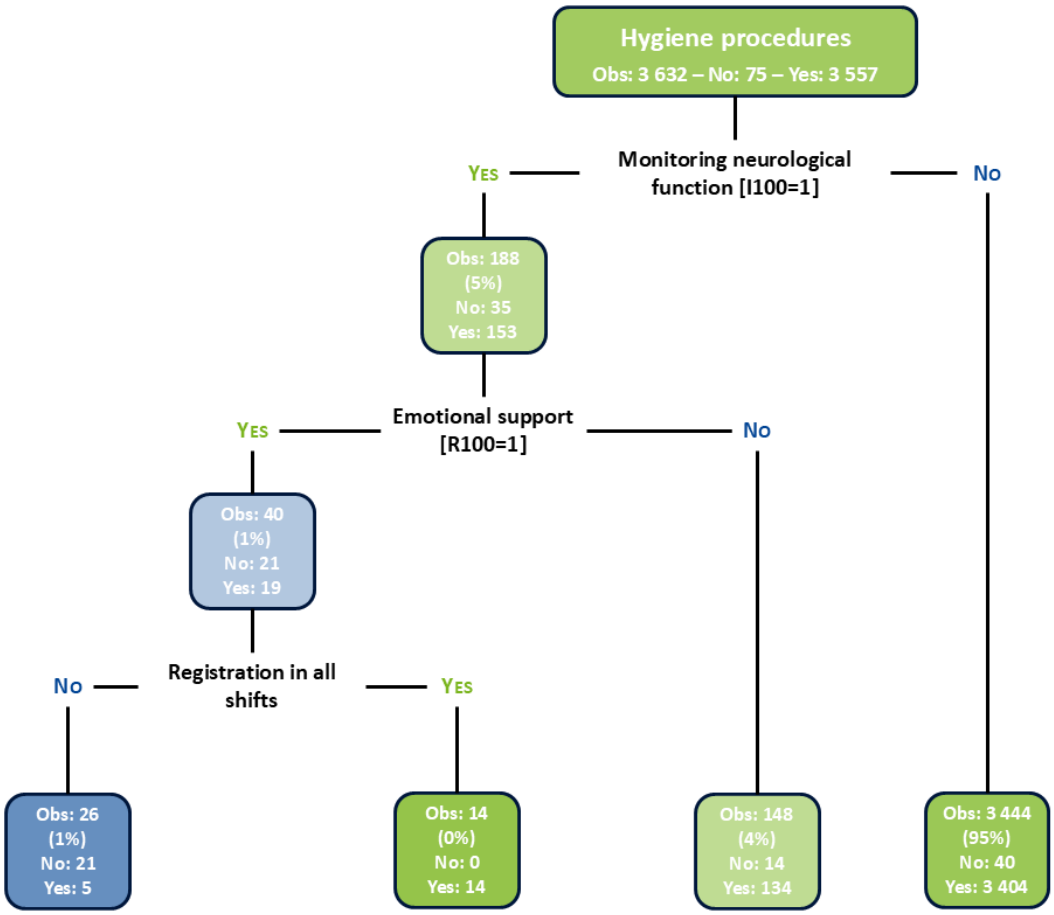
The frequency of items like administration (which occurs for almost for every patient) but also mobilisation in general and cardiopulmonary resuscitation (almost no events), hinders the discriminatory characteristics of these items.

Figure 67 – Decision tree model (3 levels) for NAS-item hygiene procedures

3 level decision tree – all observations



3 level decision tree – excluding low quality data



5.5 Discussion and conclusion

In this chapter we have compared the NAS- with the VG-MZG / DI-RHM instrument to evaluate if and how the information from both instruments relate and if the VG-MZG / DI-RHM can be used as a substitute for the NAS. After all, the NAS is, in the international literature, considered as the best performing instrument to measure workload in ICUs. Obtaining accurate workload information is crucial for making more objective staffing decisions. Our study allows us to make several observations.

First, experience with the NAS-instrument in Belgian hospitals is more limited than expected. While 20 of the 83 hospitals that participated in the first part of the study (KCE Report 353) expressed their interest (and indicated that they collect the NAS routinely or have done this in the past) to participate in the study, only 10 hospitals eventually participated. While some hospitals did not participate because the impact of the COVID-19 pandemic on their daily functioning was still too large, most hospitals could not deliver the NAS-data (e.g. no experience with coding; problems with data extraction from the electronic patient record, etc.). Moreover, from the 10 participating hospitals, 2 were removed from the sample because of serious data problems (e.g. missing values, 100% scores on some items) and in 2 hospitals some variables (e.g. hygiene, support) were removed from the analysis since initial data cleaning suggested that in these hospitals these variables were per default coded for all or none or were greatly underreported. A more widespread use of the NAS would require a solid implementation plan including training of nurses (e.g. coding), electronic patient record requirements and a more widespread use of software to automatically extract NAS-items from the patient records which would also limit the administrative burden for nurses.

Second, the objective to compare differences in patient acuity (with NAS or VG-MZG / DI-RHM) with differences in nurse staffing patterns could not be evaluated. While the nurse staffing module in the VG-MZG / DI-RHM still exists, it is no longer compulsory. As a consequence of this policy decision, most hospitals do no longer collect these data in a systematic way. Therefore, it was impossible to get hold of these data in 9 out of 10 participating hospitals. We advocated before to make this registration compulsory again which would allow to monitor and benchmark nurse staffing levels in Belgian hospitals which is an important aspect of safe staffing policies.[11]

Third, while both the NAS-instrument as the VG-MZG / DI-RHM instrument use a 'point system' to measure workload, the scores have a relatively low correlation. While the correlation between the sum scores at the unit, unit per day and stay-level are high, the correlation between the average scores per unit and unit per day are much lower. It is possible that this is due to under- or overreporting of several items in one or the other system. In addition, there is a mismatch between NAS-shifts and VG-MZG / DI-RHM care episodes which might explain lower than expected correlations.[44] Moreover, the comparison was done per day (24-hour period), which might be too blunt as a patient's condition (and care) might evolve between shifts which can be better captured by a NAS-registration per shift. Currently, the VG-MZG / RI-RHM is collected per care episode (=1 per 24 hours if the patient stays on the units) which does not allow a comparison between the NAS and the VG-MZG / DI-RHM at the shift level.

Fourth, some items in both instruments measure more or less the same activities in a direct (e.g. intracranial pressure; intravenous hyperalimentation; enteral feeding through gastric tube) or indirect way (e.g. respiratory support; care of artificial airways). This was illustrated by the content mapping and confirmed by the machine learning analyses.

Fifth, while the machine learning helped to improve the content mapping by indicating an item that was missed (i.e. hemofiltration), or by indirectly linked items (e.g. lab-testing linked to blood sampling). Yet it is clear that when there is no clear content link, the machine learning does not help. It generates an algorithm that constructs a clinical profile in which the NAS-items occur. While this could be helpful in a random sample, it is not in the context of the current study as the results cannot be generalised. In addition, it is clear that the machine learning techniques hardly improve the performance measures (e.g. Cohen's Kappa) when there is no obvious content link.

Sixth, although the NAS-instrument is considered as the best-performing ICU workload instrument in the literature, it has some limitations. Some items (e.g. cardiopulmonary resuscitation) are relatively rare while other items (e.g. administration; mobilisation, support) seem to be coded almost per default. This limits the discriminative power of the instrument. In addition, some of the NAS-items (e.g. monitoring and titration) are a collection of several nursing activities (e.g. monitoring vital observations; assessment scales; fluid balance) while in the VG-MZG / DI-RHM these are coded as separate activities. Furthermore, the relative weight of some NAS-items (monitoring; medication; vasoactive drugs excluded; hygiene procedures; mobilisation; support and care of relatives and patients; administrative support and quantitative urine output measurement) is high in the total NAS-score. An update of the NAS to include a wider spectrum of nursing activities and an update of the current activities to recent changes in practice might be considered. On the other hand, the exercise performed in this chapter also gives inspiration to change/improve the VG-MZG / DI-RHM items. NAS-item 6c (mobilisation with 3 or more nurses) is a very time-consuming nursing activity that cannot be captured directly from the VG-MZG / DI-RHM, nor deduced more indirectly.

Finally, it is clear that a holy grail to measure workload does not currently exist. Therefore, it is better to select one instrument and use it in a systematic way. This can be the NAS but also the VG-MZG / DI-RHM as the latter is used in a systematic way in all Belgian hospitals, allowing for benchmarking. The use of these instruments requires training in the coding (or electronic patient record documentation) and auditing of coding quality. While it can help to induce an objective element in the staffing discussions (e.g. on a daily, monthly or yearly basis), the user needs to be aware of the limitations inherent to the data. Therefore, these workload instruments should be used together with the assessment of, for instance, the head nurse and input of the staff nurses.

6 IN-HOSPITAL MORTALITY IN INTENSIVE CARE

KEY POINTS

- Variability in in-hospital mortality across Belgian hospital sites is examined as a key indicator of quality and safety in intensive care, with a focus on its association with hospital characteristics – with activity volume as variable of primary interest – and on the subsample of high-comorbidity patients who potentially require more complex care and have an increased mortality risk.
- The analysis is based on the Minimal Hospital Data (MZG – RHM) from 2016–2019. Stays in intensive care services are identified based on admission to a (general or paediatric) intensive care unit (ICU) or burn care unit and are classified into clinically homogeneous groups based on the principal diagnosis. In-hospital mortality refers to deaths occurring in any hospital unit. To obtain a more homogeneous sample, several exclusion criteria were applied, including short stays (<24 hours in intensive care services), palliative patients, long-term hospitalisations, transfers, and diagnosis groups that only account for a small share of in-hospital mortality.
- Two complementary methods are used. First, indirect standardisation is applied to compute Standardised Mortality Rates (SMRs) and Hospital Standardised Mortality Rates (HSMRs), assessing whether their variability is systematically associated with hospital site characteristics. However, SMRs and HSMRs have known limitations, including coding differences, case-mix adjustment biases, and sensitivity to aggregation. A second, more direct approach models patient-level in-hospital mortality risk using a multilevel logistic regression model with random site effects, linking mortality risk to both patient and hospital site characteristics.
- The analysis accounts for key case-mix variables, including age, sex, urgency of admission, socioeconomic status, and comorbidity burden (using the Elixhauser composite mortality risk score). A limitation is the absence of ICU-specific scoring systems, as physiological parameters are not available in the data. Substantial and systematic variation in in-hospital mortality across hospital sites may point to potential differences in quality and safety of care, but could also be influenced by differences in admission policy, advanced care planning decisions and unmeasured case-mix differences in patient population.
- Using SMRs and HSMRs as an intermediary step, no significant association is found between patient volume and HSMR when including all admissions, while a significant volume-outcome effect is observed in the subsample of high-comorbidity patients, suggesting that a critical mass of high-comorbidity patients may reduce in-hospital mortality. This result is robust across alternative model specifications. University hospitals exhibit higher HSMRs, possibly due to a more complex patient population, which is not fully captured by available case-mix variables. At a more detailed level, a significant impact of patient volume on SMRs is found across a range of aggregate diagnosis groups, including infectious and parasitic diseases (septicaemia), neoplasms, and diseases of the circulatory, respiratory, and digestive systems, both among all admissions and high-comorbidity admissions. The analysis of SMRs further reveals regional effects and increased mortality risk in university hospitals for some aggregate diagnosis groups.
- The multilevel logistic regression model produces comparable findings. The relationship between hospital characteristics and in-hospital mortality varies by aggregate diagnosis group. In both the overall and high-comorbidity admission samples, higher patient volume is associated with lower in-hospital mortality for certain aggregate diagnosis groups, including neoplasms, circulatory and respiratory diseases, endocrine and metabolic diseases, and immunity disorders. However, no significant volume effect is found for infectious and parasitic diseases (septicaemia), injury, and poisoning. Hospital site characteristics explain a substantial portion of inter-hospital site variation for neoplasms, diseases of the nervous system and sense organs, and injury and poisoning, while only a smaller proportion of variability is explained for

infectious and parasitic diseases (septicaemia), diseases of the circulatory, respiratory, digestive, and genitourinary systems.

- Unexplained but systematic inter-hospital site variability is substantial. For two identical patients (in the all-admissions sample) treated at randomly selected hospital sites, the median odds of dying are 50% higher in the higher-risk site for diseases of the circulatory system and neoplasms and 30% higher for diseases of the respiratory and digestive systems, or injury and poisoning. Among high-comorbidity patients, the median odds of dying for otherwise identical patients are at least 30% higher in the higher-risk site for infectious and parasitic diseases (septicaemia), neoplasms, diseases of the circulatory system, and injury and poisoning.
- Heatmaps highlight systematic performance differences across hospital sites. Hospitals with high or low HSMRs tend to perform consistently across multiple aggregate diagnosis groups, both using SMRs and random effects from the multilevel model, suggesting that overall mortality rankings reflect broader institutional patterns. The strong correspondence between both methodological approaches provides additional validation of our findings.

6.1 Introduction

The measurement of patient outcomes, the quality and safety of care are core elements to assess the performance of hospitals and intensive care services. In-hospital mortality is a key indicator of quality and safety of care that is widely used and appealing given the gravity of the outcome, its clinical relevance, and accurate registration.

In this chapter, variation in in-hospital mortality across intensive care services in Belgium is analysed for the period 2016 to 2019. While longer-term outcomes such as 90-day or 1-year survival could provide additional insights, they require time-intensive linkage between hospital data and external mortality records, which was beyond the scope and timeline of this study. Intermediate care units (IMCUs) are not included in this analysis. Although a separate assessment of mortality in IMCUs may be relevant, this was not feasible due to the lack of official IMCU registration in Belgium (see also Chapters 4 and 7). Attempts to identify IMCUs using survey responses (Chapter 7) or the Nursing Minimum Data of 2019 (Chapter 4) were descriptive in nature and not sufficiently robust to support consistent identification of these units over time for mortality analysis.

Intensive care services are defined at the hospital site level as the combination of general and paediatric intensive care units and burn care units. We examine if the variation is associated with hospital or hospital site characteristics with particular attention paid to patients who are at increased risk of complications or mortality. We compute standardised mortality rates (SMR) and hospital standardised mortality rates (HSMR), as pioneered by Jarman et al. (1999).[62] SMR and HSMR represent a quantitative approach to monitor and explain variation in, respectively, disease-specific and hospital-wide (or hospital site-wide) mortality. An indirect standardisation is applied to compare the actual number of deaths with those that would be expected given the case-mix and severity of the patient population. SMR and HSMR are used and (publicly) reported in several health systems, amongst others in the UK, Canada, the Netherlands and by the Flemish Hospital Network.[p62-71]

In what follows, we first discuss the available data and exclusion/inclusion criteria that further delineate the activity taken up in the analysis (section 6.2). Second, the applied methodology is set out, including the computation of SMR and HSMR and its limitations (section 6.3) as well as the statistical analysis of the inter-hospital site variation in mortality. Third, different sets of results are presented (section 6.4): (1) a description of the study population and the impact of the inclusion/exclusion criteria; (2) the

[p] The Flemish Hospital Network is a collaborative network of hospitals in Flanders, dedicated to optimising the quality and efficiency of patient care, education, research, and hospital management through knowledge sharing, joint research, shared training programmes, and the development of best practices.

(hospital) standardised mortality rates; (3) the association between variation in in-hospital mortality and hospital and hospital site characteristics.

6.2 Data

6.2.1 Data selection

Using the Minimal Hospital Data (MZG – RHM) (see chapter activity for a description of the MZG – RHM) for the years 2016 to 2019, we selected all inpatient hospitalisations of patients who were at any time during their hospitalisation admitted in an intensive care service, i.e. general or paediatric intensive care unit or burn care unit. Given the administrative delay in data availability and the disruptive impact of COVID-19 on activity and case-mix in intensive care services during 2020 and 2021, a longer pre-pandemic study period was preferred over a shorter post-pandemic period. Information was retrieved on patient characteristics (sex, age, zip code), diagnostic information (principal and secondary diagnosis coded in ICD-10-CM as well as a flag on presence on admission (POA)), in-hospital mortality (in any unit, not limited to intensive care services), source of admission, urgency, transfer to another hospital, hospital (site, unit) characteristics (number of beds, region, volume of activity, intensity of care based on nursing registration (see Chapter 4 on nursing activity)). No information was available on mortality outside the hospital.

In case hospital sites were merged, changed affiliation or location during a year, their status information in December of that year was used.

6.2.2 Data manipulation

CASE-MIX INFORMATION

One of the main challenges when comparing in-hospital mortality across hospital sites is adjusting for patient case-mix. Based on diagnostic information in the MZG – RHM, two additional variables were added to the dataset to account for case-mix differences.

First, patients were classified into homogeneous **clinical groups**. SMRs were calculated for each clinical group separately. To assign a clinical group to each hospitalisation, we used the Clinical Classifications Software (CCS) developed by the Agency for Healthcare Research and Quality (AHRQ) which clusters ICD-10 principal diagnosis codes into 259 mutually exclusive clinically meaningful categories.[q] The 259 categories were further clustered into 157 **diagnosis groups** and **17 aggregate diagnosis groups** using a mapping from Statistics Netherlands that has been applied in the analysis of SMR and HSMR in the Netherlands and is highly similar to the mapping used in the UK.[63, 67, 72] The mapping between CCS categories and (aggregate) diagnosis groups can be found in Appendix to Chapter 6 in the Supplement. CCS classification is preferred due to its widespread use in SMR and HSMR literature, making it the most internationally recognised method for creating clinically meaningful groups from administrative data. While alternative systems, such as APR-DRGs, have been used in specific contexts like (H)SMR calculation in Flanders,[66, 71] CCS remains the most widely applied approach.

Second, a correction for **the level of critical illness** is necessary to account for differences in case-mix between hospital sites when predicting the risk of mortality within each diagnosis group. ICU-specific scoring systems, such as the APACHE (Acute Physiology And Chronic Health Evaluation) and SOFA (Sequential Organ Failure Assessment) scores, are generally preferred for calculating risk-adjusted mortality rates in intensive care; however, they also have their limitations.[73] While, some

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[q] Since 2021, the Clinical Classifications Software Refined (CCSR) has superseded the original CCS. The CCSR expands the number of clinical categories to over 530. Furthermore, unlike CCS, which assigns each diagnosis code to a single, mutually exclusive category, CCSR permits a single diagnosis code to be classified into multiple categories, reflecting the complex nature of certain diagnoses. Given that the data used in our analysis are from the period 2016-2019, the CCS classification was employed.

studies show that the predictive validity of indices based on administrative data (e.g. Elixhauser, Charlson) is comparable to ICU-specific prognostic scores like APACHE, other studies show that it is better to complement Elixhauser or Charlson scores with ICU-specific scores.[74, 75] A limitation of this study is that the MZG – RHM data do not provide sufficient information to calculate ICU-specific scoring metrics as information on physiological parameters is not available. Therefore, the AHRQ Elixhauser comorbidity index, adapted for ICD-10 coding, was used.[23, 72]

Based on diagnostic information in hospital administrative discharge data, the AHRQ Elixhauser comorbidity index identifies 38 distinct clinical conditions which predate hospital admission and are expected to impact both mortality risk and hospital resource use.[22, 23]. To facilitate comparisons of the Elixhauser comorbidity index across patients with widely varying principal diagnoses, we included both the primary and secondary diagnoses in the index.[76] This inclusion does not affect the calculation of the SMRs, as all patients in the same clinical group have a similar principal diagnosis. However, it improves our approach to identifying high-comorbidity patients for subanalyses. For instance, a patient with HIV as principal diagnosis and diabetes as the secondary diagnosis has the same comorbidity burden as a patient with diabetes as principal diagnosis and HIV as the secondary diagnosis. Only including secondary diagnoses would lead to a different treatment of these patients.

We calculated both individual Elixhauser comorbidities and a composite mortality risk score summing up all comorbidities using pre-defined weights that reflect the association between each comorbidity and in-hospital mortality. The mortality risk weights, provided by AHRQ, were derived from logistic regression coefficients based on US hospital data, with in-hospital mortality as dependent variable and the individual comorbidities as explanatory variables.[22, 23, 31] The Elixhauser index was preferred over the Charlson index, another frequently used comorbidity measure based on hospital discharge data, due to its superior performance in predicting in-hospital mortality.[77]

AREA LEVEL DEPRIVATION

The MZG – RHM data do not contain information on lifestyle or socioeconomic status of the patient. Research has demonstrated an increased risk of mortality associated with a broad range of unhealthy lifestyle factors among more deprived socioeconomic groups.[78] Based on the zip code of the patient, information from the Belgian Index of Multiple Deprivation (BIMD) was added to the dataset.[79] The BIMD is a multidimensional measure of small-area deprivation based on 2011 census data that allows to rank municipalities from most to least deprived. The ranking information was used to create quintiles of deprivation.[79] The analysis of (H)SMR in the UK equally uses similar information on small-area deprivation indices.[64, 65, 67, 80]

6.2.3 Exclusion criteria in baseline

To address the challenges of comparing in-hospital mortality across hospital sites, one aspect of our approach was to subdivide patients into diagnosis groups and incorporate case-mix variables (see section 6.2.2). Another aspect involved reducing heterogeneity in the patient population by excluding certain patient groups from the analysis. Based on previous studies, a number of exclusions were made to refine the selection of hospitalisations in intensive care services that were included in the analysis and to enhance the comparability of the studied patient population.[63, 65-68, 80, 81] Reasons for exclusions were: the scope of the study, a limited impact of treatment in intensive care services on the outcome, no observation of the outcome, limited relevance of the pathology for in-hospital mortality.

In the baseline scenario, the following exclusion/inclusion criteria were applied in the specified order:

Exclusion of birth-related stays and psychiatric stays. These stays were considered out of scope. Therefore, we excluded intensive care units with predominantly neonatal or maternal intensive care beds. Additionally, inpatient hospitalisations were excluded if they had birth as the admission type or were classified under MDC 14 (Pregnancy, Childbirth, and the Puerperium), MDC 15 (Newborns and Other Neonates with Conditions Originating in the Perinatal Period), or MDC SS (Special DRGs, including emergency care, psychiatric care, and day-care or ambulatory care previously covered by a mini lump sum).

Exclusion of long-term stays[r] *and patients transferred to other hospitals.* For these hospitalisations, no outcome was observed. Transfers to another hospital include university hospitals, general hospitals and psychiatric hospitals.

Exclusion of palliative patients. Palliative patients were identified using ICD-10 diagnosis codes (Z51.5 present on admission or patients with cancer as the principal diagnosis and Z51.5 not coded as present on admission).[68] These patients have high in-hospital mortality rates, with the quality and safety of intensive care treatment having only a limited impact on their outcomes. Moreover, their distribution across hospital sites is uneven, which may distort (H)SMR outcomes, although similar concerns apply to other patient groups as well (see also point 4 and Textbox 3).

Exclusion of hospitalisations with only a short admission in intensive care when intensive care services are not the final unit of the hospital stay. A short admission is defined as 24 hours or less. In such cases, intensive care services potentially function as a recovery unit. These patients have a below-average mortality risk and are unevenly distributed across hospital sites which may distort (H)SMR outcomes.

Restriction to hospitalisations in diagnosis groups that account for 80% of in-hospital mortality in intensive care services. In order to further increase the comparability of patient profiles, and focus on the most relevant, 45 diagnosis groups (out of 157) that accounted for 80% of in-hospital mortality in the study period were retained. The included diagnosis groups are listed in Appendix to Chapter 6 in the Supplement.

6.3 Methodology

The applied methodology is to a large extent based on existing approaches in the UK and the Netherlands which have been developed and refined over the past two decades.[62, 64, 65, 67, 68] In Belgium, the Flemish Hospital Network has set up a similar approach for 27 Belgian hospitals.[66] While these approaches calculate SMRs and HSMRs for acute care in general, our scope was more limited and restricted to intensive care.

6.3.1 SMR and HSMR

The crude in-hospital mortality rate can be calculated as the ratio of the number of in-hospital deaths to the number of hospitalisations in the same period. It is, however, not recommended to evaluate performance based on crude mortality rates as one hospital site may have had more life-threatening cases than another, a fortiori in an intensive care setting. Therefore, different approaches, such as direct and indirect standardisation, have been developed to adjust mortality rates for differences in patient case-mix between providers. Direct standardisation is obtained by multiplying a hospital site's mortality rate with a reference patient population and case-mix, whereas indirect standardisation applies a reference mortality rate which is multiplied with the patient population and case-mix of the hospital site.[71, 82-84][s] The advantage of directly standardised mortality rates is that these rates are comparable with each other, which is not always the case for rates adjusted via the indirect standardisation method.[82, 85] On the other hand, in small samples (which is generally the case when subdividing by multiple factors such as age, sex, diagnosis groups, morbidity, etc.) direct

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[r] The MZG – RHM is registered and transmitted twice a year by the general hospitals to the Federal Public Service (FPS) Public Health. All discharges of a 6-month period are submitted together. Stays that last more than 6 months are so-called long stays. A stay of more than 6 months which is not finished at the end of the half-year, is called a first (F) administrative discharge. It may be followed by one or more intermediate administrative discharge(s) (M) of 6 months (unfinished at the end of a half-year) and is finally terminated by a last (L) administrative discharge corresponding to the actual hospital discharge.

[s] Direct standardisation aims to answer the question: 'How would the risk in a certain reference population change if all patients were to experience the care level of a specific centre?', while indirect standardisation aims to answer the question: 'How would the risk in a specific centre change if its patients were to experience the average care level across all centres?'.

standardisation often results in imprecise and unreliable mortality rates, leaving the indirect method as the only available option for standardisation.[71, 82, 83, 86]

In this study, standardised mortality rates (SMRs and HSMRs) were obtained using an indirect standardisation method that compared the actual number of deaths with those that would be expected given the case-mix and severity of the patient population. In a first step, SMRs were quantified for each diagnosis group separately. The assessment of mortality risk in a homogeneous diagnosis/patient group (see section 6.2.2) increases the comparability across hospital sites. Second, the HSMR was calculated using the SMRs as building blocks. It is an aggregation of the SMRs at the hospital site level using the case-mix of the hospital site as weights (see section 6.3.1.1).

Since its introduction in 1999, the use of the HSMRs has been debated for various reasons, such as the limited association between short-term mortality and clinical quality of care, coding differences between hospitals, insufficient case-mix adjustment, and aggregation issues, and we discuss its main strengths and weaknesses in Textbox 3. Despite its limitations, (H)SMRs remain an important indicator or screening tool for hospital quality, although its results should be interpreted with the necessary caution.

Textbox 3 – Strengths and weaknesses of SMR and HSMR

Standardised mortality rates (SMRs) and hospital standardised mortality rates (HSMRs) have emerged as key indicators to assess and (publicly) report hospital performance in terms of mortality outcomes. Understanding both the strengths and weaknesses of SMRs and HSMRs is critical for their appropriate use and interpretation.[80, 82, 85-89]

Strengths:

1. **Clear outcome**: In-hospital mortality is a clinically relevant and accurately recorded outcome. Its registration in administrative data allows for the use of complete population data in the assessment.
2. **Risk adjustment**: A key strength is the adjustment for known risk factors. SMRs and HSMRs incorporate various patient characteristics, such as diagnostic information, age, urgency, admission source, etc., either as stratification variables or explanatory factors. This ensures that crude mortality rates are adjusted for case severity and complexity.
3. **Comparative analysis**: Standardised mortality rates across a broad spectrum of diagnoses facilitate comparisons between providers and enable analyses of trends over time while accounting for differences in patient characteristics and case-mix. As a result, SMRs and HSMRs support benchmarking and monitoring and may serve as warning signal for potential shortcomings in quality and safety of care.
4. **User-friendly metric**: SMRs and HSMRs are user-friendly metrics that are relatively easy to calculate **based on administrative data and have a clear benchmark.**
5. **Quality improvement trigger**: By highlighting deviations between observed and expected mortality rates, SMRs and HSMRs can serve as a driver for quality and safety improvement initiatives within hospitals. Identifying unexpected patterns encourages healthcare providers to critically evaluate their practices, fostering a culture of continuous improvement.

Weaknesses:

1. **Data quality and coding variability**: Computations critically depend on accurate and consistent coding of diagnoses in administrative data that are commonly used for billing purposes rather than the calculation of quality metrics. Variability in coding practices (or even gaming) – think of differences in e.g. palliative coding, principal diagnosis, present on admission flag, number of registered secondary diagnoses – among hospitals can lead to distortions in SMR and HSMR outcomes, potentially compromising their validity and comparability. Note that our analysis is based on data from the period 2016–2019, during which SMRs and HSMRs were not publicly calculated nor reported in Belgium. This reduces the likelihood of coding practices aimed at **manipulating performance.**

2. **Out of hospital mortality**: Not all mortality related to a hospital episode occurs in the hospital. In-hospital mortality rates can be affected by differences in discharge and transfer policies. Some metrics therefore consider in-hospital mortality in combination with out of hospital mortality over a short period of time after admission or discharge. Mortality outside the hospital is, however, not recorded in the hospital data, requiring linkage with other data sources.
3. **Incomplete risk adjustment**: Despite comprehensive risk-adjustment models, some patient factors that influence mortality may not be captured accurately. This could result in over- or underestimation of a hospital's true performance.
4. **Sensitivity to case-mix**: HSMRs can be seen as a weighted mean of SMRs (see section 6.3.1.1). Such aggregation or combination of different SMRs, even when these were perfectly risk adjusted, may lead to a paradoxical situation in which one hospital may have better (lower) or equal values for each SMR compared to another hospital, but still have a worse (higher) HSMR due to differences in case-mix. This is known as Simpson's paradox. While this undesirable characteristic has been described and simulated, it is less clear how much bias occurs in reality.
5. **Indicator of quality and safety of care**: There is limited evidence that variation in HSMRs is directly **related to differences in quality or safety of care.**

Approach to counter weaknesses

We take the following steps to limit the impact of the described weaknesses:

1. We exclude specific patient groups, such as palliative patients and short-stay observation patients, for which the linkage between in-hospital mortality and quality of care is weak (see section 6.2.3).
2. We use a large number of diagnosis groups to create patient groups with more homogeneous risk profiles (see section 6.2.2).
3. Confidence intervals are calculated to account for statistical uncertainty (see section 6.3.1.3).
4. We account for differences in case-mix between hospital sites (see sections 6.2.2 and 6.3.1.2).
5. We assess the performance of the mortality risk prediction model (see section 6.3.1.2).
6. We examine the association between in-hospital mortality and hospital site characteristics not only through SMRs and HSMRs but also in a direct way in a model with patient-level data (see section 6.3.2).

6.3.1.1 SMR and HSMR specification

STANDARDISED MORTALITY RATE – SMR

The SMR of a hospital site h for diagnosis group d is defined as:[63]

$$SMR_{d,h} = 100 \times \frac{Observed\ mortality_{d,h}}{Expected\ mortality_{d,h}} = 100 \times \frac{O_{d,h}}{E_{d,h}} = 100 \times \frac{\sum_i D_{d,h,i}}{\sum_i \hat{p}_{d,h,i}} \qquad (1)$$

The numerator is the observed number of deaths ($O_{d,h}$) in diagnosis group d in hospital site h. This can be further detailed as the sum of the observed in-hospital mortality ($D_{d,h,i}$, with value 1 in case of in-hospital death and 0 when discharged alive) over all hospital admissions i in diagnosis group d in hospital site h.

The denominator is the expected number of in-hospital deaths ($E_{d,h}$) in diagnosis group d in hospital site h. The expected mortality can be further detailed as the sum of an estimated probability of in-hospital mortality ($\hat{p}_{d,h,i}$ with a value between 0 and 1 with larger probabilities indicative of a higher risk of in-hospital mortality) over all hospital admissions i in diagnosis group d in hospital site h. A prediction model (see section 6.3.1.2) produces the expected (estimated) probability of in-hospital mortality for each admission.

The SMR of an aggregate diagnosis group can be calculated using a similar approach but by summing over all patients in the aggregate diagnosis group.

HOSPITAL STANDARDISED MORTALITY RATE – HSMR

The HSMR of hospital site h is the sum of the SMRs of all diagnosis groups d and can be defined as:[63]

$$HSMR_h = 100 \times \frac{O_h}{E_h} = 100 \times \frac{\sum_d O_{d,h}}{\sum_d E_{d,h}} = 100 \times \frac{\sum_d \sum_i D_{d,h,i}}{\sum_d \sum_i \hat{p}_{d,h,i}}$$
$$= 100 \times \frac{\sum_d \left(E_{d,h} \frac{O_{d,h}}{E_{d,h}} \right)}{E_h} = \sum_d \left(\frac{E_{d,h}}{E_h} SMR_{d,h} \right) \quad \textbf{(2)}$$

The numerator is the observed number of deaths (O_h) in hospital site h. This can be further detailed as the sum of the observed in-hospital mortality ($D_{d,h,i}$) over all hospital admissions i and all diagnosis groups d in hospital site h.

The denominator is the expected number of in-hospital deaths (E_h) in hospital site h. The expected mortality can be further detailed as the sum of an estimated probability of in-hospital mortality ($\hat{p}_{d,h,i}$) over all hospital admissions i and all diagnosis groups d in hospital site h (see also section 6.3.1.2).

The expression can be reformulated to show that the HSMR is a weighted mean of the SMRs, where the weights are the proportion of expected in-hospital deaths for each diagnosis relative to the hospital site's total.

WARNING SIGN FOR INFERIOR QUALITY

When each hospital site is weighted by its relative share in expected mortality, the average SMRs and HSMRs across all hospital sites equal 100. Ideally, if standardisation fully accounted for all factors beyond the hospital's control – making (H)SMR a perfect measure of hospital quality and safety – then a value above 100 would indicate lower quality of care, with the difference between the numerator and denominator serving as an estimate of avoidable mortality.[63] In practice, however, interpretation is less clear-cut due to potential biases, such as residual differences in case-mix, differences in availability of highly specialised treatments, and variations in coding practices (see also Textbox 3). Despite these limitations, a significantly high (H)SMR is often regarded as a warning signal for potential shortcomings in hospital care.[63, 90]

6.3.1.2 Prediction model for probability of mortality

LOGISTIC REGRESSION MODEL

Following standard practice, expected in-hospital mortality was estimated using separate regression models for each of the 45 diagnosis groups retained in the final dataset (see section 6.2.3). Stratifying admissions by diagnosis group improves the homogeneity within each group, enhancing the precision of the estimated mortality probabilities. Using a four-year dataset (2016-2019), logistic regression models were applied to examine the relationship between in-hospital mortality and a set of explanatory variables (see below). The stratification allows the coefficient values of the explanatory variables to vary across diagnosis groups. The logistic models were used to generate a predicted probability of in-hospital mortality for each admission. Building on Equations **(1)** and **(2)**, this results in:[63]

$$\hat{p}_{d,h,i} = Prob\left(D_{d,h,i} = 1 \middle| X_{d,h,i}\right) = \frac{1}{1 + \exp\left(-\beta_d X_{d,h,i}\right)} \quad \textbf{(3)}$$

with $X_{d,h,i}$ the values on the set of explanatory variables for admission i in diagnosis group d in hospital site h, and β_d the corresponding coefficient values.

The regression analysis was performed using the logistic procedure in SAS V9.4.

DEPENDENT VARIABLE

The dependent variable is binary, indicating whether the patient died during the hospital admission (not necessarily in intensive care services), with a value of 1 for in-hospital death and 0 for discharge alive.

EXPLANATORY VARIABLES

Patient and admission characteristics were included as explanatory variables to capture their association with in-hospital mortality and adjust the predicted mortality risk for these factors. At this stage, hospital site characteristics – such as activity volume or patient-to-nurse ratio – were not incorporated into the prediction model, as we sought to avoid adjusting for differences in hospital quality and safety.[63, 89] These hospital site-level variables were instead used in a subsequent stage to explain variation in SMRs and HSMRs across hospital sites (see further in section 6.3.2.1). Based on prior research, the following set of explanatory variables was used:[60, 62-68, 80, 91]

- Age: 10-year age groups up to age 90, with patients aged 90 years or more as a residual category
- Sex: male, female
- Admission source: home, other hospital, institution (e.g. nursing home, psychiatric care home, detention centre), other (e.g. on the road, at work, in a public place)
- Urgency: urgent admission to the hospital without ambulance, urgent admission to the hospital with ambulance, not urgent
- Type of admission: medical, surgical (based on APR-DRG classification)
- Elixhauser composite mortality risk score (see section 6.2.2): composite score summing up all comorbidities weighted according to their association with in-hospital mortality. In line with the HSMR methodology in England, the score was capped between -5 and 50 to mitigate the influence of extreme outliers on coefficient estimates. While the specific thresholds were pragmatic, the capping approach itself is an established method to improve robustness.[65]
- Socioeconomic status (see section 6.2.2): socioeconomic information was added based on the zip code of the patient's residence. Using the Belgian Index of Multiple Deprivation, municipalities were categorised into quintiles of deprivation.
- Year of admission as categorical variable
- Month of admission: the months of admission were categorised into 2-month periods.

To prevent the standard errors of the regression coefficients from becoming too large, all categorical variables were examined to ensure that each category contained at least 50 admissions, including at least one death. Recategorisation was necessary for three variables: age group, admission source, and urgency. This process involved systematically combining the smallest or most similar categories, starting with the first (or lowest) category and merging it with the next lowest category. The procedure was repeated as needed for subsequent categories. If the final category contained fewer than 50 admissions, it was merged with the second last category to meet the threshold.[63, 65]

PREDICTION MODEL STATISTICS

For each regression model, we calculated the **Wald statistics** of the explanatory variables to assess their impact on in-hospital mortality. A large Wald statistic indicates a strong influence of the explanatory variable on in-hospital mortality, adjusted for the effects of the other variables in the model. This measure was used to identify the most important explanatory variable in each regression model.

The overall fit and discriminatory ability of the logistic regression models were evaluated using the C-statistic, which is equivalent to the area under the receiver operating characteristic curve (AUC, AUC-ROC, or AUROC).[63, 65, 92] The C-statistic represents the probability that a randomly selected patient who died was assigned a higher predicted risk of death than a randomly selected patient who survived. A value of 0.5 suggests that the model performs no better than random chance, while a maximum

value of 1 denotes perfect discrimination. Generally, a C-statistic above 0.7 indicates acceptable discriminatory ability, and values exceeding 0.8 denote excellent discriminatory performance.[60]

6.3.1.3 SMR and HSMR output

The prediction models (see section 6.3.1.2) were used to estimate the expected mortality probability for each admission. These probabilities were then used to calculate SMRs and HSMRs following the specifications in Equations **(1)** and **(2)**.

REPORTING UNITS

The SMRs for each diagnosis group and aggregate diagnosis group and the HSMRs were calculated for each hospital site in the final dataset (see section 6.2) over two-year periods: 2016–2017 and 2018–2019. Using two-year periods improved the precision of the SMRs and HSMRs by increasing the number of observations compared to single-year calculations. Thus, each hospital site had two observations.

For patients treated in intensive care services at multiple hospital sites within the same hospital, the observed and expected mortality of the admission was weighted by the proportion of time spent in the intensive care service of each site. This applied to approximately 1 500 stays (0.6% of the sample).

Additionally, as part of the robustness analysis, HSMRs were also calculated at the intensive care service unit level. Similar to the site-level calculation, observed and expected mortality for patients treated in multiple intensive care units were weighted by the proportion of time spent in each unit. This applied to approximately 16 000 stays (6% of the sample).

CONFIDENCE INTERVAL

A 95% confidence interval was computed for each SMR and HSMR. The confidence intervals were derived under the assumption that the numerator (observed mortality) of the SMR or HSMR follows a Poisson distribution, while the denominator remains fixed. The Poisson distribution is commonly used for modelling count data, particularly when events occur independently over a fixed period or within a defined population. This assumption is appropriate, as the variance of the denominator is small.[63, 67, 93]

SMRs and HSMRs with a lower confidence limit above 100 were interpreted as indicative of lower quality and safety of care, whereas those with an upper confidence limit below 100 were considered indicative of higher quality and safety of care.

REPORTING EXCLUSIONS

To mitigate the risk of imprecise estimates and outliers due to small sample sizes, HSMRs are not reported for hospital sites with fewer than 20 observed or expected in-hospital deaths over the two-year period, nor for intensive care units with fewer than 5 observed or expected in-hospital deaths in the same period. At the level of hospital sites, a threshold of 5 observed or expected deaths was applied for SMRs of (aggregate) diagnosis groups. Sites and units that did not meet these thresholds were also excluded from the regression analysis examining the association between standardised mortality and hospital site characteristics (see section 6.3.2.1)

The thresholds were deliberately not set too high with the objective of not discriminating against low-volume hospital sites. Similar exclusion criteria were applied in public reporting of standardised mortality rates in the UK and the Netherlands.[63, 67]

HIGH-COMORBIDITY PATIENTS

A subgroup of particular interest in this analysis are high-comorbidity patients, who potentially require more complex care and have an increased mortality risk. Their outcomes may be more strongly influenced by variations in experience, quality, and safety of care, which could justify the concentration of their treatment in a limited number of intensive care services. This group was identified as the 25%

of patients with the highest Elixhauser composite mortality risk score (see section 6.2.2), corresponding to a score of 17 or higher.

DESCRIPTIVE STATISTICS

A **funnel plot** was used to visualise the variability in SMRs and HSMRs. This scatter plot represents SMR or HSMR values on the vertical axis and their precision, measured by the expected number of deaths, on the horizontal axis. In addition to a horizontal reference line at value 100 (see section 6.3.1.1), 95% and 99.8% control limits were included to indicate expected variability. Observations within these limits are consistent with random variation, referred to as common-cause variation, whereas those outside the limits suggest significant deviations from the reference, known as special-cause variation. Under the assumption of no systematic differences in standardised mortality rates, approximately 2.5% and 0.1% of observations are expected to exceed the upper 95% and 99.8% control limits, respectively. Hence, observations above the 99.8% limit exhibit statistically highly significant deviations in SMR or HSMR, unlikely to be due to chance alone.[63, 65]

The relationship between the HSMRs and SMRs across different diagnosis groups was explored to assess whether a hospital site's poor overall performance was driven by a few or multiple (aggregate) diagnosis groups. For each hospital site, 95% confidence intervals identified diagnosis groups with significantly higher or lower standardised mortality. Additionally, a heatmap visualised the distribution of standardised mortality, categorising HSMRs and SMRs into performance quintiles.

6.3.2 Analysis of (unwanted) variation

A primary aim of this analysis is to assess whether excessive inter-hospital variation exists in in-hospital mortality in intensive care services and whether this variation is associated with hospital site characteristics. To examine unwanted variation, complementary approaches were applied, using SMRs and HSMRs as defined above, as well as direct regression analyses of admission-level mortality data.

6.3.2.1 Variation in SMR and HSMR

REGRESSION ANALYSIS

The association between standardised mortality and various hospital site characteristics was assessed using regression analysis. This analysis was conducted on both the full sample, including all selected admissions (see section 6.2), and a restricted sample of high-comorbidity patients (see section 6.3.1.3), defined as the 25% of patients with the highest Elixhauser composite mortality risk score. The exclusions outlined in section 6.3.1.3 were applied to determine which sites were included in the regression analysis. To account for the clustering of admissions within hospital sites, standard errors were adjusted accordingly.

Regressions were estimated with HSMRs and SMRs of aggregate diagnosis groups as dependent variables. For SMRs, the analysis was limited to aggregate diagnosis groups with at least 25 observations. The primary explanatory variable of interest was activity volume, particularly for high-comorbidity patients, as a volume-outcome relationship could indicate a rationale for concentrating their care. The following explanatory variables were included:

- Region of the hospital site: Flanders, Brussels, Wallonia
- Hospital type: general hospital, university hospital
- Activity volume(for the aggregate diagnosis group): the annual number of admissions, grouped per 100 patients for the HSMR regressions and per 10 patients for the SMR regressions
- Type of site: primary site of the hospital, secondary site of the hospital
- Intensity of nursing care: proportion of high technical care, calculated based on data from the Belgian Nursing Minimum Data Set (VG-MZG / DI-RHM) (see section 4.2.1).

Several potential explanatory variables related to hospital site quality and safety were considered but ultimately not included in the model. First, a survey conducted among nurses in general wards in 2019 provided information on perceived quality and safety at the hospital site level.[11] However, these data were excluded because they were collected in general care services, not intensive care services, which are the focus of the analysis. Second, a similar survey conducted among ICU nurses in 2022 provided insights on perceived quality, safety, work environment, and patient-to-nurse ratios.[10] These data were excluded due to the survey period not aligning with the study period (2016-2019) and potential disruptions caused by the COVID-19 crisis. Finally, information from the survey conducted for this study (see chapter survey), which gathered information amongst others on patient-to-nurse ratios, availability of physicians, and treatments in intensive care services, was also excluded, as the survey was carried out in 2023, beyond the study's timeframe. Moreover, a general limitation of including information from survey data is the incomplete reporting across hospital sites, which reduces the sample and may introduce bias.

Other structural characteristics, such as the number of operational or licensed beds at the hospital site, were not included in the model due to collinearity with activity volume.

As part of a **robustness check**, several alternative models were estimated. First, we explored alternative definitions of the activity volume variable, which is the variable of primary interest: (1) A log2 transformation of the number of admissions, where each additional unit represents a doubling of activity volume; (2) a categorisation of the number of admissions into quartiles of patient volume, which may be more appropriate if the association between (H)SMRs and activity volume is not linear; and (3) activity volume based on the number of patient days instead of admissions. Second, we adjusted the exclusion threshold specified in section 6.3.1.3, modifying it from 20 to either 15 or 25 observed or expected deaths. Third, we performed the regression analysis at the level of intensive care units as the unit of observation rather than hospital sites. Fourth, the impact of further refining the patient population was examined by excluding patients with an early Do-Not-Resuscitate (DNR) code (ICD-10 diagnosis code Z66 flagged at admission). Unlike palliative patients, this group was not excluded in the baseline analysis, as this is not standard practice in HSMR studies, and excluding them could unnecessarily reduce the sample size. Moreover, although DNR status is flagged at admission, it is more likely than palliative status to be assigned during hospitalisation, potentially reflecting advanced care planning decisions or available treatment options rather than pre-existing conditions.[94-96] On the other hand, withholding or withdrawing life-sustaining treatment as a consequence of DNR status may be associated with increased in-hospital mortality, warranting a robustness check to assess its potential impact on HSMR estimates.[97-99] Finally, we excluded palliative patients (ICD-10 diagnosis code Z51.5), regardless of whether the diagnosis was present on admission, as admission status was not reliably coded in 2016 (see section 6.4.1.3).

6.3.2.2 Variation based directly on mortality data

In sections 6.3.1 and 6.3.2.1, the association between hospital site characteristics and in-hospital mortality was assessed using SMRs and HSMRs as intermediary step. Another frequently followed approach to assess variation in in-hospital mortality is to include hospital site characteristics directly in a multilevel logistic regression model.[91, 92, 100 , 101, 102] In this context, it is also appropriate to estimate the association between in-hospital mortality and patient and hospital characteristics within predefined strata of patients with similar risk, i.e. the different aggregate diagnosis groups.

We continue from Equation **(3)**, a logistic regression model with only patient characteristics as fixed effects:[92]

$$\hat{p}_{d,h,i} = Prob\left(D_{d,h,i} = 1 \middle| X_{d,h,i}\right) = \frac{1}{1 + \exp\left(-\beta_d X_{d,h,i}\right)} \qquad \textbf{(3)}$$

$$\Leftrightarrow logit\left(Prob\left(D_{d,h,i} = 1\right)\right) = \beta_{0,d} + \beta_{1,d} X_{1,d,h,i} + \beta_{2,d} X_{2,d,h,i} + \cdots + \beta_{k,d} X_{k,d,h,i}$$

with $\beta_{0,d}$ the intercept and $\beta_{1,d}$ through $\beta_{k,d}$ the regression coefficients, i.e. the log-odds, for the k patient characteristic variables.

Next, a random intercept for each hospital site ($\beta_{0,d,h}$, normally distributed with variance τ^2) was added to account for hospital site-level clustering and to measure the variation in in-hospital mortality between hospital sites. This random effect (RE) model is referred to as the **patient model**. The model specification is as follows:

$$logit\left(Prob\left(D_{d,h,i}=1\right)\right)=\beta_{0,d}+\beta_{0,d,h}+\beta_{1,d}X_{1,d,h,i}+\beta_{2,d}X_{2,d,h,i}+\cdots+\beta_{k,d}X_{k,d,h,i} \quad (4)$$

$$with\ \beta_{0,d,h}\sim N(0,\tau^2)$$

A random intercept significantly higher (or lower) than zero was interpreted as indicating that a hospital site systematically has a higher (or lower) risk of in-hospital mortality for patients with otherwise similar characteristics.[92]

In the final step, hospital site characteristics ($Z_{1,d,h}$ through $Z_{m,d,h}$, with corresponding coefficients $\gamma_{1,d}$ through $\gamma_{m,d}$) were added to the patient model to obtain the **hospital model**. The same hospital site characteristics as those used in the regression analysis in section 6.3.2.1 were included. The model specification is as follows:

$$\begin{aligned} logit\left(Prob\left(D_{d,h,i}=1\right)\right) &= \beta_{0,d}+\beta_{0,d,h}+\beta_{1,d}X_{1,d,h,i}+\beta_{2,d}X_{2,d,h,i}+\cdots+\beta_{k,d}X_{k,d,h,i} \\ &+\gamma_{1,d}Z_{1,d,h}+\gamma_{2,d}Z_{2,d,h}+\cdots+\gamma_{k,d}Z_{m,d,h} \end{aligned} \quad (5)$$

$$with\ \beta_{0,d,h}\sim N(0,\tau^2)$$

INTER-HOSPITAL SITE VARIATION

By comparing the *patient model* and the *hospital model*, it is possible to evaluate whether the hospital site characteristics included in the *hospital model* can (partly) explain the inter-hospital site variability. To this end, we examined whether the coefficients for the hospital site characteristics were significant. Additionally, if the hospital site characteristics explained the inter-hospital site variation in in-hospital mortality, we would expect a reduction in the magnitude of the random effect.

Further exploration of the inter-hospital site variation for each aggregate diagnosis group was conducted using the **Wald test** to assess the significance of the random effect. We also used the **variance partition coefficient** (VPC) and the **median odds ratio** (MOR) to quantify the magnitude of the inter-hospital site variation.[92, 100]

The VPC represents the proportion of total observed individual variation in the outcome that is attributable to inter-hospital site variation. Higher VPC values indicate that a larger proportion of unexplained variance is related to inter-hospital site differences rather than individual differences. A VPC value close to 0 implies that outcomes for patients from the same hospital site are no more similar than outcomes for a random sample of patients from the population, while a value close to 1 suggests that all patients in the same hospital site have exactly the same outcome.[92]

The MOR represents the median value of the odds ratio between an admission with a higher and a lower risk of in-hospital mortality, obtained by repeatedly sampling two admissions from patients with identical characteristics (i.e., same values for the explanatory variables) but from different hospital sites. Thus, the MOR captures the extent to which the odds of the outcome change when moving from a hospital site with a lower risk of mortality to one with a higher risk. The value of the MOR ranges from 1 to infinity. A MOR of 1 suggests no significant inter-hospital site variation in mortality, while values greater than 1 indicate variation. For example, a MOR of 1.5 suggests that, when comparing two identical patients from randomly selected hospital sites, the median odds of dying are 1.5 times higher among patients treated at the higher-risk site than those treated at the lower-risk site.[92, 100] An advantage of the MOR for quantifying the inter-hospital site variation is that it is on the same scale as is used to quantify the other associations between patient characteristics and in-hospital mortality.

MINIMUM THRESHOLD FOR ANALYSIS

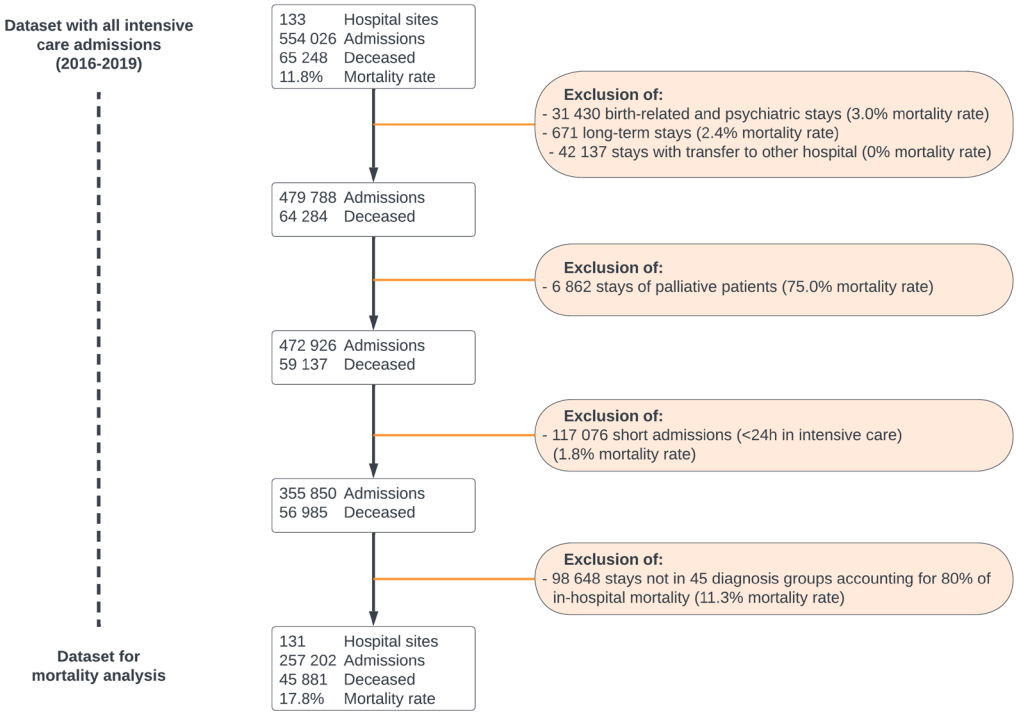
Given that the multilevel logistic regression model includes more than 30 explanatory variables and considering the rule of thumb requiring at least 10 events per variable, we set a threshold of 350 in-hospital deaths for an aggregate diagnosis group to be included in the analysis.[60, 103]

The multilevel logistic regression models were estimated using the Glimmix procedure in SAS V9.4.

6.4 Results

6.4.1 Study population

Figure 68 – Flowchart of data selection process for in-hospital mortality analysis in intensive care services



6.4.1.1 Final sample

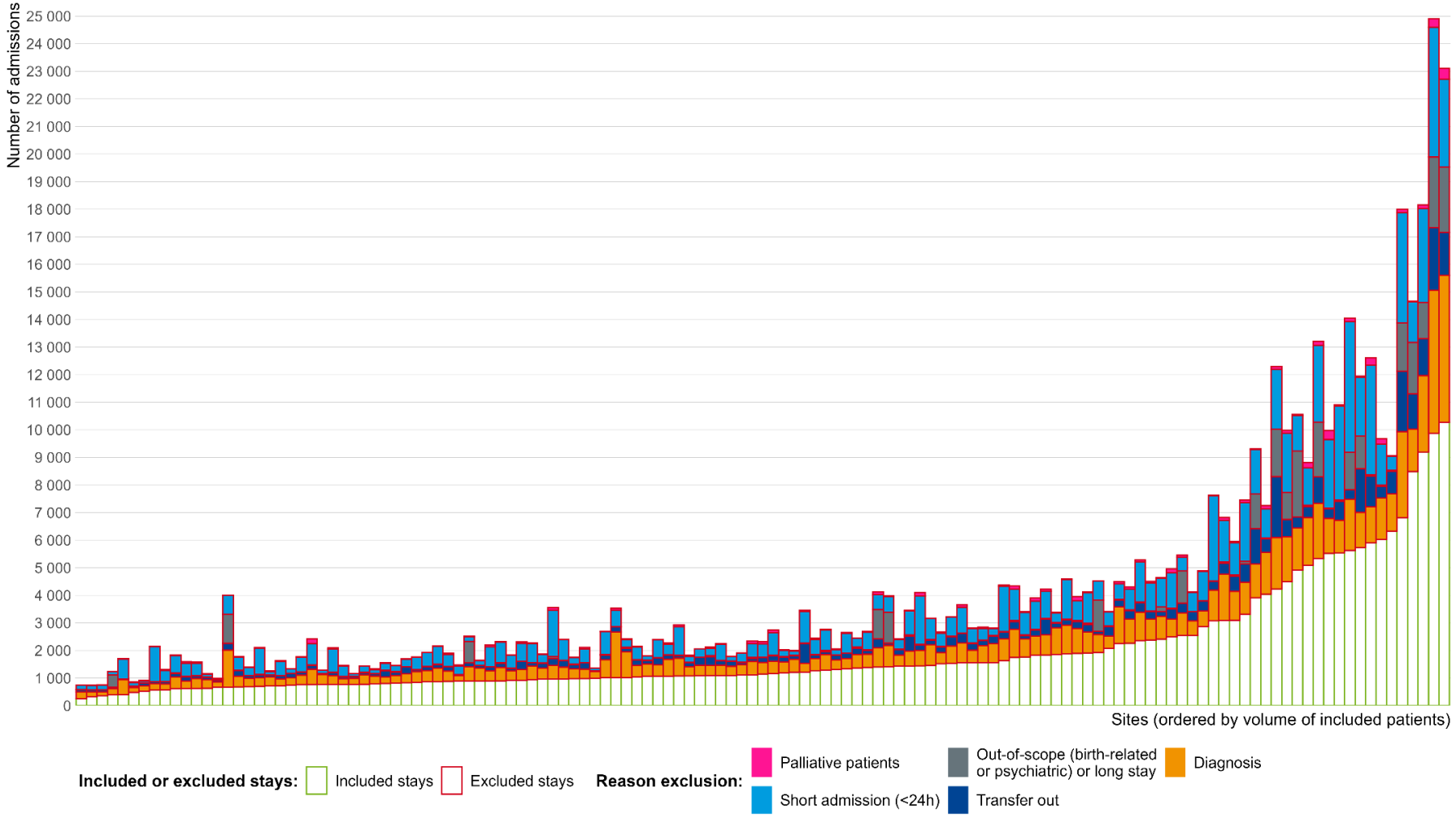
The flowchart in Figure 68 provides an overview of the data selection process and exclusions. The main reasons for exclusion were the short length of stay in intensive care (approximately 117 000 admissions), the principal diagnosis (approximately 98 500 admissions) and transfers to another hospital (approximately 42 000 admissions). Additionally, nearly 7 000 palliative patient admissions were excluded from the final sample. After applying the exclusion criteria, the final sample for model fitting consists of data from 257 202 admissions across 131 hospital sites with intensive care services, covering discharge years from 2016 to 2019. The crude mortality rate in this sample was 17.8%. Among all admissions of patients who were ever admitted to intensive care services, the final selection includes 46.4% of total admissions and 70.3% of admissions that resulted in in-hospital mortality.

6.4.1.2 Variability in exclusions across sites

Figure 69 and Figure 70 illustrate the variability in the impact of exclusions across hospital sites, with a median share of 47% of admissions included (P25: 41% – P75: 55%). Birth-related and psychiatric stays are concentrated in a limited number of hospital sites, particularly those with neonatal intensive care units. In most sites, palliative patients were treated, typically accounting for about 1% to 2% of

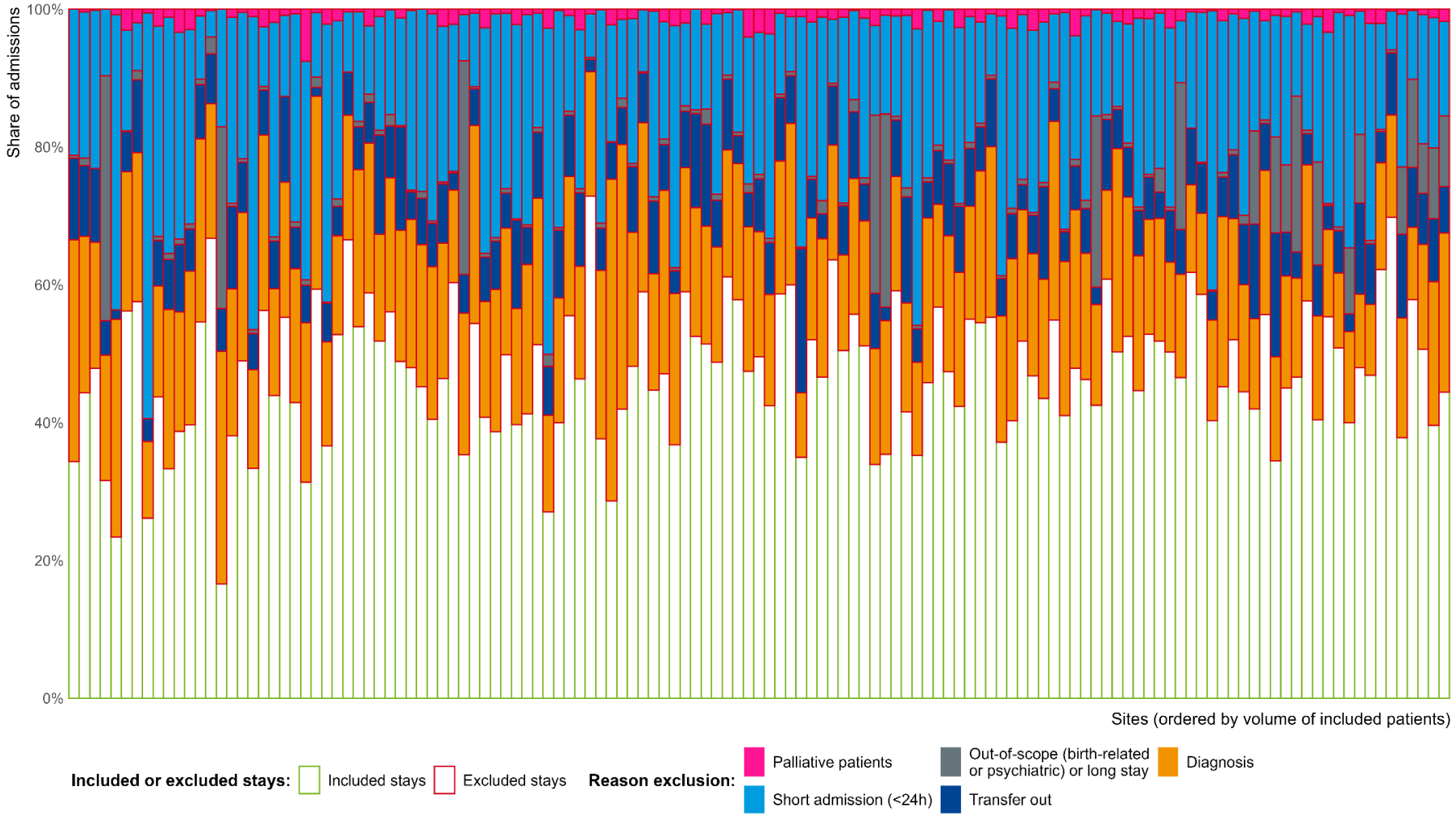
admissions, although some intensive care services had higher proportions. There is also substantial variation in the share of admissions with a duration of 24 hours or less in in intensive care (P25: 14% – P75: 27%), which does not appear to be directly related to patient volume. In contrast, the share of exclusions due to principal diagnosis was more consistent (P25: 16% – P75: 22%), as was the share of exclusions for transfers (P25: 5% – P75: 9%).

Figure 69 – Number of included and excluded admissions by reasons of exclusion and site



Source: Minimal Hospital Data (MZG – RHM).

Figure 70 – Share of included and excluded admissions by reasons of exclusion and site



Source: Minimal Hospital Data (MZG – RHM).

6.4.1.3 *Patient profile*

The demographic and morbidity characteristics of the study population, as well as those of the excluded groups, are presented in Table 22. Crude mortality rates are also reported for each subgroup. The sample is relatively evenly distributed across years, with a slight decrease in crude mortality rates over time.

Approximately 61% of the final sample is male. Older age groups and patients from more deprived municipalities are overrepresented. Nearly three-quarters of admissions are classified as urgent. About 65% of patients have comorbidities associated with an increased mortality risk. Crude mortality rates rise with age and comorbidity burden, as captured by the Elixhauser composite mortality risk score. Similarly, mortality is higher for urgent admissions, medical admissions and for patients transferred from another hospital or institution.

Table 22 also highlights differences between the excluded and included populations, supporting the rationale for their exclusion. Compared to the final sample, palliative patients have higher crude mortality rates, are older, are less frequently admitted for surgery, and have a substantially higher comorbidity burden. The number of excluded palliative patients admitted to intensive care services increased over time, not due to an actual rise in palliative admissions but as a result of the lack of presence on admission (POA) coding in 2016, when it was recorded as a generic category (‘not applicable’) rather than specifying whether or not the status was present on admission. However, this issue was consistent across hospitals. POA registration improved in 2017, though with greater variability between hospital sites, and from 2018 onwards, it was consistently recorded. We verified that hospital sites with higher POA non-registration rates in 2017 do not systematically diverge in HSMR results. Moreover, as a robustness check, a regression analysis was conducted excluding all palliative patients regardless of POA registration (see sections 6.3.2.1 and 6.4.3.1).

In contrast, patients with a short stay in intensive care have a much lower crude mortality risk than patients in the final sample. Admissions excluded based on the principal diagnosis also have lower crude mortality risk. Both groups – short admissions and those excluded due to principal diagnosis – are less likely to be urgent, more often related to surgery, and more frequently involve patients who are on average younger, have fewer comorbidities and live at home.

Table 22 – Descriptives of main covariates and mortality for the sample and excluded groups

	Final sample			Palliative			Short admission			Diagnosis		
	N	Share in group	Mortality rate	N	Share in group	Mortality rate	N	Share in group	Mortality rate	N	Share in group	Mortality rate
Admissions												
All	257 202		17.8%	6 862		75.0%	117 076		1.8%	98 648		11.3%
2016	65 481	25.5%	18.6%	460	6.7%	68.0%	29 679	25.4%	2.0%	25 551	25.9%	11.4%
2017	64 309	25.0%	17.7%	1 973	28.8%	73.4%	29 773	25.4%	1.8%	24 815	25.2%	11.1%
2018	63 800	24.8%	17.7%	2 173	31.7%	76.6%	28 911	24.7%	1.9%	24 354	24.7%	11.3%
2019	63 644	24.7%	17.3%	2 256	32.9%	76.2%	28 713	24.5%	1.7%	23 896	24.2%	11.3%
Sex												
Male	156 069	60.7%	17.4%	3 894	56.7%	75.7%	65 489	55.9%	1.8%	55 138	55.9%	11.3%
Female	101 165	39.3%	18.5%	2 968	43.3%	74.1%	51 587	44.1%	1.9%	43 478	44.1%	11.2%
Age												
0-19	6 830	2.7%	4.8%	36	0.5%	58.3%	6 729	5.7%	0.0%	10 128	10.3%	2.3%
20-39	14 700	5.7%	6.5%	97	1.4%	67.0%	10 146	8.7%	0.2%	8 306	8.4%	3.1%
40-59	52 450	20.4%	10.9%	797	11.6%	70.5%	27 591	23.6%	0.5%	21 146	21.4%	6.4%
60-79	125 245	48.7%	17.6%	3 392	49.4%	74.5%	51 413	43.9%	1.5%	41 248	41.8%	12.9%
80+	58 009	22.6%	29.1%	2 540	37.0%	77.6%	21 197	18.1%	5.7%	17 788	18.0%	22.0%
Admission source												
Home	211 177	82.1%	16.7%	5 577	81.3%	74.1%	104 332	89.1%	1.6%	83 892	85.1%	10.6%
Other hospital	18 067	7.0%	23.0%	474	6.9%	83.8%	4 113	3.5%	2.9%	6 088	6.2%	15.7%
Other institution	16 334	6.3%	29.0%	689	10.0%	75.0%	4 307	3.7%	7.5%	4 201	4.3%	23.2%
Other	11 656	4.5%	15.1%	122	1.8%	83.6%	4 324	3.7%	1.0%	4 435	4.5%	5.6%
Urgency												
Not urgent	70 533	27.4%	8.5%	1 432	20.9%	71.9%	63 818	54.5%	0.6%	46 850	47.5%	6.6%

	Final sample			Palliative			Short admission			Diagnosis		
	N	Share in group	Mortality rate	N	Share in group	Mortality rate	N	Share in group	Mortality rate	N	Share in group	Mortality rate
Urgent without ambulance	70 973	27.6%	14.4%	1 917	27.9%	69.8%	28 421	24.3%	1.8%	25 062	25.4%	11.3%
Urgent with ambulance	115 728	45.0%	25.6%	3 513	51.2%	79.1%	24 837	21.2%	5.0%	26 704	27.1%	19.4%
Type of admission												
Medical	123 049	47.8%	21.0%	3 629	52.9%	76.1%	35 228	30.1%	3.5%	32 283	32.7%	15.7%
Surgical	134 185	52.2%	14.9%	3 233	47.1%	73.8%	81 840	69.9%	1.1%	66 313	67.2%	9.1%
Elixhauser composite mortality risk score												
Negative-0	90 789	35.3%	8.5%	449	6.5%	80.0%	52 062	44.5%	0.5%	38 185	38.7%	5.1%
1-9	62 166	24.2%	16.6%	965	14.1%	77.5%	28 525	24.4%	1.7%	22 299	22.6%	10.9%
10-19	51 371	20.0%	22.2%	1 502	21.9%	75.4%	20 229	17.3%	2.6%	18 785	19.0%	13.8%
20-29	31 682	12.3%	27.8%	1 851	27.0%	73.1%	11 485	9.8%	4.1%	12 335	12.5%	17.5%
30+	21 226	8.3%	35.9%	2 095	30.5%	74.1%	4 775	4.1%	9.3%	7 012	7.1%	27.9%
Socioeconomic status municipality												
Lowest quintile	92 676	36.0%	20.2%	1 979	28.8%	74.3%	38 201	32.6%	2.3%	34 998	35.5%	12.7%
Quintile 2	43 726	17.0%	17.9%	1 147	16.7%	79.3%	18 849	16.1%	1.9%	16 469	16.7%	11.6%
Quintile 3	43 378	16.9%	16.9%	1 198	17.5%	76.0%	20 913	17.9%	1.8%	16 537	16.8%	10.9%
Quintile 4	36 789	14.3%	16.3%	1 171	17.1%	75.5%	17 969	15.3%	1.6%	14 381	14.6%	10.2%
Highest quintile	34 436	13.4%	15.3%	1 303	19.0%	71.5%	18 392	15.7%	1.3%	13 179	13.4%	9.5%

Source: Minimal Hospital Data (MZG – RHM).

6.4.1.4 Variability across aggregate diagnosis groups

Descriptive statistics for the different aggregate diagnosis groups are presented in Table 23, while a more detailed breakdown at the level of individual diagnosis groups is provided in Appendix to Chapter 6 in the Supplement. In terms of admission volume, diseases of the circulatory system is the most important aggregate diagnosis group by a large margin, followed by injury and poisoning and diseases of the respiratory system. Additionally, diseases of the digestive system, infectious and parasitic diseases, and neoplasms are the only other groups with more than 10 000 admissions during the study period.

Activity across all aggregate diagnosis groups is recorded in nearly all hospital sites. However, for some groups, the number of annual admissions per site is very low, with a median of 5 or lower in five aggregate diagnosis groups. Infectious and parasitic diseases, which includes septicaemia, and ill-defined conditions, which include shock, have the highest crude mortality rates, exceeding 30%. Three additional diagnosis groups have crude mortality rates between 20% and 30%.

Patients with a high comorbidity burden (Elixhauser composite mortality risk score ≥ 17, see section 6.3.1.3) account for between 20% and 40% of admissions in most diagnosis groups, except for neoplasms, where this share reaches 62.8%, and mental illness, where it is lowest at 9.6%. In all diagnosis groups, mortality rates are higher among patients with a high comorbidity burden compared to the overall population in intensive care services.

The mean patient age exceeds 60 years in most aggregate diagnosis groups, with substantially lower ages observed in mental illness and diseases of the nervous system and sense organs. The proportion of urgent admissions is above 80% for most groups, except for neoplasms (24.7%), diseases of the circulatory system (59.9%), and ill-defined conditions (71.4%). Particularly high shares of urgent admissions are observed in infectious and parasitic diseases (94.9%), mental illness (94.6%), and diseases of the nervous system (94.2%).

Table 23 – Descriptives of admissions and selected covariates by aggregate diagnosis group

Aggregate diagnosis group		sites	All admissions			High-comorbidity admissions (Mortality risk score ≥ 17)			Age: mean ± standard deviation	Share of urgent admissions	Share of admissions from other hospital or institution
No	Label		N	Annual per site: median [P25-P75]	Mortality rate	N	Share in all admissions	Mortality rate			
1	Infectious and parasitic diseases	131	14 534	24 [11-39]	33.4%	5 925	40.8%	40.1%	69±16	94.9%	18.0%
2	Neoplasms	131	12 990	18 [10-33]	14.2%	8 164	62.8%	16.9%	67±13	24.7%	4.7%
3	Endocrine, nutritional and metabolic diseases, and immunity disorders	131	7 090	12 [7-18]	11.6%	1 474	20.8%	21.9%	59±22	91.7%	12.0%
4	Diseases of the blood and blood-forming organs	130	1 562	3 [2-3]	20.7%	563	36.0%	31.6%	65±23	83.9%	15.5%
5	Mental illness	131	3 006	5 [3-9]	11.3%	289	9.6%	33.9%	48±17	94.6%	9.9%
6	Diseases of the nervous system and sense organs	131	4 442	5 [3-9]	10.3%	1 096	24.7%	17.5%	49±26	94.2%	20.5%
7	Diseases of the circulatory system	131	116 888	87 [56-210]	14.4%	24 605	21.1%	28.1%	69±14	59.9%	11.8%
8	Diseases of the respiratory system	131	34 121	56 [42-81]	26.0%	9 415	27.6%	35.9%	68±17	92.1%	16.2%
9	Diseases of the digestive system	131	15 868	25 [17-39]	24.1%	5 428	34.2%	34.9%	65±17	86.5%	14.0%
10	Diseases of the genitourinary system and non-neoplastic breast conditions	130	2 267	4 [2-6]	16.2%	878	38.7%	24.0%	71±14	92.6%	14.1%
16	Injury and poisoning	131	42 275	60 [38-108]	15.7%	7 009	16.6%	30.1%	58±22	85.4%	15.5%
17	Symptoms; signs; and ill-defined conditions and factors influencing health status	129	2 159	3 [2-6]	35.2%	727	33.7%	48.0%	64±19	71.4%	23.0%

Source: Minimal Hospital Data (MZG – RHM).

6.4.1.5 Remaining variability in case-mix across sites

The primary reason for applying exclusion criteria and subdividing admissions into (aggregate) diagnosis groups is to create more homogeneous groups, allowing for a more robust estimation of mortality risk (see sections 6.2.2 and 6.2.3). However, even after applying the exclusion criteria, patient case-mix varies substantially across hospital sites, as illustrated in Figure 71 to Figure 75. This underscores the importance of accounting for case-mix differences through stratification and the inclusion of case-mix variables as covariates in the estimation model.

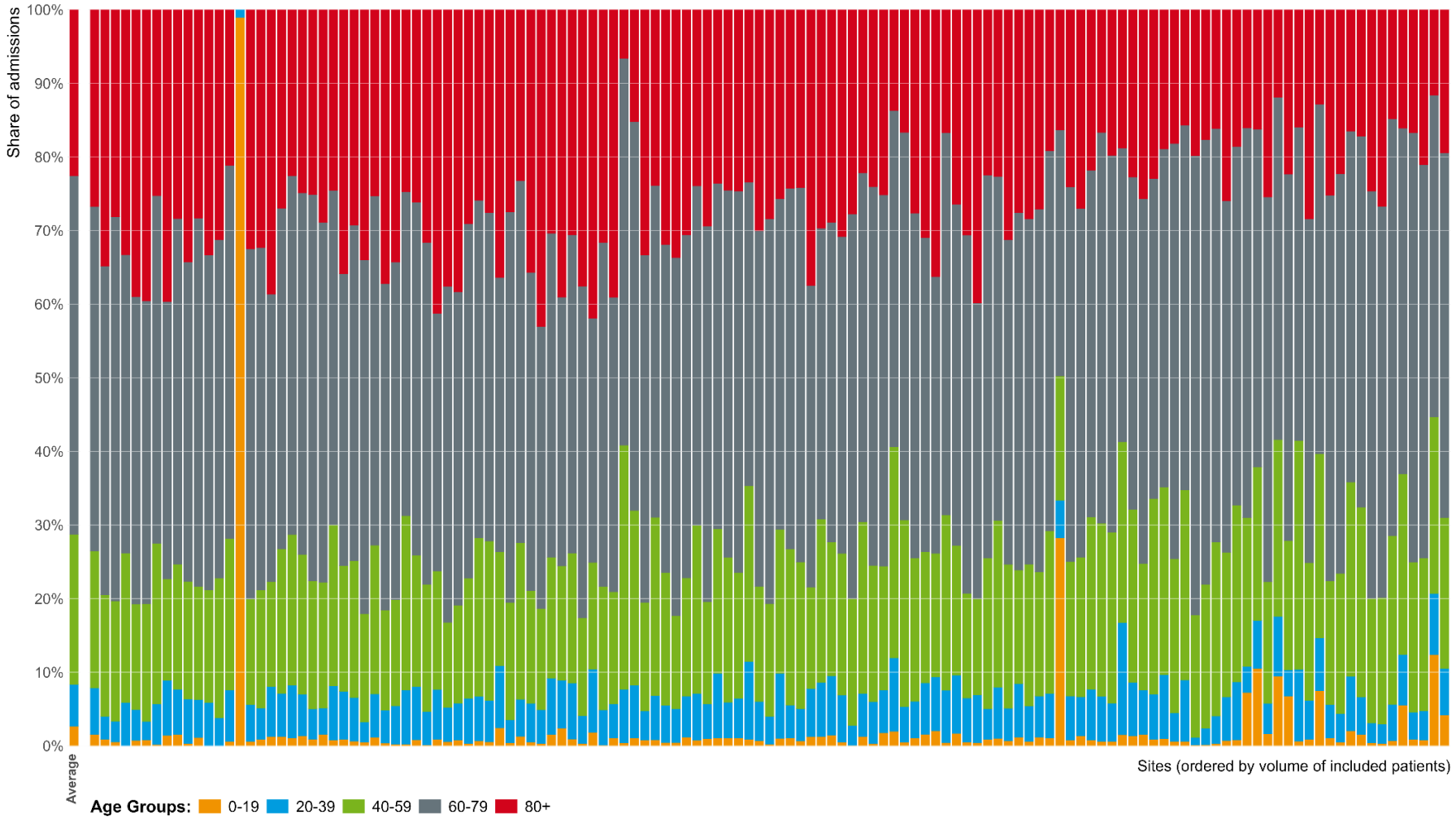
Figure 71 presents the relative distribution of age groups by hospital site. One hospital site is fully dedicated to paediatric care, while another site has a relatively high share of paediatric patients (almost 30%). On average, lower-volume hospital sites have a higher proportion of older patients.

Figure 72 shows the relative distribution of patients' socioeconomic status, based on the deprivation level of their municipality, across hospital sites. The median share of patients from municipalities in the most deprived quintile is 35%, but there is considerable variation [min: 0% - P25: 3% - P75: 70% - max: 98%]. This variation is largely driven by the hospital site's location. Differences in crude mortality rate by deprivation of the municipality are limited (see Table 22).

Figure 73 displays the relative distribution of the Elixhauser composite mortality risk score by hospital site. High-comorbidity patients (in red and grey) are treated at all hospital sites to varying degrees and may even represent a larger fraction of patients in low-volume sites compared to high-volume sites. Two outliers stand out: a dedicated paediatric hospital site has a significantly higher proportion of low-comorbidity patients, while a specialised oncology hospital site, has a substantially higher proportion of high-comorbidity patients.

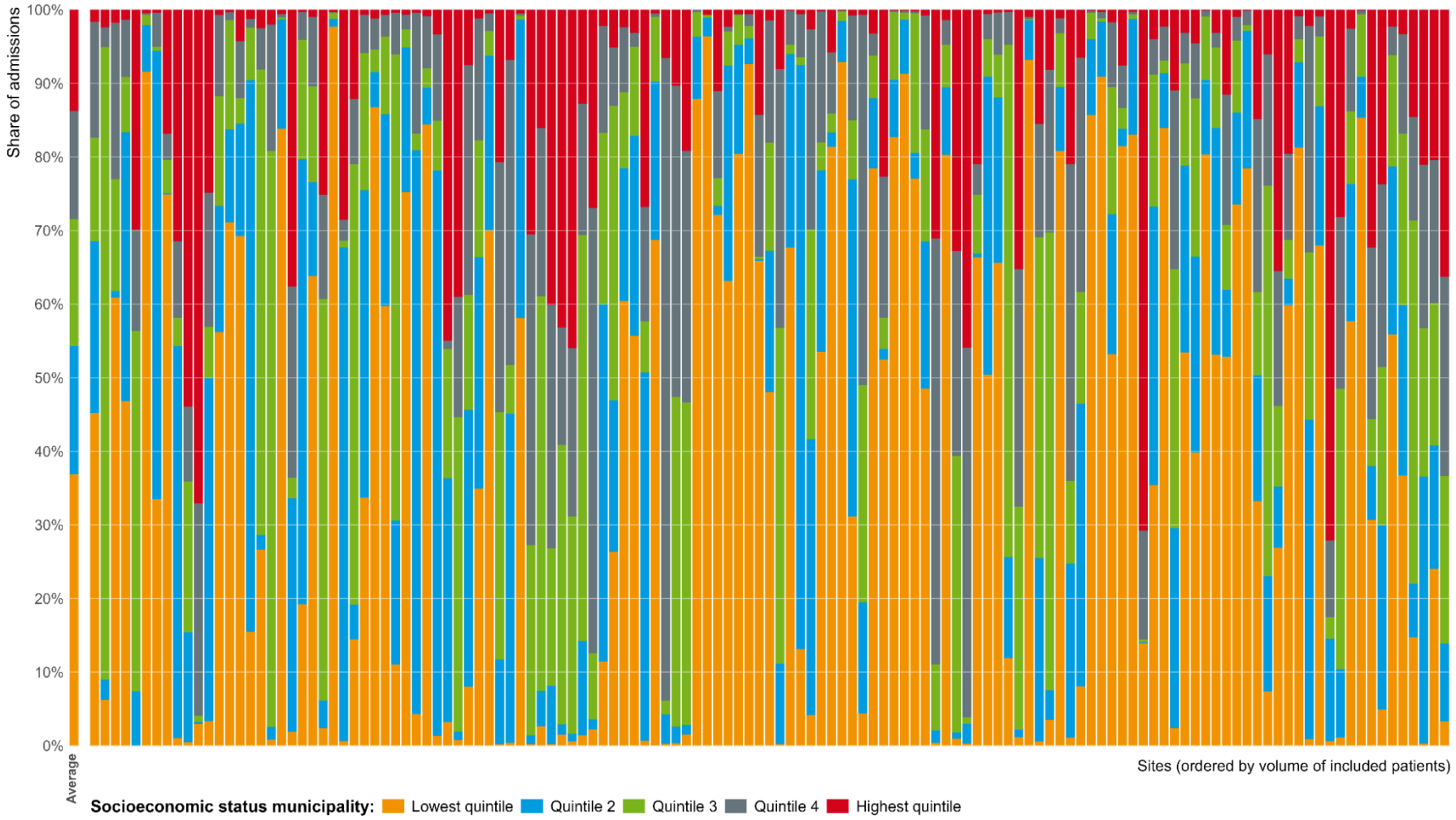
Figure 74 illustrates the relative distribution of medical versus surgical admissions by hospital site. High-volume hospital sites have a greater proportion of surgical procedures compared to low- or medium-volume sites. This pattern is directly related to Figure 75, which demonstrates that hospital sites with a higher share of surgical procedures also have a greater share of non-urgent admissions.

Figure 71 – Distribution of patients' age per site



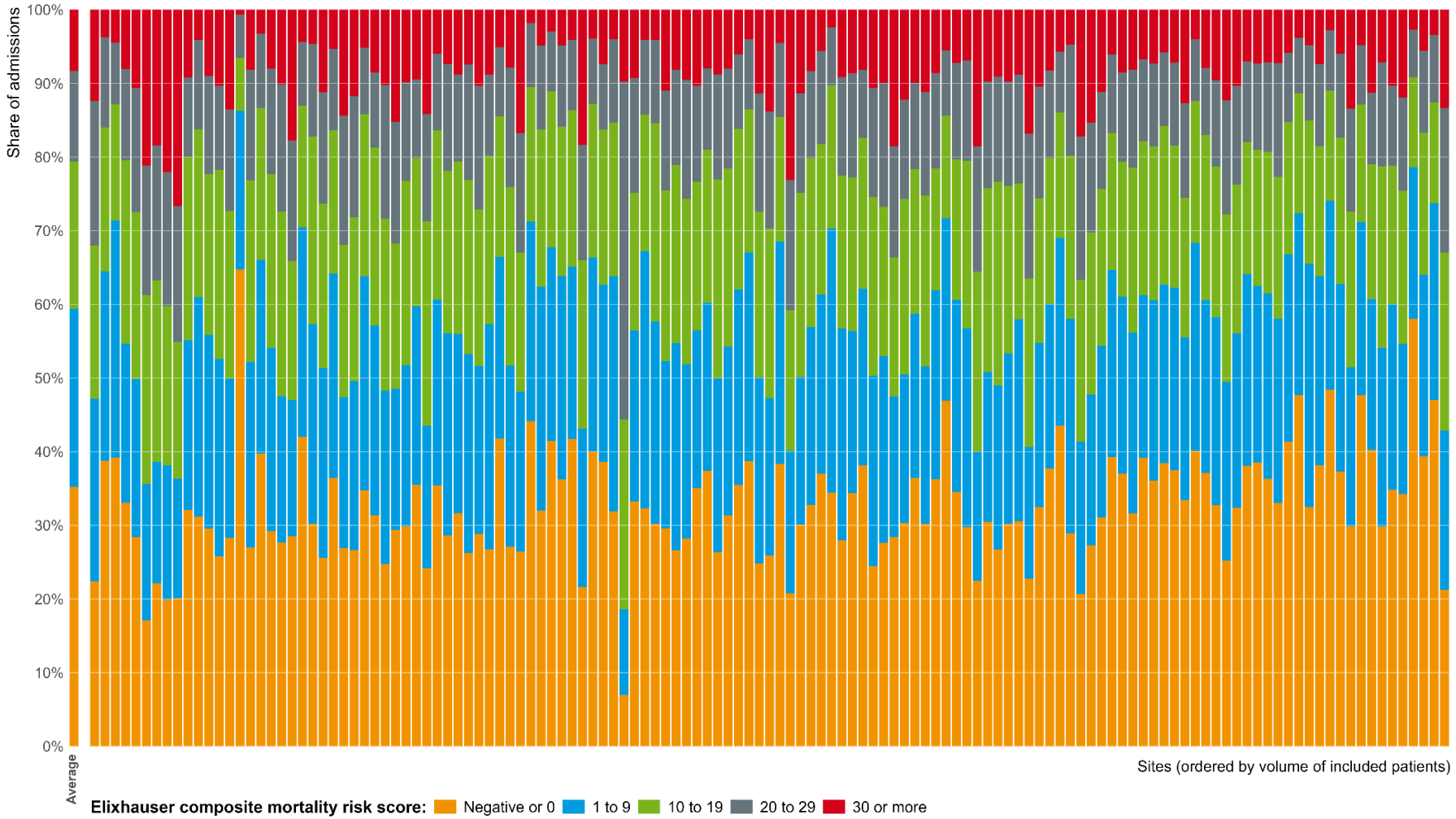
Note: One hospital site is fully dedicated to paediatric care.
Source: Minimal Hospital Data (MZG – RHM).

Figure 72 – Distribution of socioeconomic status of patients' municipality per site



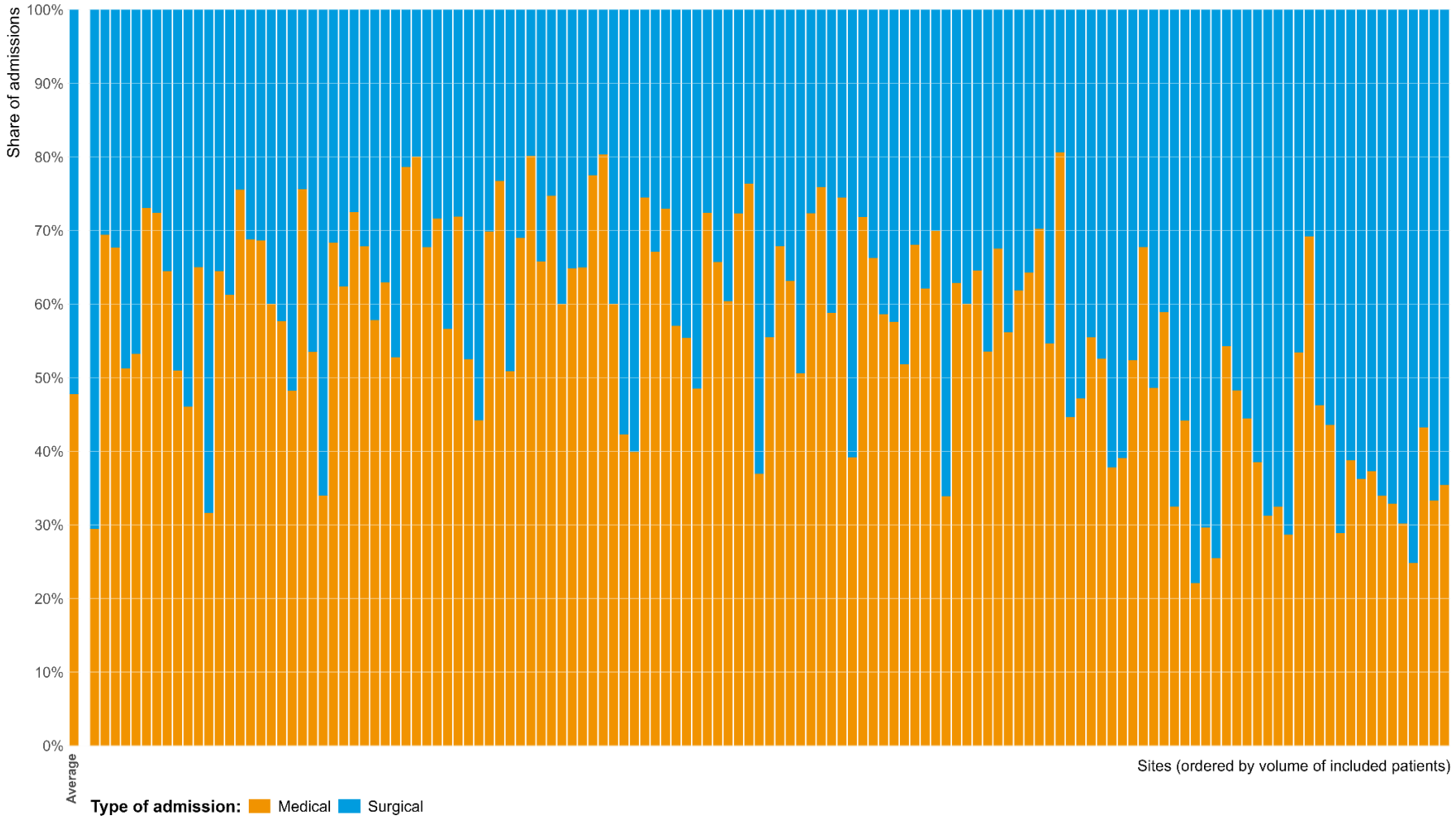
Source: Minimal Hospital Data (MZG – RHM).

Figure 73 – Distribution of patients' Elixhauser composite mortality risk score per site



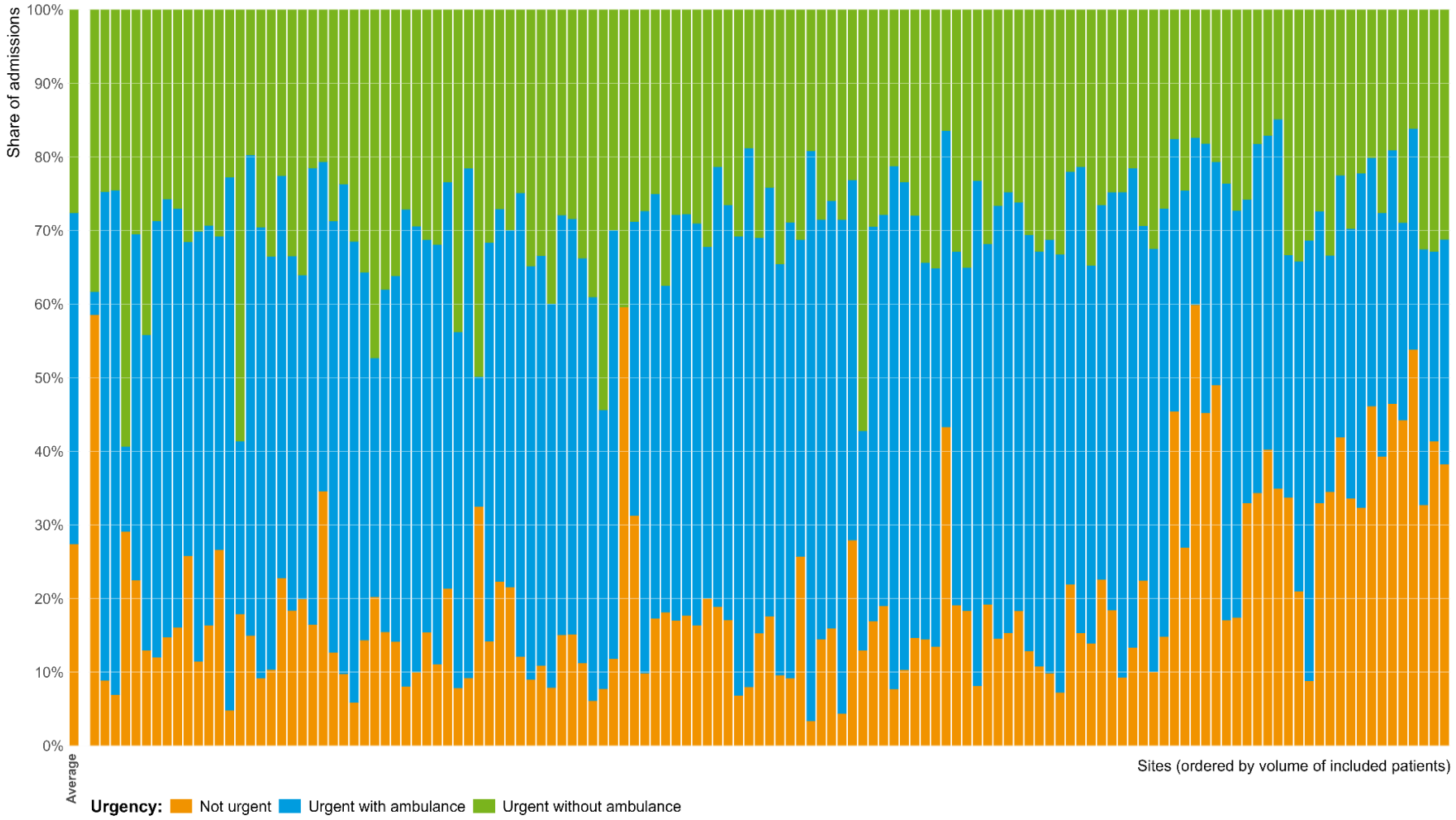
Note: A dedicated paediatric hospital site has a significantly higher proportion of low-comorbidity patients, while a specialised oncology hospital site, has a substantially higher proportion of high-comorbidity patients.
Source: Minimal Hospital Data (MZG – RHM).

Figure 74 – Distribution of type of admissions per site



Source: Minimal Hospital Data (MZG – RHM).

Figure 75 – Distribution of urgency per site



Source: Minimal Hospital Data (MZG – RHM).

6.4.2 Standardised mortality rates

6.4.2.1 Estimation of standardised mortality rates

The c-statistic of the SMR-models (estimated at the level of diagnosis groups) ranges between 65% and 88% with a mean value of 75% (see Appendix to Chapter 6 in the Supplement). This appendix also provides information on the most important covariates in the estimation of the SMR models. Age group, the Elixhauser composite mortality risk score and urgency were among the explanatory variables capturing most variability in in-hospital mortality.

6.4.2.2 Hospital standardised mortality rate (HSMR)

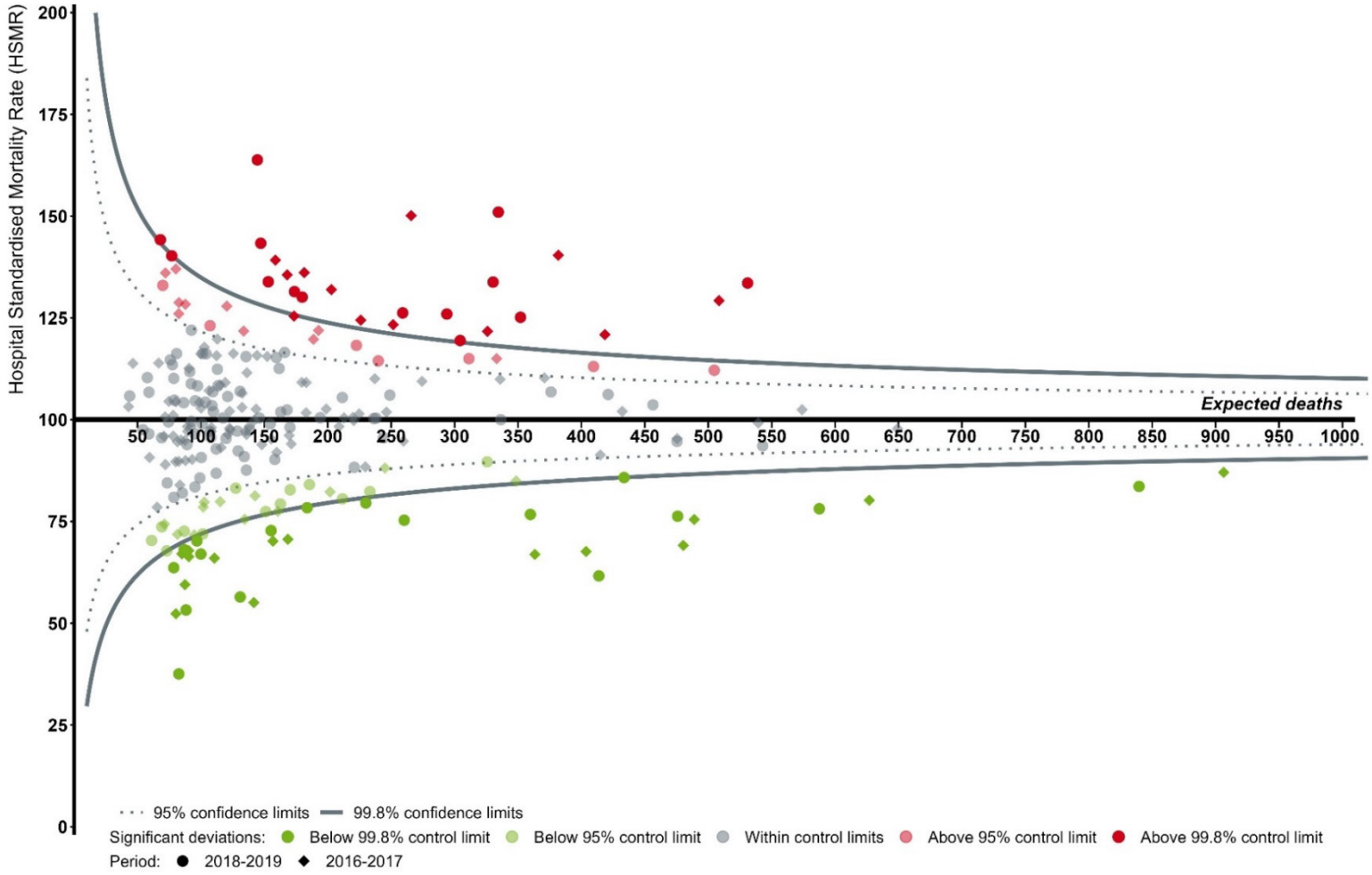
After calculating the SMRs, they were aggregated into a HSMR at the hospital site level covering a period of two years. For the hospital sites that attain the minimum threshold in terms of expected and observed deaths (see section 6.3.1.3), the results are visually depicted in a funnel plot in Figure 76 (for all admissions) and Figure 77 (for admissions of high-comorbidity patients). A funnel plot is a scatter plot where each point represents a hospital site in a two-year period, comparing the HSMR on the y-axis against the number of expected deaths predicted by the SMR-models on the x-axis. The higher the number of expected deaths, the more precise a HSMR estimate gets, leading to more narrow confidence limits. Observations below the confidence limit, depicted in green, indicate that mortality in the hospital site is significantly better than expected based on the observed patient characteristics, while observations above the confidence limit, depicted in red, indicate the opposite, a significantly worse mortality than expected.

Figure 76 shows that the majority of observations fall within the confidence limits. However, a notable number of hospital sites exhibit observed mortality rates that differ significantly from expected values, both higher and lower. This may partly be related to differences in case-mix across hospital sites (see section 6.4.1.5). While observed case-mix differences are accounted for in the regression models used to predict expected mortality, they still impact the HSMR through their role in the aggregation process (see Textbox 3). Residual variation may also be linked to hospital site characteristics, which is further examined in section 6.4.3. When restricting the analysis to high-comorbidity patients in Figure 77 – thereby reducing case-mix heterogeneity – fewer observations fall outside the confidence limits.

Given the potential impact of data quality and coding variability on HSMR results (see Textbox 3), we examine the extent to which outlier HSMR values are associated with potential differences in coding practices across hospital sites, particularly in the registration of diagnoses, comorbidities, and the proportion of palliative patients. A key concern is that hospital sites with higher HSMR values may underreport palliative patients or comorbidities, leading to an underestimation of expected mortality risk and artificially inflated HSMR outcomes. Figure 78 presents scatter plots of hospital site-level HSMR in relation to three variables capturing differences in diagnostic registration: (A) the average number of registered diagnoses per admission, (B) the average number of comorbidities per patient, and (C) the share of palliative patients (before their exclusion from the final sample). Significant deviations from control limits are colour-coded as in Figure 76.

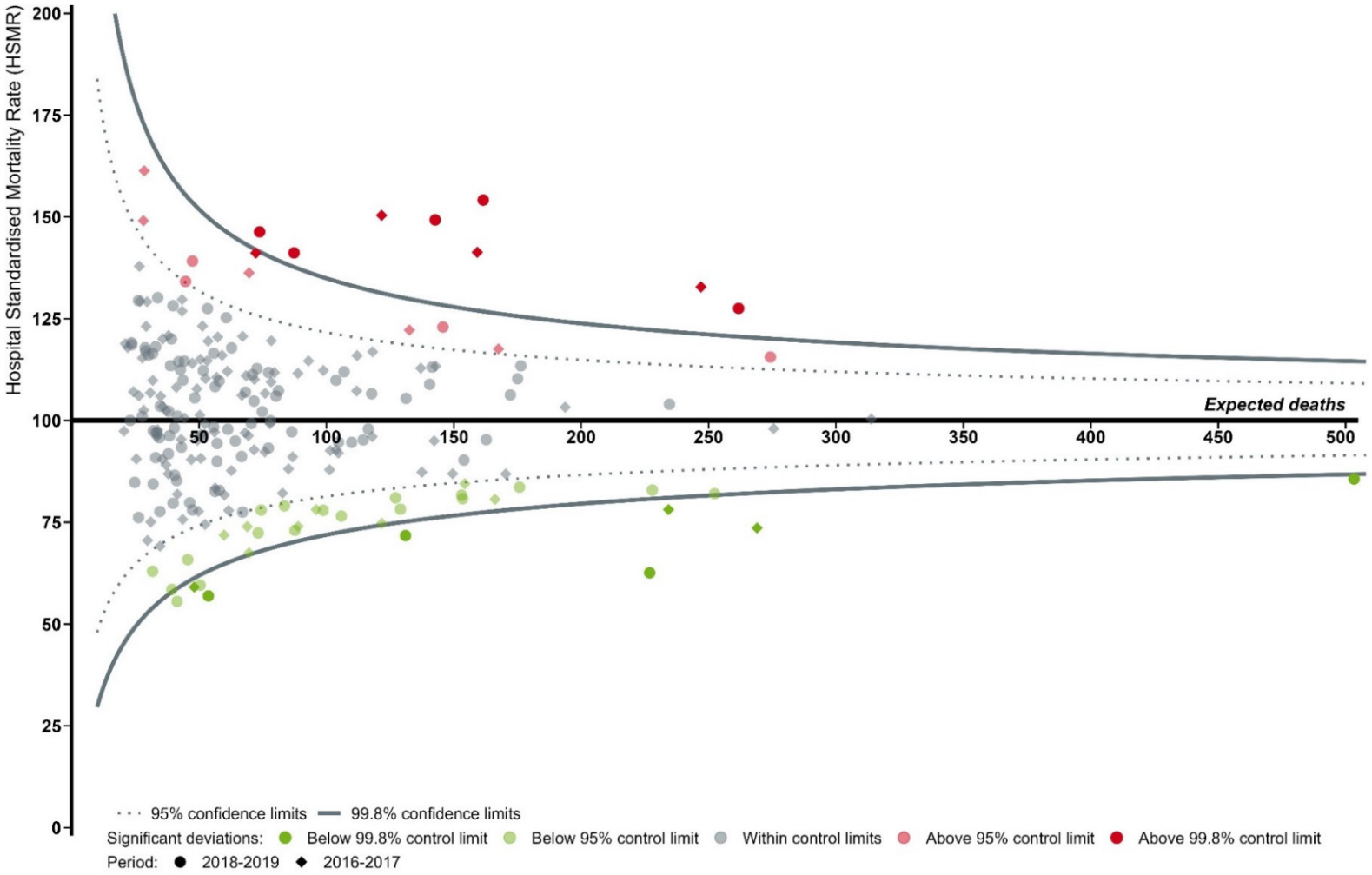
Pearson correlation coefficients were computed separately for each time period and case-mix variable. They reveal two small but statistically significant associations: a negative correlation between HSMR and the share of palliative patients in 2018–2019 (correlation = -0.2, $p \leq 0.05$) and a positive correlation between HSMR and the average number of diagnoses in 2016–2017 (correlation = 0.18, $p \leq 0.05$). These findings suggest that hospital sites registering fewer diagnoses and those with a higher proportion of palliative patients tend to have lower HSMR values. A low reported share of palliative patients may indicate underreporting of such patients, who typically have a higher mortality risk. When such patients are not excluded from our final sample, this may inflate HSMR values.

Figure 76 – Funnel plot of HSMR at the hospital site level, in two-year periods



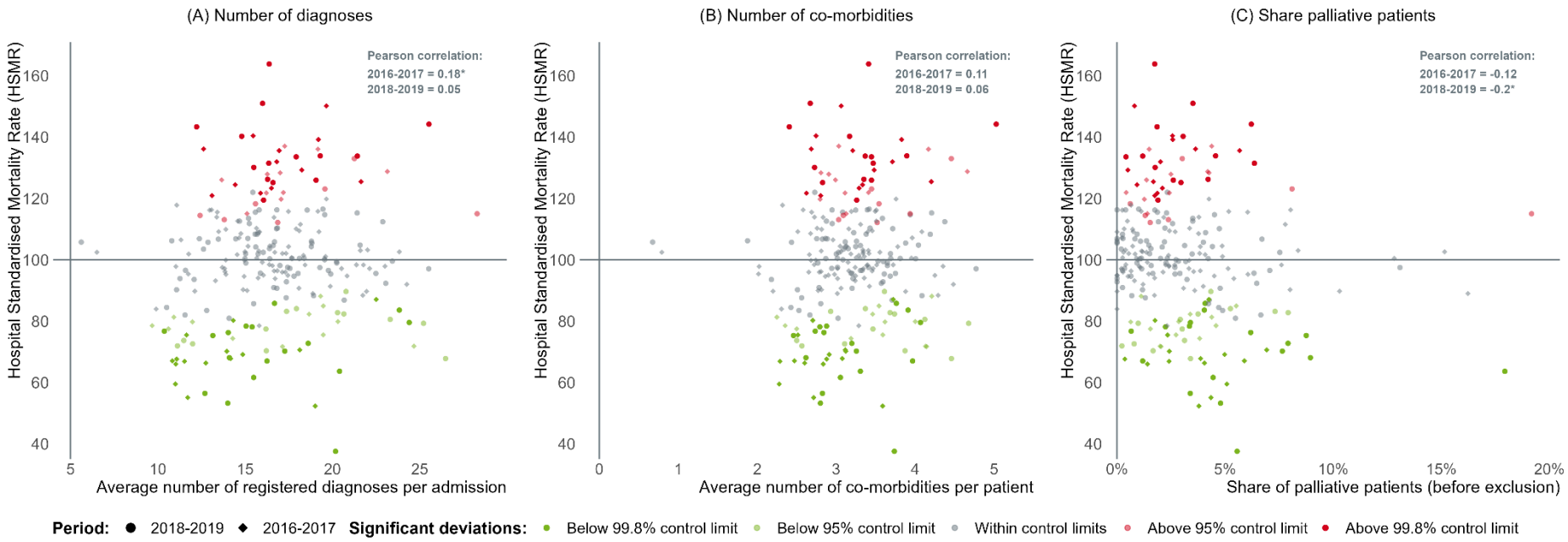
Source: Minimal Hospital Data (MZG – RHM).

Figure 77 – Funnel plot of HSMR at the hospital site level restricted to high-comorbidity patients, in two-year periods



Source: Minimal Hospital Data (MZG – RHM).

Figure 78 – Relationship between Hospital Standardised Mortality Rate (HSMR) and selected case-mix variables



*Note: Significance level: * = ≤ 0.05; ** = ≤ 0.01; *** = ≤0.001.*
Source: Minimal Hospital Data (MZG – RHM).

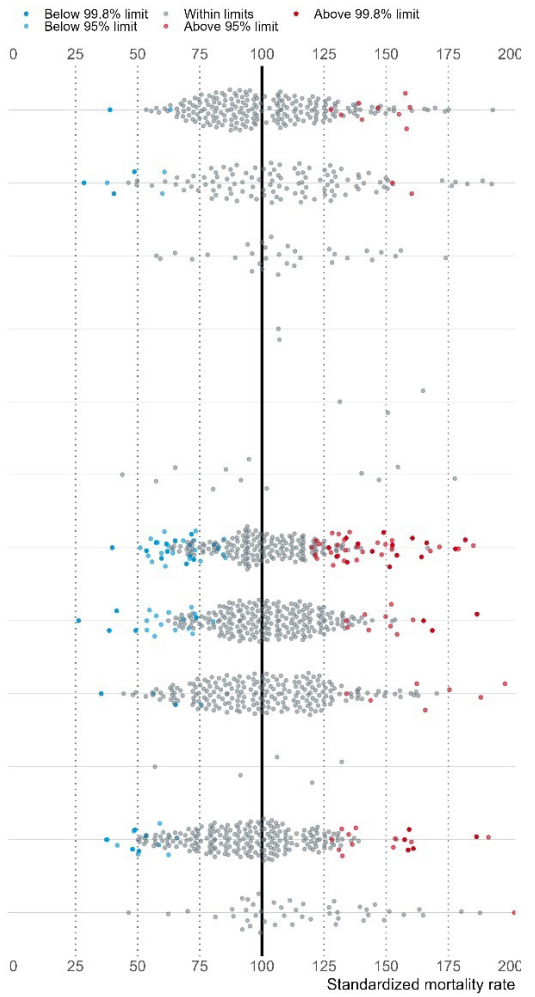
6.4.2.3 Standardised mortality rates (SMR) at the level of aggregate diagnosis groups

Table 24 and Table 25 provide a concise summary of SMR results for aggregate diagnosis groups, for all admissions and high-comorbidity admissions, respectively. For each group, the tables report the number of hospital sites included in the analysis over a two-year period, i.e. those meeting the minimum thresholds for observed and expected mortality, and indicate how many fall within or outside the confidence limits. Additionally, the distribution of SMRs is visualised, with sites exceeding the 95% or 99.8% confidence limits highlighted in blue (below) or red (above).

In some aggregate diagnosis groups, the number of remaining observations is very low (fewer than 25), particularly for groups 4, 5, 6, and 10 in Table 24 (all admissions), and additionally for groups 3 and 17 in Table 25 (high-comorbidity admissions). Significant deviations are most frequently observed in circulatory diseases, and injury and poisoning across both samples. Table 24 also shows significant deviations for respiratory diseases, and to a lesser extent for digestive diseases, neoplasms and infectious and parasitic diseases when considering all admissions.

Table 24 – Distribution standardised mortality rate by aggregate diagnosis group and site (all admissions grouped in two-year periods)

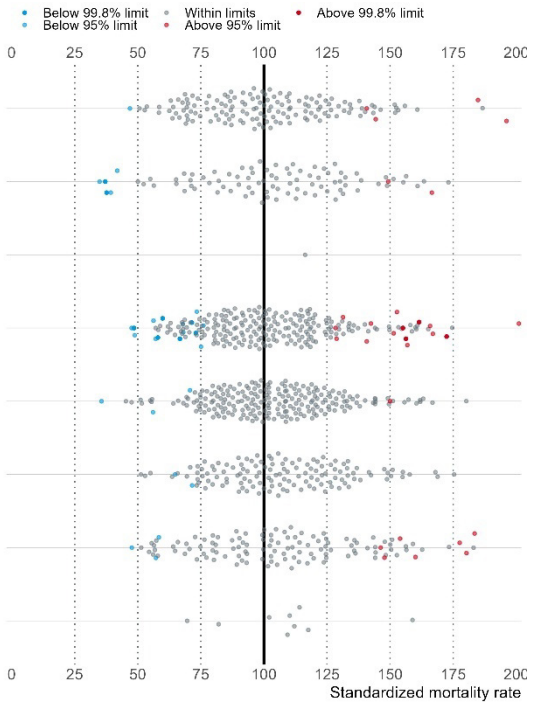
Aggregate diagnosis group		N	Observations by significance level					Distribution
No	Label		Below 99.8% limit	Below 95% limit	Within 95% limits	Above 95% limit	Above 99.8% limit	
1	Infectious and parasitic diseases	222	1	1	210	10	0	
2	Neoplasms	119	3	3	108	4	1	
3	Endocrine, nutritional and metabolic diseases, and immunity disorders	33	0	0	32	1	0	
4	Diseases of the blood and blood-forming organs	2	0	0	2	0	0	
5	Mental illness	3	0	0	3	0	0	
6	Diseases of the nervous system and sense organs	12	0	0	12	0	0	
7	Diseases of the circulatory system	249	14	20	172	27	16	
8	Diseases of the respiratory system	250	5	14	219	9	3	
9	Diseases of the digestive system	225	2	2	213	8	0	
10	Diseases of the genitourinary system and non-neoplastic breast conditions	5	0	0	5	0	0	
16	Injury and poisoning	244	5	9	213	12	5	
17	Symptoms; signs; and ill-defined conditions and factors influencing health status	47	0	0	46	1	0	



Source: Minimal Hospital Data (MZG – RHM).

Table 25 – Distribution standardised mortality rate by aggregate diagnosis group and site (high-comorbidity admissions grouped in two-year periods)

Aggregate diagnosis group		N	Observations by significance level					Distribution
No	Label		Below 99.8% limit	Below 95% limit	Within 95% limits	Above 95% limit	Above 99.8% limit	
1	Infectious and parasitic diseases	146	0	1	141	4	0	
2	Neoplasms	89	2	3	82	2	0	
3	Endocrine, nutritional and metabolic diseases, and immunity disorders	1	0	0	1	0	0	
7	Diseases of the circulatory system	235	6	9	205	11	4	
8	Diseases of the respiratory system	222	0	3	217	2	0	
9	Diseases of the digestive system	131	0	2	129	0	0	
16	Injury and poisoning	120	0	3	110	7	0	
17	Symptoms; signs; and ill-defined conditions and factors influencing health status	9	0	0	9	0	0	



Source: Minimal Hospital Data (MZG – RHM).

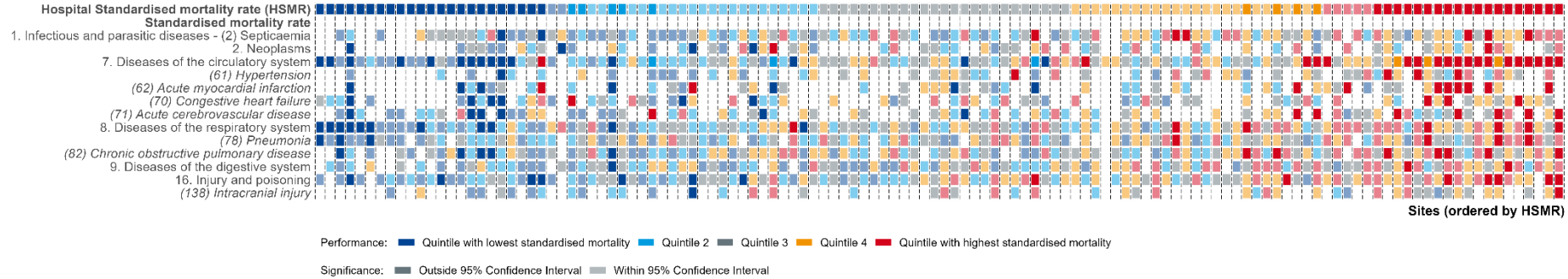
6.4.2.4 High- and low-performing hospital sites

Figure 79 (all admissions) and Figure 80 (high-comorbidity admissions) are heatmaps that visualise hospital site performance for the HSMR, SMRs of aggregate diagnosis groups, and a selection of high-volume diagnosis groups. These heatmaps help identify high- and low-performing hospital sites, i.e. intensive care services with consistently better or worse outcomes across different treatments, and assess whether this performance pattern aligns with the overall HSMR.

To achieve this, the HSMR and SMRs for the 2018-2019 period were categorised into quintiles, ranging from better/lower (in blue) to worse/higher (in red) than expected in-hospital mortality. Classification was conducted separately in the sample with all admissions (Figure 79) and in the sample restricted to high-comorbidity admissions (Figure 80). Each column represents a hospital site, while each row corresponds to a (aggregate) diagnosis group. Diagnosis groups are distinguished by having their label number in brackets, unlike aggregate diagnosis groups. Diagnosis groups are listed under their corresponding aggregate diagnosis group unless they fully overlap, in which case they share a row. In case hospital sites do not meet the reporting threshold for a SMR, the square remains uncoloured, while values outside the 95% confidence interval are highlighted with brighter colours.

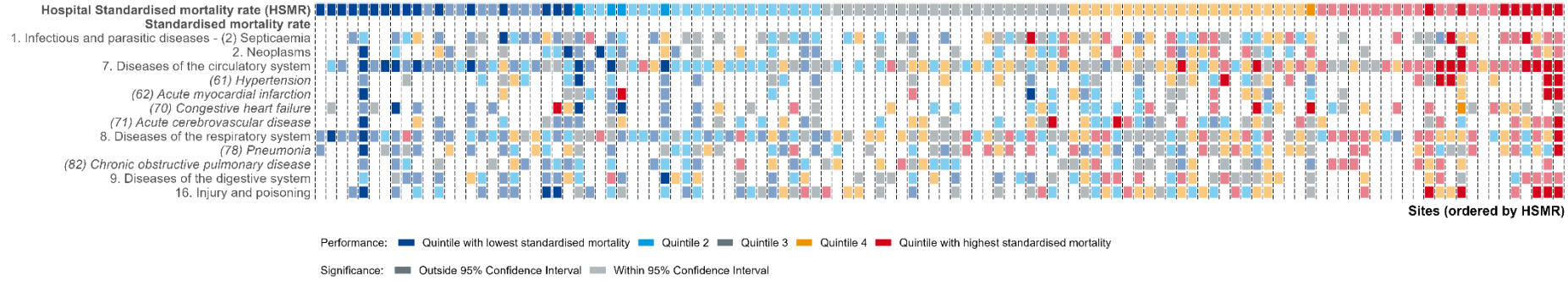
Overall, Figure 79 and Figure 80 show a clear association between HSMR, as an aggregate performance measure of in-hospital mortality in a site, and the underlying SMRs. The heatmaps reveal a distinction between high- and low-performing hospital sites, driven by performance across multiple diagnosis groups. Hospital sites in the lowest/highest HSMR quintile tend to have consistently lower/higher SMRs across (aggregate) diagnosis groups, whereas those with an average HSMR exhibit a mix of low and high SMR values.

Figure 79 – Heatmap showing association between HSMR and SMR of (aggregated) diagnosis groups by site (all admissions, period 2018-2019)



Source: Minimal Hospital Data (MZG – RHM).

Figure 80 – Heatmap showing association between HSMR and SMR of (aggregated) diagnosis groups by site (high-comorbidity admissions, period 2018-2019)



Source: Minimal Hospital Data (MZG – RHM).

6.4.3 Association between in-hospital mortality in intensive care and hospital site characteristics

6.4.3.1 Association between standardised mortality and hospital site characteristics

In section 6.4.2.4, we found a pattern of high and low performers with respect to standardised mortality. In a next step, we analyse whether there is a systematic association between hospital site characteristics and performance.

HSMR OF HIGH-COMORBIDITY PATIENTS IMPROVES WITH ACTIVITY VOLUME

Table 26 summarises the associations between the HSMR in two-year periods and hospital characteristics, particularly the activity volume of intensive care services at the hospital site, for both the full sample (panel A) and the sample restricted to high-comorbidity patients (panel B). Results in Panel A show no significant correlation between the HSMR and annual patient volume, nor between the HSMR and hospital type (general or university hospital) or site type (primary or secondary). However, the HSMR is significantly higher in hospital sites in Wallonia compared to those in Flanders. In the subgroup of high-comorbidity patients (panel B), an increase of 100 high-comorbidity patients in annual volume is significantly associated with a decrease or improvement in the HSMR by 3.9. This indicates that a higher volume of high-comorbidity patients in a hospital site is associated with a better performance with respect to in-hospital mortality, as standardised by the case-mix variables in the model.

Furthermore, university hospitals exhibit significantly higher HSMR values among high-comorbidity patients. This may be partly due to a more severe and complex patient population with a higher risk of mortality not fully captured by the case-mix variables at our disposal, which do not include ICU-specific measures of severity of illness (see section 6.2.2).

Table 26 – Regression results on association between HSMR and hospital site-level characteristics (all admissions and high-comorbidity admissions)

A. All admissions

		Coefficient (standard error)	P-value
Annual volume of patients (in 100 patients) (range: 0.9-26.4)		-0.396 (0.369)	0.283
Hospital type	General hospital [REF] (N=236)	--	--
	University hospital (N=16)	17.907 (9.440)	0.058
Site type	Primary [REF] (N=192)	--	--
	Secondary (N=60)	-1.245 (3.796)	0.743
Region	Flanders [REF] (N=127)	--	--
	Wallonia (N=92)	9.773 (3.547)**	0.006
	Brussels (N=33)	6.767 (4.651)	0.146

B. High-comorbidity admissions (Mortality risk score ≥ 17)

		Coefficient (standard error)	P-value
Annual volume of patients (in 100 patients) (range: 0.3-10.6)		-3.886 (1.546)*	0.012
Hospital type	General hospital [REF] (N=218)	--	--
	University hospital (N=16)	25.322 (12.579)*	0.044
Site type	Primary [REF] (N=180)	--	--
	Secondary (N=54)	-0.919 (3.824)	0.810
Region	Flanders [REF] (N=117)	--	--
	Wallonia (N=87)	2.448 (3.337)	0.463
	Brussels (N=30)	-2.585 (4.446)	0.561

*Significance level: * = ≤ 0.05; ** = ≤ 0.01; *** = ≤0.001. Note: regressions also control for time trend.*
Source: Minimal Hospital Data (MZG – RHM).

WORSE MORTALITY OUTCOMES IN HOSPITAL SITES WITH HIGHER LEVELS OF TECHNICAL CARE: UNMEASURED CASE-MIX OR QUALITY CONCERNS?

Table 27 presents regression results on the association between HSMR and hospital site-level characteristics, incorporating 2019 site-level data on nursing care intensity as an additional variable. Only HSMR data from the 2018–2019 period were used, reducing the sample to 124 hospital sites for all admissions and 116 for high-comorbidity admissions, i.e. approximately half of the sample size in Table 26.

The results indicate that a higher proportion of high-technical care patients is significantly associated with an increased HSMR in the full sample (panel A), suggesting that hospital sites treating a larger share of patients with high-technical care needs experience higher than expected in-hospital mortality. There are competing explanations for this finding. A higher average intensity of nursing care may reflect a more severe and complex patient population with a higher mortality risk, that is not fully captured by the case-mix variables used to calculate SMRs, contributing to higher HSMR scores. Alternatively, inadequate hospital quality or safety may be related to a deterioration in patient health, resulting in higher high-technical care needs as well as increased mortality risk.

In the high-comorbidity sample (panel B), the effect of intensity of nursing care is not significant, suggesting that among this more homogeneous patient group, the level of high-technical care does not further explain mortality differences.

The inclusion of nursing care intensity also affects the estimated effects of other hospital characteristics. The previously observed negative association between annual patient volume and HSMR in high-comorbidity admissions remains similar in magnitude to the baseline results in Table 26 but is now less precisely estimated and just above the 5% significance threshold ($p = 0.051$). The effect of university hospital status on HSMR remains positive, though the coefficient is somewhat lower than in Table 26 and no longer significant in the high-comorbidity sample. This suggests that part of the higher HSMR observed in university hospitals may be explained by their larger share of high-technical care patients. Regional differences remain largely consistent with those in Table 26. In the full sample, HSMR remains significantly higher in Wallonia and, to a lesser extent, in Brussels compared to Flanders, while in the high-comorbidity sample, regional differences are not significant.

Table 27 – Regression results on association between HSMR, site-level characteristics and intensity of nursing care (all admissions and high-comorbidity admissions, sample restricted to period 2018-2019)

A. All admissions

		Coefficient (standard error)	P-value
Annual volume of patients (in 100 patients) (range: 0.9-25.0)		-0.452 (0.378)	0.232
Percentage high technical care (range: 0.6-71.3)		0.438 (0.109)***	<.001
Hospital type	General hospital [REF] (N=116)	--	--
	University hospital (N=8)	14.113 (8.746)	0.107
Site type	Primary [REF] (N=95)	--	--
	Secondary (N=29)	-1.688 (3.595)	0.639
Region	Flanders [REF] (N=62)	--	--
	Wallonia (N=46)	13.395 (3.783)***	<.001
	Brussels (N=16)	9.240 (4.001)*	0.021

B. High-comorbidity admissions (Mortality risk score ≥ 17)

		Coefficient (standard error)	P-value
Annual volume of patients (in 100 patients) (range: 0.4-10.6)		-3.305 (1.695)	0.051
Percentage high technical care (range: 0.6-70.0)		0.163 (0.159)	0.305
Hospital type	General hospital [REF] (N=108)	--	--
	University hospital (N=8)	23.530 (13.928)	0.091
Site type	Primary [REF] (N=89)	--	--
	Secondary (N=27)	0.968 (4.351)	0.824
Region	Flanders [REF] (N=57)	--	--
	Wallonia (N=44)	-0.541 (5.329)	0.919
	Brussels (N=15)	3.243 (9.121)	0.722

*Significance level: * = ≤ 0.05; ** = ≤ 0.01; *** = ≤0.001.*
Source: Minimal Hospital Data (MZG – RHM).

CRITICAL MASS OF HIGH-COMORBIDITY PATIENTS IS ASSOCIATED WITH LOWER MORTALITY RISK

Table 28 reports on the robustness of the baseline results in Table 26, with respect to a different specification of the volume variable (log2 transformation, quartiles instead of a continuous variable, days instead of patients), the inclusion threshold (number of observed and expected deaths to be included in the analysis), the level of analysis (unit instead of site), and a further exclusion of DNR patients and all palliative patients regardless of POA flag. Altogether, the results of the robustness analysis support the baseline results. In the analysis with all admissions, none but one association is significant, while in the analysis restricted to high-comorbidity patients, the reverse is true. Coefficient values at the unit level are higher, which can be explained by the smaller range in activity volume at the unit level than at the site level. Also, the higher number of observations in the analysis at the unit level increases the precision and significance. Interestingly, the use of quartiles of patient volume in Table 28 panel B indicates that the volume-outcome relation is not linear, but that in particular sites in the lowest quartile with fewer than 61 high-comorbidity patients per year perform significantly worse.

Table 28 – Robustness of regression results on association between HSMR and site-level characteristics (all admissions and high-comorbidity admissions)

A. All admissions

		Coefficient (standard error)	P-value
Annual patient volume (in 100 patients) (range: 0.9-26.4)		-0.396 (0.369)	0.283
Annual volume of patients (Log2 transformation) (range: 6.5-11.4)		-0.648 (1.715)	0.705
Quartiles of patient volume	Lowest [REF] (N=63, range=92-227)	--	--
	Quartile 2 (N=63, range=227-298)	-4.815 (4.011)	0.230
	Quartile 3 (N=63, range=298-602)	1.642 (4.540)	0.718
	Highest (N=63, range=602-2497)	2.711 (4.748)	0.568
Annual volume of patient days (in 500 days) (range: 1.2-37.0)		-0.014 (0.390)	0.972
Change inclusion threshold	Threshold 15 deaths – annual patient volume (in 100 patients) (range: 0.9-26.4)	-0.396 (0.369)	0.283
	Threshold 25 deaths – annual patient volume (in 100 patients) (range: 0.9-26.4)	-0.395 (0.369)	0.285
At unit level	Annual patient volume (in 100 patients) (range: 0.2-15.1)	-2.739 (0.848)**	0.001
DNR patients excluded	Annual patient volume (in 100 patients) (range: 0.8-24.9)	-0.192 (0.467)	0.681
All palliative patients excluded	Annual patient volume (in 100 patients) (range: 0.9-25.8)	-0.440 (0.389)	0.258

B. High-comorbidity admissions (Mortality risk score ≥ 17)

		Coefficient (standard error)	P-value
Annual volume of patients (in 100 patients) (range: 0.3-10.6)		-3.886 (1.546)*	0.012
Annual volume of patients (Log2 transformation) (range: 4.9-10.0)		-4.193 (1.822)*	0.021
Quartiles of patient volume	Lowest [REF] (N=59, range=38-61)	--	--
	Quartile 2 (N=58, range=61-99)	-8.859 (4.315)*	0.040
	Quartile 3 (N=58, range=99-167)	-4.889 (3.990)	0.220
	Highest (N=58, range=167-1057)	-9.709 (4.625)*	0.036
Annual volume of patient days (in 500 days) (range: 0.3-16.8)		-1.629 (1.109)	0.142
Change inclusion threshold	Threshold 15 deaths – annual patient volume (in 100 patients) (range: 0.3-10.6)	-3.389 (1.518)*	0.026
	Threshold 25 deaths – annual patient volume (in 100 patients) (range: 0.4-10.6)	-4.489 (1.612)**	0.005
At unit level	Annual patient volume (in 100 patients) (range: 0.1-3.9)	-11.577 (3.188)***	<.001
DNR patients excluded	Annual patient volume (in 100 patients) (range: 0.4-9.4)	-4.859 (2.057)*	0.018
All palliative patients excluded	Annual patient volume (in 100 patients) (range: 0.3-10.4)	-4.751 (1.706)**	0.005

*Significance level: * = ≤ 0.05; ** = ≤ 0.01; *** = ≤0.001. Note: all regressions control for time trend, site region, site type, and hospital type.*
Source: Minimal Hospital Data (MZG – RHM).

Table 29 and Table 30 summarise the associations between SMRs of aggregate diagnosis groups in two-year periods and hospital site characteristics. Three different specifications for volume are reported, annual volume in admissions grouped per 10 admissions, a log2 transformation and a division into quartiles of volume. Note that there is large variation in range of volume by aggregate diagnosis group which may have an impact on the coefficient values and their interpretation.

LOWER STANDARDISED MORTALITY ASSOCIATED WITH INCREASING VOLUME IN A RANGE OF AGGREGATE DIAGNOSIS GROUPS

The analysis at the level of aggregate diagnosis groups paints a different picture than the analysis of HSMRs. While no significant association was found between the HSMR and volume in the analysis that includes all admissions, we do find a significant volume effect in all aggregate diagnosis groups, with the exception of injury and poisoning. It is possible that the overall HSMR has levelled out the volume effects that are visible at a more detailed level. The effect is particularly clear for infectious and parasitic diseases (septicaemia) with increasing volume of treated patients associated with decreasing standardised mortality. For neoplasms, the effect is also highly significant. Based on the regression with quartiles, standardised mortality is significantly better in the upper two quartiles (above 30 cases per year). With respect to endocrine and metabolic diseases, and immunity disorders, there is a particularly strong improvement in the highest volume quartile (above 36 cases per year). With regard to diseases of the circulatory system and ill-defined conditions, we find that the lowest volume quartile underperforms compared to the three other quartiles. For diseases of the respiratory system and the digestive system, the results are less clear-cut. For 5 out of 8 aggregate diagnosis groups in Table 29, there is a positive association between university hospital and SMR, implying worse performance. As already mentioned above, this may be partly related to unmeasured complexity and mortality risk in the patient population of university hospitals. Moreover, we find that hospital sites in Flanders have lower standardised mortality rates in 4 out 8 aggregate diagnosis groups, infectious and parasitic diseases (septicaemia), neoplasms, diseases of the respiratory system and injury and poisoning.

In the sample restricted to high-comorbidity patients, we find a significant volume outcome effect for all 6 considered aggregate diagnosis groups for all specifications of the volume measure. For three aggregate diagnosis groups, i.e. infectious and parasitic diseases (septicaemia), injury and poisoning and diseases of the digestive system, we find that the lowest volume quartile underperforms compared to the three other quartiles. For neoplasm standardised mortality is significantly better in the upper two quartiles. For diseases of the respiratory system, there is a linear improvement with increasing volume, while for diseases of the circulatory system we find there is in particular an improvement in the highest volume quartile (above 36 cases per year). In 3 out of 6 aggregate diagnosis groups, we find higher SMRs in university hospitals and for diseases of the circulatory system we find lower standardised mortality rates in hospitals in Brussels.

Table 29 – Regression results (coefficient (standard error)) on association between SMR in aggregate diagnosis groups and hospital site-level characteristics (all admissions, different variables for annual volume)

Aggregate diagnosis group		N	Range patient volume	Region [REF: Flanders]		Hospital type [REF: general]	Annual Volume	Thresholds quartiles annual volume	Annual Volume [REF: lowest volume quartile]			Range patient volume	Annual Volume
No	Label		Min - Max (per 100)	Brussels	Wallonia	University	Per 10 patients	Min - P25 - Median - P75 - Max	Quartile 2	Quartile 3	Highest quartile	Min - Max (log2 scale)	Log2 scale
1	Infectious and parasitic diseases (septicaemia)	222	0.6-13.9	17.18 (7.90)*	12.96 (4.48)**	13.17 (9.59)	-3.06 (0.89)***	6 - 15 - 29 - 43 - 139	-14.82 (5.49)**	-18.52 (5.34)***	-22.13 (5.33)***	2.6-7.1	-8.53 (2.03)***
2	Neoplasms	119	0.8-14.7	5.76 (6.70)	15.79 (7.97)*	51.13 (11.41)***	-6.58 (1.27)***	10 - 20 - 30 - 48 - 136	-4.37 (10.13)	-34.50 (8.30)***	-39.00 (9.97)***	2.9-7.2	-20.95 (3.94)***
3	Endocrine, and metabolic diseases, and immunity disorders	33	1.4-5.2	10.45 (12.83)	2.89 (12.36)	27.68 (13.04)*	-18.00 (7.28)*	14 - 21 - 27 - 36 - 52	-23.31 (15.91)	-18.37 (15.39)	-49.66 (18.82)**	3.8-5.7	-32.44 (13.35)*
7	Diseases of the circulatory system	249	1.0-161.4	-1.41 (7.25)	4.11 (5.13)	22.93 (9.52)*	-0.21 (0.06)***	10 - 59 - 86 - 202 - 1614	-16.36 (6.99)*	-11.66 (6.60)	-12.53 (6.83)	3.4-10.7	-3.97 (1.55)*
8	Diseases of the respiratory system	250	1.3-34.4	19.49 (5.36)***	11.74 (3.99)**	8.65 (6.80)	-1.06 (0.39)**	20 - 43 - 58 - 83 - 344	0.91 (5.20)	-7.92 (5.02)	-8.41 (4.83)	3.8-8.4	-6.28 (2.48)*
9	Diseases of the digestive system	225	0.8-18.8	3.46 (5.64)	6.70 (4.44)	15.84 (12.20)	-2.40 (1.21)*	8 - 19 - 27 - 41 - 167	-3.86 (5.86)	-14.95 (6.03)*	-4.67 (6.19)	3.0-7.6	-6.17 (3.30)
16	Injury and poisoning	244	1.5-44.8	13.05 (6.32)*	13.89 (4.34)**	30.51 (11.86)*	0.35 (0.35)	16 - 40 - 62 - 117 - 424	4.68 (5.24)	9.55 (5.41)	10.78 (5.98)	3.9-8.8	2.54 (2.60)
17	Symptoms, ill-defined conditions influencing health status	47	0.4-3.3	-2.28 (13.43)	-8.92 (8.70)	27.18 (12.71)*	-20.46 (5.10)***	5 - 7 - 8 - 14 - 28	-27.74 (9.73)**	-23.90 (12.72)	-27.85 (14.33)	2.1-5.0	-17.72 (6.29)**

*Significance level: * = ≤ 0.05; ** = ≤ 0.01; *** = ≤0.001. Note: all regressions control for time trend, site region, site type, and hospital type.*
Source: Minimal Hospital Data (MZG – RHM).

Table 30 – Regression results (coefficient (standard error)) on association between SMR in aggregate diagnosis groups and hospital site-level characteristics (high-comorbidity admissions, different variables for annual volume)

Aggregate diagnosis group		N	Range patient volume	Region [REF: Flanders]		Hospital type [REF: general]	Annual Volume	Thresholds quartiles annual volume	Annual Volume [REF: lowest volume quartile]			Range patient volume	Annual Volume
No	Label		Min - Max (per 100)	Brussels	Wallonia	University	Per 10 patients	Min - P25 - Median - P75 - Max	Quartile 2	Quartile 3	Highest quartile	Min - Max (log2 scale)	Log2 scale
1	Infectious and parasitic diseases (septicaemia)	146	0.5-7.9	3.99 (9.76)	3.93 (5.72)	15.82 (11.24)	-5.90 (2.40)*	6 - 10 - 15 - 22 - 79	-22.99 (6.93)***	-17.95 (6.68)**	-27.02 (6.86)***	2.3-6.3	-10.99 (3.41)**
2	Neoplasms	89	0.7-10.1	6.65 (6.80)	14.80 (6.42)*	43.05 (7.56)***	-7.70 (1.34)***	7 - 16 - 22 - 35 - 99	-8.87 (5.32)	-32.24 (6.60)***	-39.46 (9.78)***	2.8-6.7	-20.26 (3.24)***
7	Diseases of the circulatory system	235	0.8-48.1	-12.19 (5.56)*	-2.02 (4.58)	38.63 (10.57)***	-1.31 (0.28)***	10 - 18 - 30 - 62 - 481	-10.49 (5.78)	-9.84 (5.11)	-15.41 (6.03)*	3.0-8.9	-5.86 (1.81)**
8	Diseases of the respiratory system	222	0.6-11.9	6.38 (5.15)	3.99 (4.02)	8.73 (8.98)	-4.02 (1.40)**	7 - 12 - 17 - 27 - 119	-4.28 (4.88)	-10.75 (4.99)*	-14.83 (5.31)**	2.6-6.9	-8.17 (2.44)***
9	Diseases of the digestive system	131	0.6-9.5	1.61 (5.86)	3.28 (4.82)	21.20 (11.57)	-7.99 (2.07)***	6 - 10 - 14 - 20 - 95	-13.95 (6.50)*	-18.71 (6.98)**	-18.30 (6.91)**	2.5-6.6	-13.52 (4.02)***
16	Injury and poisoning	120	0.6-14.7	-0.19 (10.36)	1.86 (7.22)	51.43 (14.99)***	-5.36 (1.87)**	6 - 11 - 16 - 27 - 147	-24.52 (8.43)**	-18.53 (8.09)*	-25.24 (11.04)*	2.5-7.2	-12.88 (4.59)**

*Significance level: * = ≤ 0.05; ** = ≤ 0.01; *** = ≤0.001. Note: all regressions control for time trend, site region, site type, and hospital type.*
Source: Minimal Hospital Data (MZG – RHM).

6.4.3.2 *Association between in-hospital mortality risk and hospital characteristics*

An alternative and more direct approach to analysing variation in HSMRs and SMRs is to model in-hospital mortality at the individual level using a multilevel logistic regression model (see section 6.3.2.2). Table 31 summarises the odds ratios for the association between in-hospital mortality and hospital site characteristics (**hospital model**) in the full study population, stratified by aggregate diagnosis group. Table 32 presents the corresponding results for the high-comorbidity patient sample. Three different specifications for volume are reported: annual admission volume grouped per 10 admissions, a log2 transformation, and quartiles of volume. As discussed in section 6.4.1.4, there is considerable variation in the range of activity volume across aggregate diagnosis groups, which may influence coefficient values and their interpretation. Nevertheless, for comparability, we applied the same volume variables to each aggregate diagnosis group.

In Table 31, we find that, regardless of the volume specification used, higher annual admission volume is significantly associated with a lower mortality risk across four aggregate diagnosis groups: neoplasms; endocrine, metabolic, and immunity disorders; diseases of the circulatory system; and diseases of the respiratory system. For neoplasms and diseases of the circulatory system, hospital sites in the lowest volume quartile have significantly higher mortality odds compared to the three higher quartiles. For endocrine, metabolic, and immunity disorders, as well as diseases of the respiratory system, the odds of dying are significantly lower in the upper two quartiles. Across all four groups, the odds ratio for the log2-transformed admission volume is consistently around 0.88, indicating a 12% reduction in mortality odds for every doubling in admissions.

For injury and poisoning, we find a significant volume-mortality association for both annual volume per 10 admissions and the log2-transformed volume, indicating higher mortality odds in higher-volume sites.

For diseases of the nervous system, only annual volume per 10 admissions shows a significant higher volume-lower mortality effect. In contrast, for four other aggregate diagnosis groups, including high-volume categories such as infectious and parasitic diseases (septicaemia) and diseases of the digestive system, no significant volume effect is found.

For 6 out of 10 aggregate diagnosis groups in Table 31, the odds of dying are significantly higher in university hospitals. As noted in section 6.4.2.1, this may be partly due to unmeasured differences in patient complexity and mortality risk. Additionally, mortality odds are significantly higher in hospital sites in Brussels and Wallonia for 4 and 5 aggregate diagnosis groups, respectively, most notably for diseases of the respiratory system, infectious and parasitic diseases (septicaemia), injury and poisoning, and neoplasms.

In Table 32, the number of observations is substantially lower across all aggregate diagnosis groups compared to Table 11, and fewer groups meet the threshold for analysis. A higher annual volume of admissions for high-comorbidity patients is significantly associated with lower mortality risk in two aggregate diagnosis groups: neoplasms and diseases of the respiratory system, regardless of the volume specification used. For diseases of the circulatory and digestive systems, a significant association is found for both annual volume per 10 patients and the log2-transformed annual number of admissions, indicating lower odds of in-hospital mortality in higher-volume sites. No significant volume effect is observed for injury and poisoning or infectious and parasitic diseases (septicaemia). In 4 out of 6 aggregate diagnosis groups in Table 32, the odds of in-hospital mortality are significantly higher in university hospitals. Additionally, mortality risk is significantly higher in hospital sites in Brussels and Wallonia for 1 and 4 aggregate diagnosis groups, respectively, with the strongest effects observed for diseases of the respiratory system and neoplasms.



Table 31 – Regression results (odds ratio [confidence interval]) on association between in-hospital mortality and hospital site-level characteristics per aggregate diagnosis group (all admissions, different variables for annual volume)

Aggregate diagnosis group		N	Range patient volume	Region [REF: Flanders]		Hospital type [REF: general]	Annual Volume	Thresholds and N of quartiles annual volume	Annual Volume [REF: lowest volume quartile]			Range patient volume	Annual Volume
No	Label	Stays [sites 2019]	Min - Max (per 10)	Brussels	Wallonia	University	Per 10 patients	Threshold (T): Min - P25 - Median - P75 - Max N: stays [sites 2019]	Quartile 2	Quartile 3	Highest quartile	Min - Max (log2 scale)	Log2 scale
1	Infectious and parasitic diseases (septicaemia)	15 453 [131]	0.1-15.4	1.45 [1.16-1.81]***	1.39 [1.21-1.61]***	1.11 [0.86-1.44]	0.98 [0.96-1.01]	T: 1 - 12 - 26 - 40 - 154 N: 847 [30] - 2 107 [30] - 4 091 [32] - 8 264 [31]	1.01 [0.83-1.22]	0.94 [0.78-1.14]	0.88 [0.72-1.08]	0.0-7.3	0.95 [0.89-1.01]
2	Neoplasms	13 642 [131]	0.1-15.0	1.37 [1.01-1.87]*	1.60 [1.27-2.03]***	2.61 [1.75-3.88]***	0.95 [0.92-0.99]**	T: 1 - 8 - 18 - 33 - 137 N: 700 [30] - 1 668 [31] - 3 198 [31] - 8 040 [31]	0.68 [0.51-0.91]**	0.72 [0.55-0.96]*	0.60 [0.45-0.81]***	0.0-7.2	0.88 [0.81-0.96]**
3	Endocrine, and metabolic diseases, and immunity disorders	7 350 [131]	0.1-5.6	0.97 [0.71-1.34]	1.22 [0.98-1.53]	1.68 [1.20-2.36]**	0.89 [0.81-0.97]*	T: 1 - 8 - 13 - 21 - 53 N: 613 [30] - 1 195 [31] - 1 976 [31] - 3 517 [32]	0.91 [0.66-1.24]	0.70 [0.52-0.94]*	0.74 [0.55-1.00]*	0.0-5.8	0.84 [0.76-0.94]**
6	Diseases of the nervous system and sense organs	4 662 [131]	0.0-9.6	0.91 [0.58-1.41]	0.93 [0.68-1.28]	2.31 [1.47-3.65]***	0.89 [0.81-0.98]*	T: 1 - 3 - 5 - 11 - 96 N: 190 [31] - 618 [29] - 878 [30] - 2 953 [29]	1.27 [0.71-2.25]	1.14 [0.64-2.02]	1.38 [0.77-2.45]	-4.1-6.6	0.97 [0.86-1.09]
7	Diseases of the circulatory system	126 215 [131]	0.3-166.6	1.00 [0.78-1.29]	1.07 [0.90-1.27]	1.67 [1.17-2.37]**	0.99 [0.99-1.00]***	T: 7 - 57 - 87 - 208 - 1 563 N: 4 922 [31] - 8 944 [31] - 16 866 [31] - 94 986 [31]	0.85 [0.74-0.97]*	0.80 [0.69-0.93]**	0.79 [0.66-0.94]**	1.7-10.7	0.87 [0.83-0.92]***
8	Diseases of the respiratory system	36 078 [131]	0.4-34.4	1.45 [1.20-1.75]***	1.32 [1.16-1.51]***	1.28 [1.00-1.64]	0.98 [0.97-0.99]**	T: 16 - 44 - 59 - 83 - 344 N: 4 021 [31] - 6 181 [31] - 8 863 [31] - 16 760 [31]	0.98 [0.87-1.10]	0.88 [0.78-1.00]*	0.86 [0.75-0.99]*	2.1-8.4	0.88 [0.82-0.95]***
9	Diseases of the digestive system	17 013 [131]	0.3-20.9	1.12 [0.90-1.39]	1.21 [1.04-1.40]*	1.39 [1.03-1.86]*	0.98 [0.95-1.01]	T: 5 - 16 - 23 - 38 - 156 N: 1 541 [29] - 2 679 [33] - 4 009 [31] - 8 636 [31]	1.07 [0.90-1.26]	1.01 [0.85-1.21]	0.95 [0.79-1.14]	1.6-7.7	0.95 [0.87-1.03]
10	Diseases of genitourinary system and non-neoplastic breast conditions	2 396 [130]	0.0-2.6	1.23 [0.74-2.02]	1.07 [0.77-1.49]	1.36 [0.83-2.22]	0.86 [0.67-1.10]	T: 0 - 2 - 3 - 6 - 23 N: 450 [58] - . - 576 [26] - 1 340 [30]	0.67 [0.38-1.19]	0.95 [0.57-1.60]	0.81 [0.49-1.33]	-4.1-4.7	0.96 [0.85-1.09]
16	Injury and poisoning	45 054 [131]	0.4-45.0	1.44 [1.16-1.78]***	1.42 [1.23-1.65]***	1.55 [1.16-2.08]**	1.01 [1.00-1.02]*	T: 8 - 39 - 60 - 113 - 415 N: 3 526 [31] - 5 986 [31] - 10 084 [31] - 25 219 [31]	1.07 [0.92-1.25]	1.15 [0.97-1.36]	1.18 [0.99-1.41]	2.0-8.8	1.09 [1.01-1.16]*

17	Symptoms, ill-defined conditions influencing health status	2 290 [129]	0.0-3.8	1.29 [0.84-2.00]	1.11 [0.79-1.55]	1.16 [0.70-1.93]	1.04 [0.85-1.26]	T: 1 - 2 - 3 - 6 - 32 N: 446 [56] - . - 555 [32] - 1 271 [24]	0.90 [0.54-1.50]	0.95 [0.59-1.53]	1.12 [0.70-1.81]	-1.1-5.2	1.06 [0.94-1.19]

Note: Multilevel logistic regressions control for age, sex, admission source, urgency, type of admission (medical or surgical), Elixhauser composite mortality risk score, socioeconomic status of the municipality, year and month of admission, site type (primary or secondary), hospital type (general or university) and annual activity volume using different specifications. Random effects for the intercept are modelled at the level of the hospital site. However, due to convergence issues, random effects at the hospital level are used for aggregate diagnosis group 10 in the regression using quartiles of annual volume. Aggregate diagnosis groups diseases of the blood and blood-forming organs and mental illness did not meet the threshold of 350 in-hospital deaths and are excluded from the analysis.
*Significance level: * = ≤ 0.05; ** = ≤ 0.01; *** = ≤0.001.*
Source: Minimal Hospital Data (MZG – RHM).

Table 32 – Regression results (odds ratio [confidence interval]) on association between in-hospital mortality and hospital site-level characteristics per aggregate diagnosis group (high-comorbidity admissions, different variables for annual volume)

Aggregate diagnosis group		N	Range patient volume	Region [REF: Flanders]		Hospital type [REF: general]	Annual Volume	Thresholds and N of quartiles annual volume	Annual Volume [REF: lowest volume quartile]			Range patient volume	Annual Volume
No	Label	Stays [sites 2019]	Min - Max (per 10)	Brussels	Wallonia	University	Per 10 patients	Threshold (T): Min - P25 - Median - P75 - Max N: stays [sites 2019]	Quartile 2	Quartile 3	Highest quartile	Min - Max (log2 scale)	Log2 scale
1	Infectious and parasitic diseases (septicaemia)	6 357 [130]	0.1-9.3	1.27 [0.96-1.67]	1.23 [1.02-1.47]*	1.00 [0.74-1.35]	0.96 [0.91-1.02]	T: 1 - 4 - 10 - 17 - 93 N: 308 [30] - 739 [30] - 1 588 [31] - 3 659 [30]	1.13 [0.84-1.51]	1.15 [0.87-1.52]	0.93 [0.70-1.23]	-0.3-6.5	0.95 [0.88-1.02]
2	Neoplasms	8 610 [131]	0.1-11.3	1.32 [0.99-1.77]	1.59 [1.27-1.99]***	2.54 [1.80-3.57]***	0.90 [0.86-0.95]***	T: 1 - 5 - 11 - 21 - 102 N: 349 [30] - 970 [30] - 1 839 [31] - 5 423 [32]	0.77 [0.55-1.09]	0.77 [0.55-1.08]	0.63 [0.45-0.88]**	0.0-6.8	0.86 [0.80-0.93]***
7	Diseases of the circulatory system	27 250 [131]	0.1-49.6	0.92 [0.74-1.14]	1.06 [0.91-1.22]	1.86 [1.40-2.46]***	0.98 [0.97-0.99]***	T: 3 - 16 - 28 - 58 - 496 N: 1 399 [32] - 2 613 [30] - 4 679 [31] - 18 368 [31]	0.90 [0.76-1.06]	0.88 [0.74-1.05]	0.84 [0.70-1.02]	0.5-9.0	0.92 [0.87-0.97]**
8	Diseases of the respiratory system	10 054 [131]	0.1-12.6	1.24 [1.01-1.52]*	1.19 [1.03-1.37]*	1.06 [0.84-1.34]	0.96 [0.93-1.00]*	T: 2 - 11 - 17 - 26 - 126 N: 883 [32] - 1 559 [30] - 2 470 [30] - 5 053 [32]	0.92 [0.77-1.10]	0.84 [0.70-1.00]	0.81 [0.68-0.97]*	0.0-7.0	0.91 [0.85-0.98]**
9	Diseases of the digestive system	5 987 [130]	0.1-10.1	0.92 [0.73-1.16]	1.16 [0.98-1.37]	1.72 [1.27-2.33]***	0.89 [0.84-0.94]***	T: 1 - 5 - 8 - 14 - 95 N: 296 [28] - 831 [32] - 1 290 [32] - 3 522 [29]	1.02 [0.76-1.37]	1.07 [0.81-1.43]	0.95 [0.71-1.26]	-0.3-6.7	0.92 [0.85-1.00]*
16	Injury and poisoning	7 839 [131]	0.1-15.6	1.29 [0.97-1.73]	1.23 [1.01-1.50]*	1.68 [1.16-2.43]**	0.99 [0.94-1.04]	T: 1 - 6 - 10 - 19 - 156 N: 418 [29] - 816 [31] - 1 525 [31] - 5 012 [31]	0.85 [0.65-1.13]	0.97 [0.74-1.26]	0.96 [0.73-1.26]	0.0-7.3	1.01 [0.93-1.09]

Note: Regressions control for age, sex, admission source, urgency, type of admission (medical or surgical), Elixhauser composite mortality risk score, socioeconomic status of the municipality, year and month of admission, site type (primary or secondary), hospital type (general or university) and annual activity volume using different specifications. Random effects for the intercept are modelled at the level of the hospital site. Aggregate diagnosis groups Endocrine, and metabolic diseases, and immunity disorders, diseases of the blood and blood-forming organs, mental illness, diseases of the nervous system and sense organs, diseases of genitourinary system and non-neoplastic breast conditions, and symptoms, ill-defined conditions influencing health status did not meet the threshold of 350 in-hospital deaths and are excluded from the analysis.
*Significance level: * = ≤ 0.05; ** = ≤ 0.01; *** = ≤0.001.*
Source: Minimal Hospital Data (MZG – RHM).

6.4.3.3 Unaccounted (and unwanted) inter-hospital site variability

Variability in in-hospital mortality can be partly explained by patient and hospital site characteristics. Moreover, multilevel logistic regression model allows to quantify inter-hospital site variability that is not accounted for by the hospital site characteristics included in the model, but taken up by the random effects specified at the hospital site level (see section 6.3.2.2). At the individual site level, we can assess whether the random effect is significantly associated with increased or reduced mortality risk.

Differences in the magnitude of the random effects, the variance partition coefficient (VPC), and the median odds ratio (MOR) between the patient model and the hospital model indicate how much of the variability between hospital sites can be explained by hospital site characteristics such as annual volume, region, hospital type, and site type. Additionally, the magnitude of the random effects, the VPC, and the MOR in the hospital model provide information on the remaining inter-hospital site variability not explained by the included hospital site characteristics.

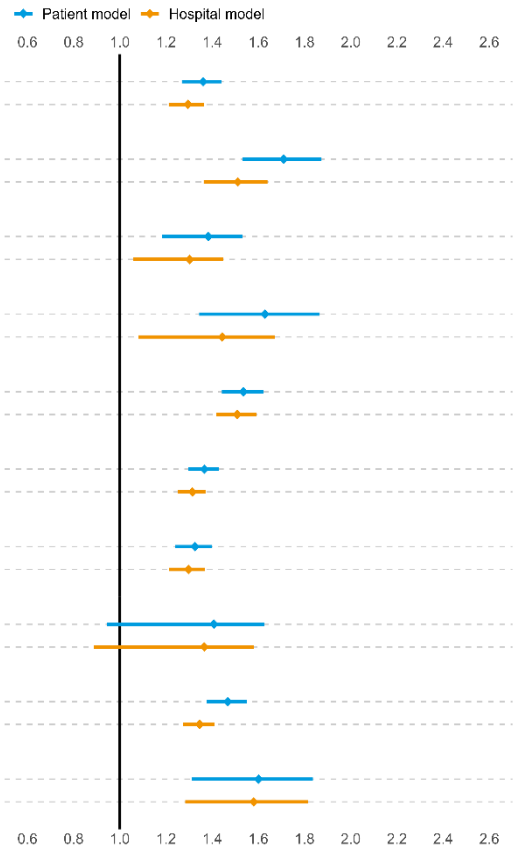
Table 33 shows that for one aggregate diagnosis group, the estimated random effect is not significant in either the patient or hospital model. A VPC above 5% is observed for four aggregate diagnosis groups in the patient model and three in the hospital model. A substantial reduction in VPC and MOR between both models is found for neoplasms, diseases of the nervous system and sense organs, and injury and poisoning, suggesting that hospital site characteristics account for a significant portion of inter-hospital site variability. However, for infectious and parasitic diseases (septicaemia), diseases of the circulatory, respiratory, digestive, and genitourinary systems, and ill-defined conditions, the reduction in VPC and MOR is small.

In the hospital model, the MOR for diseases of the circulatory system and neoplasms is approximately 1.5, meaning that, for two identical patients treated at randomly selected hospital sites, the median odds of dying are 50% higher in the higher-risk site. Similarly, the risk is about 30% higher for diseases of the respiratory and digestive systems or injury and poisoning. The effects for these five aggregate diagnosis groups are precisely estimated, and a substantial number of sites have a random effect significantly associated with increased or reduced mortality risk. Hence, for these aggregate diagnosis groups there is substantial and systematic unaccounted and unwanted variability that may point to potential quality and safety differences between sites, differences in admission policy, advanced care planning decisions or unmeasured case-mix differences in patient population.

Table 34 summarises inter-hospital site variation in the high-comorbidity sample. For four aggregate diagnosis groups, the random effect is substantially lower than in Table 33. Only for neoplasms is there a marked reduction in VPC and MOR when adding hospital site characteristics. For infectious and parasitic diseases (septicaemia), neoplasms, diseases of the circulatory system, and injury and poisoning, the MOR in the hospital model remains significant and above 1.3, meaning that the median odds of dying for otherwise identical patients are at least 30% higher in the higher-risk site. In these groups, a substantial number of hospital sites have a random effect significantly associated with increased or reduced mortality risk, again suggesting substantial and systematic unaccounted and potentially avoidable variability.

Table 33 – Hospital site level variation in in-hospital mortality by aggregate diagnosis group (all admissions, period 2016-2019)

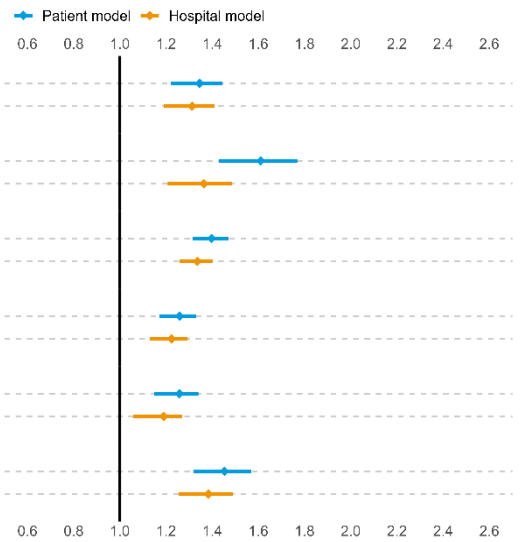
Aggregate diagnosis group		Model	Random effect – coefficient (standard error)	Significant mortality difference		Variance partition coefficient (VPC)	Median odds ratio (MOR)	Median odds ratio – confidence interval
No	Label			Lower	Higher			
1	Infectious and parasitic diseases	Patient	**0.104 (0.022)*** **	15	13	3.1%	1.36	
		Hospital	**0.073 (0.017)*** **	6	6	2.2%	1.30	
2	Neoplasms	Patient	**0.316 (0.060)*** **	9	17	8.8%	1.71	
		Hospital	**0.187 (0.042)*** **	3	9	5.4%	1.51	
3	Endocrine, nutritional and metabolic diseases, and immunity disorders	Patient	**0.116 (0.043)** **	0	1	3.4%	1.38	
		Hospital	**0.077 (0.037)***	0	0	2.3%	1.30	
6	Diseases of the nervous system and sense organs	Patient	**0.262 (0.085)** **	2	2	7.4%	1.63	
		Hospital	**0.148 (0.072)***	0	0	4.3%	1.44	
7	Diseases of the circulatory system	Patient	**0.202 (0.028)*** **	30	34	5.8%	1.54	
		Hospital	**0.185 (0.027)*** **	27	31	5.3%	1.51	
8	Diseases of the respiratory system	Patient	**0.107 (0.017)*** **	21	24	3.2%	1.37	
		Hospital	**0.082 (0.014)*** **	14	13	2.4%	1.31	
9	Diseases of the digestive system	Patient	**0.087 (0.019)*** **	4	11	2.6%	1.33	
		Hospital	**0.074 (0.017)*** **	3	5	2.2%	1.30	
10	Diseases of the genitourinary system and non-neoplastic breast conditions	Patient	0.128 (0.067)	0	0	3.8%	1.41	
		Hospital	0.107 (0.063)	0	0	3.1%	1.37	
16	Injury and poisoning	Patient	**0.162 (0.025)*** **	19	27	4.7%	1.47	
		Hospital	**0.097 (0.017)*** **	13	15	2.9%	1.35	
17	Symptoms; signs; and ill-defined conditions and factors influencing health status	Patient	**0.243 (0.083)** **	1	3	6.9%	1.60	
		Hospital	**0.230 (0.082)** **	1	1	6.5%	1.58	



*Significance level: * = ≤ 0.05; ** = ≤ 0.01; *** = ≤0.001. Aggregate diagnosis groups diseases of the blood and blood-forming organs and mental illness did not meet the threshold of 350 in-hospital deaths and are excluded from the analysis.*
Source: Minimal Hospital Data (MZG – RHM).

Table 34 – Hospital site level variation in in-hospital mortality by aggregate diagnosis group (high-comorbidity admissions, period 2016-2019)

Aggregate diagnosis group		Model	Random effect – coefficient (standard error)	Significant mortality difference		Variance partition coefficient (VPC)	Median odds ratio (MOR)	Median odds ratio – confidence interval
No	Label			Lower	Higher			
1	Infectious and parasitic diseases	Patient	**0.097 (0.027)*** **	6	4	2.9%	1.35	
		Hospital	**0.081 (0.024)*** **	3	2	2.4%	1.31	
2	Neoplasms	Patient	**0.249 (0.055)*** **	7	7	7.0%	1.61	
		Hospital	**0.106 (0.034)****	1	2	3.1%	1.36	
7	Diseases of the circulatory system	Patient	**0.123 (0.020)*** **	18	17	3.6%	1.40	
		Hospital	**0.092 (0.017)*** **	13	13	2.7%	1.34	
8	Diseases of the respiratory system	Patient	**0.058 (0.016)*** **	4	2	1.7%	1.26	
		Hospital	**0.045 (0.014)****	0	2	1.3%	1.22	
9	Diseases of the digestive system	Patient	**0.058 (0.019)****	1	1	1.7%	1.26	
		Hospital	**0.033 (0.015)***	0	1	1.0%	1.19	
16	Injury and poisoning	Patient	**0.153 (0.035)*** **	4	9	4.5%	1.45	
		Hospital	**0.116 (0.030)*** **	2	8	3.4%	1.38	



*Significance level: * = ≤ 0.05; ** = ≤ 0.01; *** = ≤0.001. Aggregate diagnosis groups Endocrine, and metabolic diseases, and immunity disorders, diseases of the blood and blood-forming organs, mental illness, diseases of the nervous system and sense organs, diseases of genitourinary system and non-neoplastic breast conditions, and symptoms, ill-defined conditions influencing health status did not meet the threshold of 350 in-hospital deaths and are excluded from the analysis.*
Source: Minimal Hospital Data (MZG – RHM)

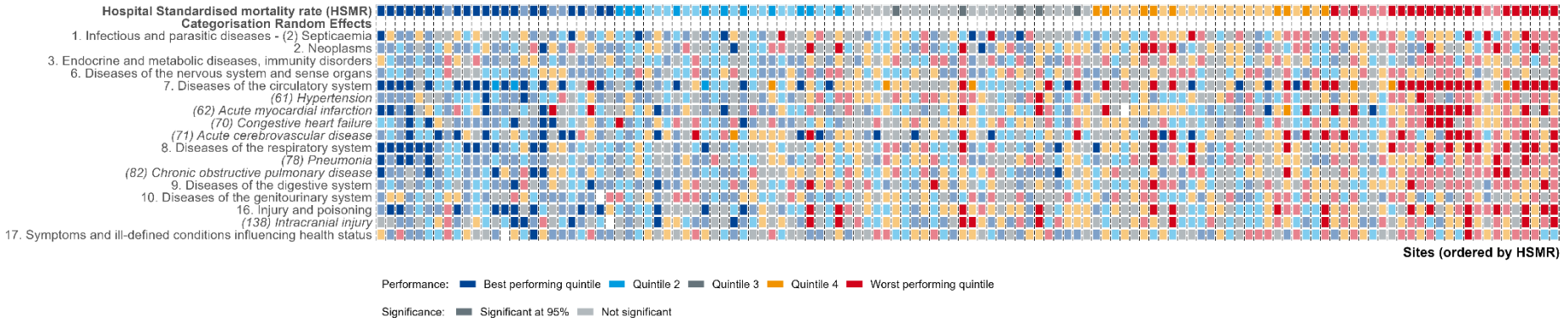
6.4.3.4 Correlation between random effects and HSMR

Figure 81 (all admissions) and Figure 82 (high-comorbidity admissions) are heatmaps that visualise hospital site performance for the HSMR over the 2018-2019 period (top row) and the random effects estimated in the multilevel logistic regression models for each aggregated diagnosis groups and a selection of high-volume diagnosis groups over the period 2016-2019. These heatmaps help, on the one hand, in identifying high- and low-performing hospital sites, i.e. intensive care services with consistently better or worse outcomes across different treatments, and, on the other hand, in assessing the correspondence between both methodological approaches.

To achieve this, the HSMR for the 2018-2019 period were categorised into quintiles, ranging from better/lower (in blue) to worse/higher (in red) than expected in-hospital mortality. Similarly, the random effects was categorised into quintiles going from better/lower (in blue) to worse/higher (in red) in-hospital mortality risk. Classification was conducted separately in the sample with all admissions (Figure 81) and in the sample restricted to high-comorbidity admissions (Figure 82). Each column represents a hospital site, while each row corresponds to an (aggregate) diagnosis group. Diagnosis groups are distinguished by having their label number in brackets, unlike aggregate diagnosis groups. Diagnosis groups are listed under their corresponding aggregate diagnosis group unless they fully overlap, in which case they share a row. In case hospital sites do not meet the analysis threshold for an (aggregate) diagnosis group, the square remains are uncoloured, and significant random effects ($p \leq 0.05$) are highlighted with brighter colours.

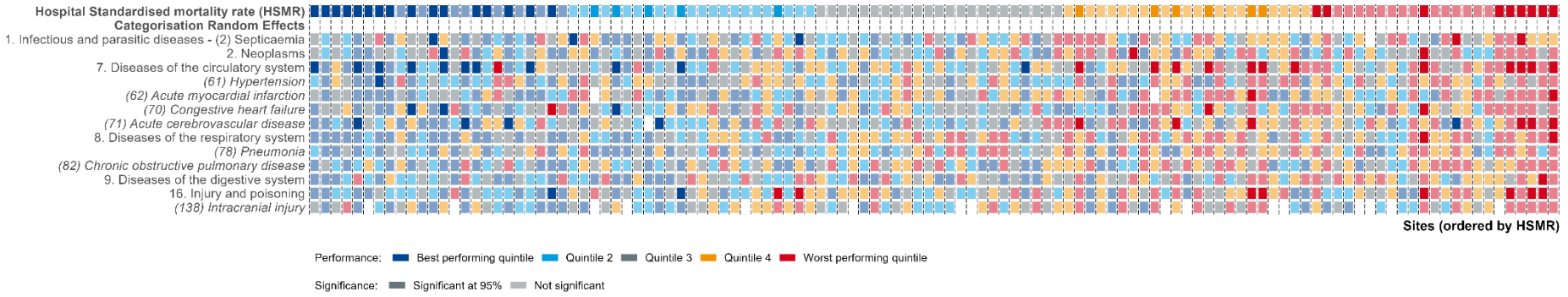
Overall, Figure 81 and Figure 82 show a high level of correspondence between the HSMR as an aggregate performance measure of in-hospital mortality and the categorisation of random effects of the hospital sites. In the heatmaps there is a clear delineation between high- and low-performing hospital sites, driven by performance across multiple diagnosis groups. Hospital sites in the lowest/highest HSMR quintile tend to have a consistently lower/higher mortality risk across (aggregate) diagnosis groups, whereas those with an average HSMR exhibit a mix of lower and higher mortality risk

Figure 81 – Heatmap showing association between HSMR (all admissions, period 2018-2019) and random effect of (aggregated) diagnosis groups by site (all admissions, period 2016-2019)



Source: Minimal Hospital Data (MZG – RHM).

Figure 82 – Heatmap showing association between HSMR (high-comorbidity admissions, period 2018-2019) and random effect of (aggregated) diagnosis groups by site (high-comorbidity admissions, period 2016-2019)



Source: Minimal Hospital Data (MZG – RHM).

7 ORGANISATION OF INTENSIVE AND INTERMEDIATE CARE IN BELGIAN HOSPITALS: RESULTS FROM AN ONLINE SURVEY

KEY POINTS

- A questionnaire was sent to all Belgian acute hospitals via the Chief Medical Officer and the Chief Nursing Officer. Among the 97 contacted hospitals, 80 completed the survey between February and June 2023, corresponding to a response rate of 82.5%.
- Respondents were asked to select intensive care units (ICUs) and intermediate care units (IMCUs) based on how their hospital functions on a day-to-day basis. ICUs include burn units and paediatric intensive care units. IMCUs are units that are set up to offer specialised treatment and close monitoring for those patients that do not require intensive care resources.

Intensive care units (ICUs)

- A total of 164 ICUs were identified in 99 different hospital sites, most of them being described as medical-surgical units. More than half of them are characterised by the respondent as general ICUs (ICUs managing patients with multiple organ dysfunctions) while a large number are defined as specialised ICUs (ICUs with complex management of organ dysfunctions requiring highly specialised techniques or populations of patients with specific or rare conditions).
- Most ICUs are led by a physician in chief specialised in either anaesthesia-resuscitation or internal medicine. At most hospital sites, one physician with a title in intensive care is always present in the ICU. The median number of licensed beds in an ICU is 10, primarily consisting of I-beds, C-beds, and D-beds. Invasive ventilation is possible in nearly all ICUs, often in all operational beds.
- In 59 ICUs, at least one bed was closed at the time of the survey, mainly due to a shortage of nursing staff. 115 ICUs reported at least one nurse absent during the survey, with a median absence rate of 7.3%. Most ICU nurses hold a special title in emergency and critical care with a higher proportion of such nurses in specialised ICUs compared to general ICUs.
- In most ICUs, regardless of the shift, the scheduled patient-to-nurse ratio (the number of available beds divided by the number of scheduled registered nurses providing direct patient care for a specific shift) ranges between 2 and 3 patients per nurse. For morning shifts, some ICUs have a patient-to-nurse ratio of less than 2, but always greater than 1. In all units except one outlier, the morning shift patient-to-nurse ratio is less than 4. Scheduled patient-to-nurse ratios tend to be higher for evening shifts and even higher for night shifts. When a 1:1 ratio is required, the number of patients per nurse is reduced mainly by closing some beds and/or increasing scheduled staff using a float pool specific to the ICU. Relying on nurses from other units is also common.
- Physiotherapists are available on a daily basis in almost all ICUs while psychologists and social workers are mostly available when needed. A large range of monitoring, diagnostic and therapeutic options is available in Belgian ICUs. The following is present in almost all ICUs: bed-side monitor (with ECG, pulse oximeter, blood pressure, etc.); invasive blood pressure measurement; blood gas analyser; blood gas analyser with lactate measurement; end tidal CO_2 monitoring; mechanical ventilation, non-invasive ventilation; high-flow oxygen therapy; percutaneous tracheostomy; bronchial fibroscopy (inside unit, performed by the attending physician); continuous veno-venous hemodiafiltration/hemofiltration; haemodialysis; and external cooling devices. Options that are not available everywhere tend to be more commonly available in specialised ICUs than in general ICUs.

Intermediate care units (IMCUs)

- A total of 91 IMCUs were designated by the participating hospitals. A large proportion of these units (35.2%) are stroke units, 24.2% are medical and/or surgical step-up and/or step-down units, 17.6% are Post-Anaesthesia Care Units (PACUs) and 16.5% are cardiac or coronary care units. Some units combine several of these categories. Except for PACUs, most IMCUs are organised as a dedicated part within a general hospital unit, sharing the same management. Twelve IMCUs are stand-alone units with their own management. The primary reason to set up an IMCU is the need for close patient monitoring or specific interventions that are not feasible in a general hospital unit.
- A large group of IMCUs (almost all PACUs but also other types of IMCUs) are led by a chief physician specialised in anaesthesia-resuscitation. Another large group of IMCUs (almost exclusively stroke units) are led by a neurologist. Most cardiac units or CCUs are led by a cardiologist, though this also occurs in other types of IMCUs. The median number of licensed beds in an IMCU is 6, primarily consisting of D-beds and C-beds.
- In 31 IMCUs, at least one nurse was absent at the time of the survey. The median proportion of nurse absences is 3.1%. The vast majority of nurses working in IMCUs do not hold a special title in emergency and critical care.
- Regardless of the shift, the scheduled patient-to-nurse ratio in most IMCUs ranges between 2 and 8 patients per nurse. For the morning shift of a typical weekday, the median scheduled number of patients per nurse is 4. Scheduled patient-to-nurse ratios appear to be larger for the evening shifts, compared to the morning shifts and even larger for the night shifts.
- Physiotherapists are available on a daily basis in 40.3% of the IMCUs, much less than for ICUs. Bed-side monitoring (with ECG, pulse oximeter, blood pressure, etc.) is available in almost all IMCUs but other monitoring, diagnostic and therapeutic options are less frequently available.

Organisation of intensive and intermediate care

- When asked about transfers, the largest group of hospitals classified themselves as neither a receiving hospital nor a referring one. However, an almost equally large group identified themselves as receiving hospitals, of which all university hospitals. Among general hospitals, however, only 25% define themselves as receiving hospitals. Patients are mainly referred because appropriate medical expertise is lacking.
- In several countries, intensive care is organised in levels. Although it is not formally the case in Belgium, using responses from the survey we can estimate that, based on the definition of the World Federation of Societies of Intensive and Critical Care Medicine, 21.8% of the hospitals provide level 3 ICU care (full spectrum of monitoring and life support technologies, serves as a regional resource for the care of critically ill patients, and may play an active role in developing the specialty of intensive care through research and education); 59.8% provide level 2 ICU care (invasive monitoring and basic life support for a short period) and 17.2% provide level 1 ICU care (capable of providing oxygen, non-invasive monitoring, and more intensive nursing care than on a ward). Respondents were asked whether they supported a reform of intensive care that formally introduces levels of care. Opinions on this matter are mixed. However, if the intensive care landscape in Belgium is reformed, 79.5% of respondents are in favour of including intermediate care units in the care offer.
- A third of hospitals considers extending their intermediate care capacity in the future, mainly with step-down units, linked to the ICU. Reasons include the use of IMCU as buffer capacity within the ICU, the use of IMCU to allow safer staffing levels compared to general hospital units and the use of IMCU to allow earlier discharge from the ICU. A large group of respondents stated they did not consider to open (additional) IMCUs or beds in the future. For most of them it is preferable to include intermediate care patients within the ICU. Also, for a large group of respondents there is not enough staff available to organise intermediate care.

- Most hospitals scaled up IMCUs during the COVID-19 pandemic. They would also do so in the future if needed, using various strategies including mixing the nursing teams of the IMCUs with ICU teams to scale up overall ICU expertise. According to 9 out of 10 respondents, the lack of nursing staff is a barrier to scale up intermediate care units in case of a future pandemic.

7.1 Objective

A survey was carried out to gain insight into the current organisation of intensive care and intermediate care services (if present) in Belgium. All Belgian acute hospitals were invited to participate.

7.2 Methods

7.2.1 Data collection process

An online survey was conducted, using Qualtrics, which is a web-based survey software tool for the creation and administration of online surveys. The Chief Medical Officer (CMO) and Chief Nursing Officer (CNO) of all 97 Belgian acute hospitals[t] were contacted by e-mail and were invited to participate in the online survey. Each hospital (via the CMO and CNO) received a unique survey link in the invitation e-mail. The CMO and CNO were encouraged to forward the e-mail with the unique link to relevant staff members, such as the medical or nursing head of intensive care services. Although only one questionnaire could be completed per hospital, multiple people within the hospital could access and complete the survey via the unique link. Responses were saved as respondents advanced through the survey facilitating completion by several people. The profile of respondents of each hospital was not asked.

The invitations were sent on 13 February 2023 and the deadline was set at 6 March 2023. In total, 51 hospitals were contacted in Dutch[u] and 46 in French[v]. A reminder was sent on 1 March 2023 to the hospitals that had not yet responded, and the deadline was extended to 13 March 2023. In order to increase the response rate (that was lower than 60%), all hospitals that had not yet started to complete the survey on 13 March 2023, were contacted by phone. A special effort was made to encourage the university hospitals to participate, because in these hospitals the response rate was only 1/7. A second extension was granted and the online survey was open until 6 June 2023.

Although the name and license number of the hospital and the hospital site were asked in the survey, it was guaranteed that this information would only be made available to the KCE research team, that responses would be treated confidentially, and that it would not be possible to link published responses to a specific hospital (site).

7.2.2 Data collection tool

7.2.2.1 Questionnaire development

The questionnaire was developed and distributed both in Dutch and French. The usefulness and the formulation of each question were discussed within the research team and tested with KCE researchers not involved in the study. An online pilot version of the survey was sent to four hospitals (a university and a non-university hospitals in Flanders, a non-university hospital in Wallonia and an

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[t] One hospital has two different licence numbers but the same CMO and CNO; these two institutions were considered as one hospital. Also, two hospitals (with two different licence numbers) have a common ICU; these two institutions were considered as one hospital.

[u] No e-mail was sent to one hospital in Flanders because it had completed a pilot version of the questionnaire (see section 7.2.2.1).

[v] Two e-mails were initially sent to the two hospitals with a common ICU.

university hospital in Brussels) in January 2023. Comments and suggestions from the pilot respondents were taken into account to develop the final version of the survey that was sent on 13 February 2023 after it was tested for technical aspects by the members of the research team. One pilot hospital in Flanders not only gave comments, but also completed all questions. Therefore, only the questions that changed or were added were sent again to this hospital.

7.2.2.2 Structure of the questionnaire

The complete set of questions asked in the online survey is available upon request. Questions were asked at three levels: the hospital level, the hospital site level and the intensive care unit (ICU) or intermediate care unit (IMCU) level. In addition to identification questions, three main types of questions were asked: quantitative questions regarding data that cannot be retrieved from administrative databases (number of operational beds, number of medical specialists or other staff at the ICU or IMCU level, etc.); multiple choice questions on the organisation or financing of intensive and intermediate care; and a (limited) number of open questions where respondents were encouraged to describe elements in their own words.

The questionnaire was composed of 10 main parts:

1. **General information**: respondents were asked to select the hospital site(s) with an ICU and/or IMCU and to select intensive care units based on how their hospital functions on a day-to-day basis (i.e. self-selection). A working definition of an ICU was provided: '*Next to units that are labelled (or known) as ICUs in the hospital also burn units and paediatric intensive care units are included. Units that were upscaled to an ICU during the COVID-19 pandemic and which are at the moment of the survey still used as an ICU are also included. However, neonatal intensive care units (NICU) and maternal intensive care units were excluded.'* For each ICU the name as used in the hospital was asked, as well as the name in the MZG – RHM (Minimal Hospital Data) in order to be able to link the survey results to administrative data.
2. **Organisation and structure of intensive care units**: number of licensed, operational and closed beds per ICU; main reason for closing beds; main specialty area of ICU; number of isolation rooms per ICU.
3. **Organisation and structure of intermediate care units**: respondents had to identify all the units in their hospital that meet the following definition:[3, 104] '*Intermediate care units are units that are set up to offer specialised treatment and close monitoring for those patients that do not require intensive care resources. The condition of patients targeted by these units are, in general, characterised by a moderate or potentially severe instability of physiological parameters that require equipment-based monitoring and organ support, but do not require organ replacement. These units can be considered as a level of care between a general hospitalisation unit and the intensive care unit (ICU). 'Intermediate Care Unit' is used as an umbrella term for various labels or names such as: Coronary Care Unit/Chest Pain Unit; High Dependency Care Unit; Intermediate Care Unit; Post-Anaesthesia Care Unit (units attached to operating theatres where patients are temporarily admitted after surgery to recover from anaesthesia); Step-Down Unit (to enable to discharge ICU-patients to a unit with a higher level of care than a general hospital unit) or Step-Up units (to provide a level of care that is higher than a general hospital unit) but lower than an ICU. It can function as a physically independent unit or as a dedicated section (incorporated within or adjacent to the ICU or a general hospitalisation unit).'* In addition '*the units with the abovementioned labels are only considered as intermediate care units if they are effectively used as an intermediate care unit.'* For each identified IMCU, respondents were asked the following information: name of the IMCU used in the hospital and in the MZG-RHM; type of IMCU (for example, PACU (Post-Anaesthesia Care Unit), medical-surgical step up, medical-surgical step down, coronary care unit, neurosurgery unit or stroke unit); architectural organisation (for example, separate ward adjacent to the ICU (own management/head nurse)); number of licensed, operational and closed beds per IMCU; main reason for closing beds; main reasons for setting up an IMCU; funding sources; unplanned readmissions to an ICU.

4. **Medical staff**: main medical specialism of ICU or IMCU physician in chief; number of physicians connected to the ICU (headcount and FTE; per hospital site); number of physicians available during the night/weekend/bank holidays (with or without a special title in intensive care; per hospital site); staffing model of IMCU (for example, role of intensive care specialist); presence or not of a formal training programme in intensive care in the hospital.
5. **Nursing and caring staff**: staff numbers by category (headcount and FTE; per ICU or IMCU); staff absence; staff planning (number of people for the available number of beds, including the float pool), for a typical weekday/weekend day/bank holiday, by staff category and shift type (per ICU or IMCU); indications for which a planning of 1 patient per nurse in used (per ICU); indications for which a 1:1 ratio is required but not applied (per ICU); availability of other staff (per ICU or IMCU).
6. **Availability of monitoring and diagnostic options**: monitoring and diagnostic services (e.g. bed-side monitor, invasive blood pressure measurement) that are available in each ICU or IMCU; frequency of use.
7. **Availability of therapeutic options**: therapeutic services (e.g. mechanical ventilation, non-invasive ventilation) that are available in each ICU or IMCU; frequency of use; number of patients requiring invasive ventilation who can be treated at the same time.
8. **Interconnection with other services**: diagnostic and therapeutic services (e.g. cardiac surgery) that are available at the hospital or network level; transfers of ICU-patients; number of transport ventilators.
9. **Hospital collaborations**: existing collaboration initiatives for intensive care (e.g. joint investment in equipment); telemedical network.
10. **Future priorities**: attitudes towards IMCUs as part of the care offer; intention to open (additional) IMCUs; attitudes towards organisation of intensive care in levels; current level of intensive care; IMCUs open during the COVID-19 pandemic; strategies to scale up in case of a future pandemic; barriers to scale up; policy measures to be taken in the future during a crisis such as the COVID-19 crisis.

7.2.3 Analysis

Responses to each closed question (single or multiple choice) were first analysed separately. As no question was mandatory, the number of responding hospitals may be different for different questions or even for different items within the same question. Also, as questions were asked at different levels (hospital level, hospital site level and the unit – ICU or IMCU – level), percentages are calculated with respect to the number of responses for each particular question (*N*) which is specified in the figures and tables. In addition, the number of missing values is specified.

In addition to the univariate analysis, a complementary analysis was carried out to explore the link between responses and some characteristics of the responding hospitals. The following characteristics were taken into account:

- the region of the hospital;
- the type of hospital (university or not);
- the total number of licensed beds in September 2022, in four categories (less than 200, 200-299, 300-449, 450 and more).

Data regarding these characteristics were provided by the Federal Public Service (FPS) Public Health.

The link between responses and some characteristics of the hospital, hospital site or unit (e.g. number of beds) identified in the survey itself was also explored.

The full-text answers to the open questions were analysed by two researchers. Based on a thorough reading of all answers, a summary of the major themes was made by the first researchers and critically reviewed by the second researcher.

7.2.4 Limitations of the survey

The information retrieved from the questionnaire can only be partial. In addition, no question in the survey required a mandatory answer, so that the number of responses and the number of missing values vary for different questions. For some specific questions, the number of missing values is not negligible.

To increase the response rate, the online survey was open during several months. However, certain time-varying information was asked for *at the time of survey* (number of operational beds, number of closed beds, number of staff members, absences of staff members, etc.) so that differences in results could emerge between hospitals that completed the questionnaire at different moments. Also, results are placed in the context of the Belgian hospital landscape, using administrative data (total number of licensed beds) from September 2022. Small inconsistencies may appear due to the differences in the time period.

The formulation of the survey questions was carefully tested, but it cannot be ruled out that certain response categories may be interpreted differently by respondents, leading to unclear data. In particular, two interpretations were identified for the notion of 'specialised ICU'. In addition, questions were asked at different levels (at the unit level, the hospital site level, or the hospital level). We identified several responses that did not correspond to the required level (for instance, the number of licensed beds was given at the hospital site level instead of at the unit level). When possible, a correction was made.

Finally, no information is available on the identity of the respondent(s). As multiple persons within the hospital could access and complete the survey via the unique link, it is unclear what the profile of respondents was. The reason was that different persons within the organisation may have different pieces of information (e.g. the number of licenced beds vs the number of scheduled staff members). Since most of the required data are factual, the responses should not be influenced by the identity of the respondent. However, the last part of the questionnaire concerns opinions and future priorities at the hospital level, that can be assessed differently by one person or another.

7.3 Results

Disclaimer. The results and figures presented in this chapter are derived from the responses to the online survey. These data have not been cross-verified with administrative data or other sources for accuracy. Additionally, any statements lacking references to research reports or data sources reflect the opinions of the respondents alone.

7.3.1 Response rate

Among the 97 contacted hospitals, 80 completed the survey. Most of them completed the online survey, but five sent their answers in a separate document enclosed to an e-mail. The latter included one hospital that participated in the pilot phase and for which only missing information with respect to the pilot responses was asked. In that case, the answers were manually encoded.

This process provides us with exploitable responses for 80 hospitals (52 from Flanders, 29 from Wallonia and 9 from Brussels), corresponding to a response rate of 82.5%. Table 35 shows descriptive statistics for the hospitals that participated and the entire group of contacted hospitals.

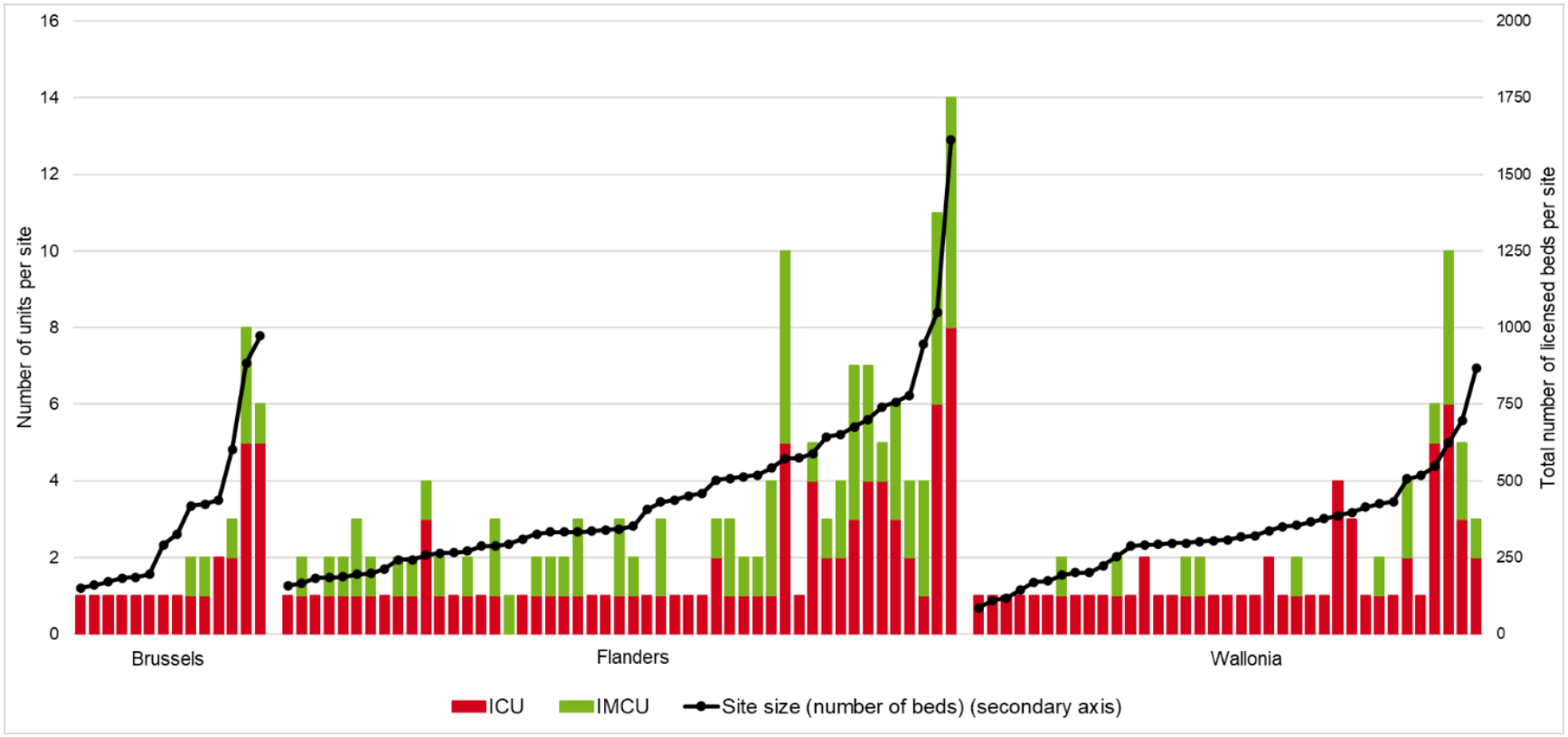
Table 35 – Response rate by region, hospital type and size

	Survey responses	Contacted hospitals	Response rate (%)
Region			
Brussels	9	11	81.8%
Flanders	42	51	82.4%
Wallonia	29	35	82.9%
Type			
University	6	7	85.7%
University-like	14	16	87.5%
General	60	74	81.1%
Number of beds			
<200 licensed beds	5	8	62.5%
200-299 licensed beds	12	19	63.2%
300-449 licensed beds	23	27	85.2%
450+ licensed beds	40	43	93.0%

Number of licensed beds refers to the total number of licensed beds in the hospital in September 2022 (data FOD – SPF).

Respondents were asked to identify all ICUs and IMCUs, following working definitions provided in sections 7.3.2 and 7.3.3. A total of 255 units (164 ICUs and 91 IMCUs) were identified, in 100 different hospital sites (see Figure 83). Note that one respondent only registered an IMCU and no ICU. Therefore, the number of respondents (hospitals) with an ICU is 79 and the number of hospital sites with an ICU in the survey is 99. This corresponds to 73.9% of hospital sites with C- and/or D-beds in Belgium in September 2022 (data FOD-SPF).

Figure 83 – Units identified in the survey, per hospital site



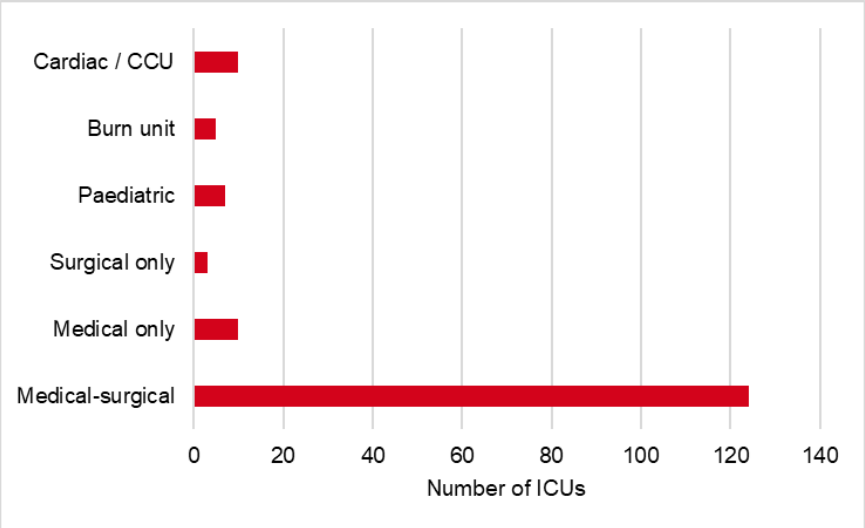
Hospital sites are ordered by region and by total number of licensed beds in the hospital site in September 2022 (data FOD-SPF) showed by the black dots.

7.3.2 Intensive care units

A LANDSCAPE OF MEDICAL-SURGICAL ICUs, WITH MANY GENERAL AND SPECIALISED UNITS

A total of 164 ICUs were identified in 99 different hospital sites. Figure 84 shows the type of ICU as described by the respondents. Most of them (78.0%) were described as medical-surgical units.

Figure 84 – Types of ICUs



N = 159; missing = 5. CCU = coronary care unit. Four units were described as 'other' by the respondents but requalified as 'medical-surgical' based on the description given by the respondent, one unit was described as 'other' by the respondent but requalified as 'medical only' based on the description given by the respondent. The initial category 'cardiac post-surgery' was extended to CCU and includes four units described as 'other' by the respondents but requalified as 'Cardiac / CCU' based on the description given by the respondent.

Seven units were described as paediatric units. For six of them, the respondent reported that only children are admitted in the unit while for one unit children are regularly admitted. Regarding units that are not described as paediatric units, half of them (53.9%) never admit children and 38.8% occasionally admit children. Only 6.6% of them regularly admit children (for more details see Appendix to Chapter 7 in the Supplement).

Respondents were also asked to assess to which level the ICU belongs. Although the definition of levels of care differs between countries (see Chapter 9), a 'general ICU' was defined as an '*ICU managing patients with multiple organ dysfunctions'* and a 'specialised ICU' as an *'ICU with complex management of organ dysfunctions requiring highly specialised techniques or populations of patients with specific or rare conditions'*. Among the 161 ICUs for which a response was provided, 86 (53.4%) were designated as general ICU, 72 (44.7%) as specialised ICU, and three units were designated as IMCUs (for more details see Appendix to Chapter 7 in the Supplement). The ICU landscape seems therefore to be composed by a large proportion of specialised units alongside general units. However, it should be kept in mind that 'specialised ICU' may have been interpreted as an ICU that is specific to a given organ (e.g. cardiac ICU). It that case, specialised ICUs do not necessarily provide highly specialised care.

TRAINING PROGRAMME IN INTENSIVE CARE

Around half of the responding hospitals (54.7%) reported having a formal training programme in intensive care, that is with an official internship supervisor (see Table 36). All university hospitals have such a programme.

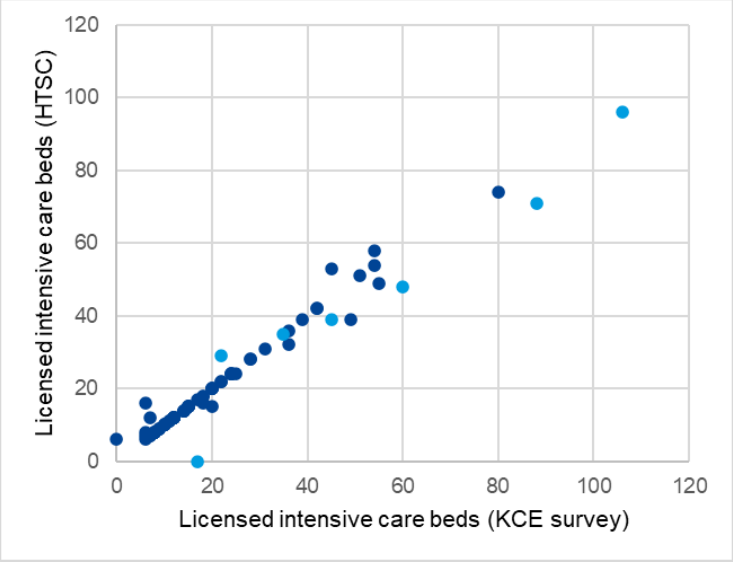
Table 36 – Formal training programme in intensive care

	Hospitals with formal training programme in intensive care		N	Missing
	Number	Percentage		
All hospitals	41	54.7%	75	5
Brussels	7	77.8%	9	0
Flanders	17	41.5%	41	1
Wallonia	8	68.0%	25	4
University hospitals	5	100.0%	5	1

LICENSED BEDS ATTRIBUTED TO THE FUNCTION INTENSIVE CARE

Intensive care beds are not licensed as such. Instead, the function intensive care is licensed, and a number of beds (for instance licensed C-beds) is attributed to the function (see Chapter 2). These beds are further referred to as 'licensed intensive care beds'. In Figure 85 a comparison is made between the number of licensed intensive care beds declared in the survey and data used by the Hospital and Transport Surge Capacity (HTSC) Committee (data September 2022). The latter were provided, per hospital, by the federated entities in the context of the COVID-19 crisis. As paediatric beds are excluded in the HTSC data but included in the survey responses, the seven hospitals that reported a paediatric intensive care unit in the survey (see above) are identified in light blue. For the other hospitals, there is a strong correlation between the number of licensed intensive care beds reported in the survey and the data used by the HTSC Committee. Only for 13 hospitals, the number of licensed intensive care beds differs between both sources.

Figure 85 – Number of licensed intensive care beds per hospital, comparison with official data

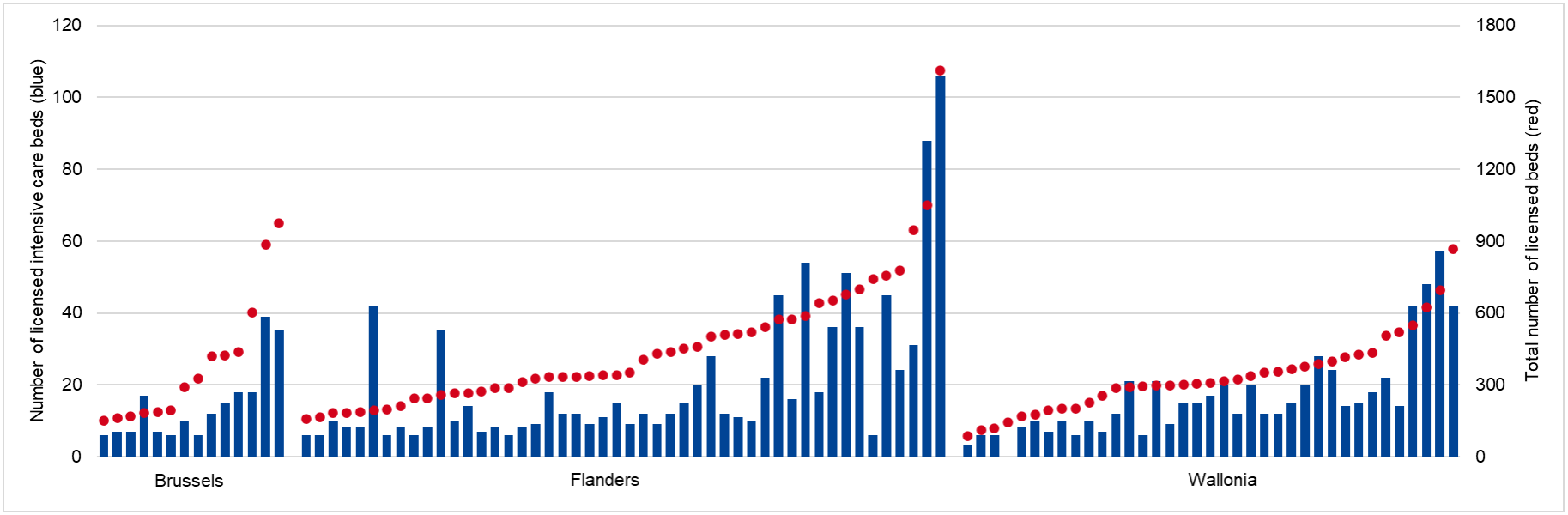


N = 81, missing = 0. Each dot represents a hospital (licence number). Hospitals that were grouped in the survey are presented separately. HTSC = Hospital and Transport Surge Capacity.

LARGER HOSPITAL SITES TEND TO HAVE MORE LICENSED INTENSIVE CARE BEDS

Figure 86 shows the number of licensed intensive care beds per hospital site from the survey responses. The responding hospital sites are ordered for each region according to their number of licensed beds (all types) in September 2022 (depicted in red). Larger hospitals sites (in terms of total number of licensed beds) tend to have a larger number of licensed intensive care beds, but there are many exceptions in the three regions.

Figure 86 – Number of licensed intensive care beds, per hospital site



N = 99, missing = 0. Total number of licensed beds refers to the number of licensed beds in the hospital site in September 2022 (data FOD – SPF) and are shown by the red dots.

Licensed intensive care beds can be set up outside the ICU, for instance in the emergency department. However, in 96 hospital sites (98.0% – N = 98, missing = 1), no licensed intensive care beds are set up outside the intensive care unit. Only two hospital sites mentioned that licensed intensive care beds are set up outside the ICU.

A THIRD OF ICUs HAVE AT LEAST ONE I-BED

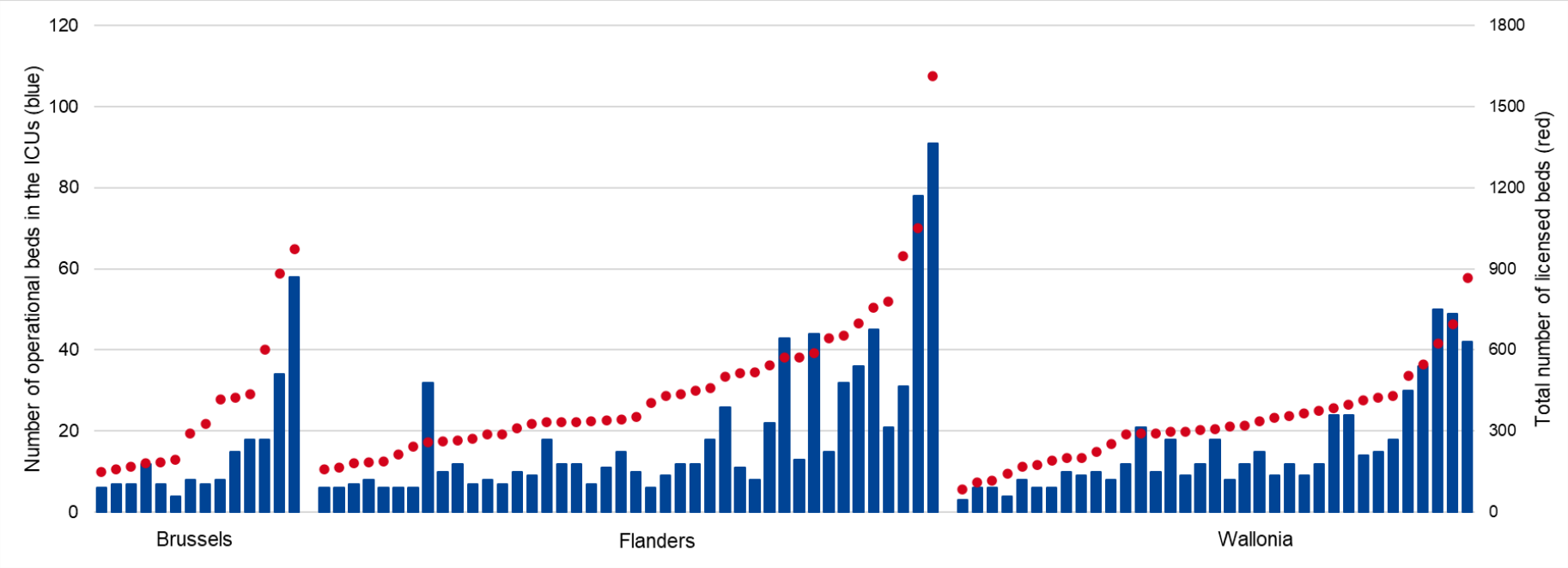
In addition to the number of licensed intensive care beds at the hospital site level, respondents were also asked to provide the number and type of licensed beds, per ICU. Due to recording errors and missing values, the responses regarding the number of beds are only exploitable for 137 ICUs (missing = 27) and those regarding the type of beds for 123 ICUs (missing = 41). The median number of licensed beds in an ICU is 10 (IQR = 6).

Respondents had to provide the number of beds in the unit for seven types of licensed beds: C-beds (surgery), D-beds (medical), CD-beds (medical-surgical), E-beds (paediatrics), G-beds (geriatrics), M-beds (maternity) and L-beds (contagious diseases). Intensive care beds are not licensed as such but are C-, D-, CD- or E-beds that make part of the intensive care function (see Chapters 2 and 3). These beds (called CI-, DI-, HI-, and EI-beds respectively) are grouped in an I-beds category. A third of the ICUs (43 units – 35.0%) include at least one such I-bed. The same proportion (43 units – 35.0%) includes at least one C-bed. Other common bed types are D-beds (39 units – 31.7%) and CD-beds (23 units – 18.7%). Seven units reported at least one E-bed. G-beds, M-beds and L-beds were suggested in the survey, but not selected by the respondents.

LARGE CORRESPONDENCE BETWEEN THE NUMBER OF LICENSED AND OPERATIONAL BEDS

Operational beds are the hospital beds that can actually be used in the hospital service. This number does not necessarily correspond to the number of licensed beds. Therefore, hospitals were asked to provide the number of beds that are effectively deployable (with the necessary staff) in the ICUs. The median number of operational beds in an ICU is 9 (IQR = 5, N = 161, missing = 3). Figure 87 shows the number of operational beds in ICUs, aggregated per hospital site. The responding hospital sites are ordered for each region according to their number of licensed beds (all types) in September 2022 (depicted in red). Larger hospitals (in terms of total number of licensed beds) tend to have more operational ICU beds, but there are exceptions.

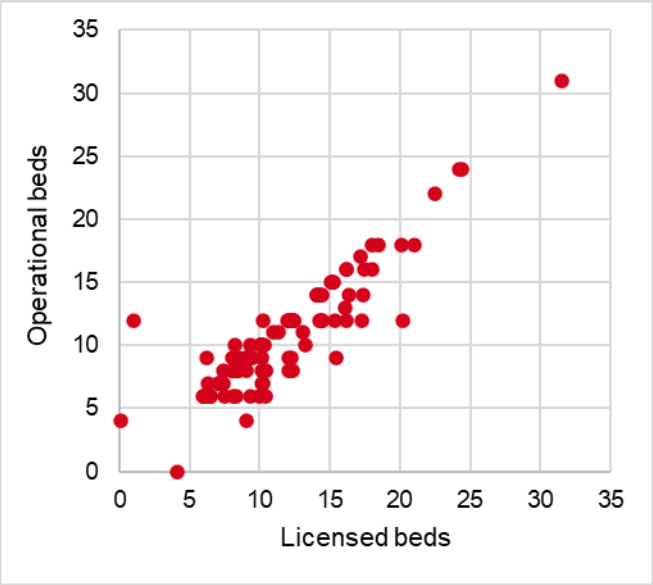
Figure 87 – Number of operational beds in the ICUs, per hospital site



N = 91, missing = 8. Total number of licensed beds refers to the number of licensed beds in the hospital site in September 2022 (data FOD – SPF) and are shown by the red dots.

There is a strong correlation between the number of operational beds and the number of licensed beds, as depicted by Figure 88, at the ICU level. Due to registration errors for the number of licensed beds and some missing values, the correlation can only be shown for 137 ICUs (missing = 27). The number of operational beds is exactly equal to the number of licensed beds in 89 ICUs (65.0%). In 38 ICUs (27.7%) the number of operational beds is smaller than the number of licensed beds and in 10 ICUs (7.3%) it is larger.

Figure 88 – Number of licensed and operational beds per ICU



N = 137, missing = 27.

In 59 ICUs (36.6% – N = 161, missing = 3), at least one bed was closed at the time of the survey. On average 1.4 beds were closed per ICU (minimum = 0, maximum = 12). Among the respondents who selected a reason for closing beds (N= 36), a large majority (75.0%) pointed at a shortage of nursing staff. For six respondents (16.7%) too few patients requiring this level of care were admitted to the hospital. Other reasons (four respondents) include a shortage of medical staff and infrastructure issues.

At the time of the survey, most of the ICUs (91.8 %) did not have any surge beds (intensive care beds that were created during the COVID-19 pandemic) that were still operational (N=158; missing=6).

INVASIVE VENTILATION IS AVAILABLE IN THE MAJORITY OF BEDS

In almost all ICUs, invasive ventilation is available: all but three units (98.1%) reported at least one operational bed with invasive ventilation and a large majority of the units (85.4%) stated that ventilation is available in all operational beds (N = 158, missing = 6). Among the ICUs without invasive ventilation, two units are self-defined by the respondent as intermediate care units, the other one is a coronary unit.

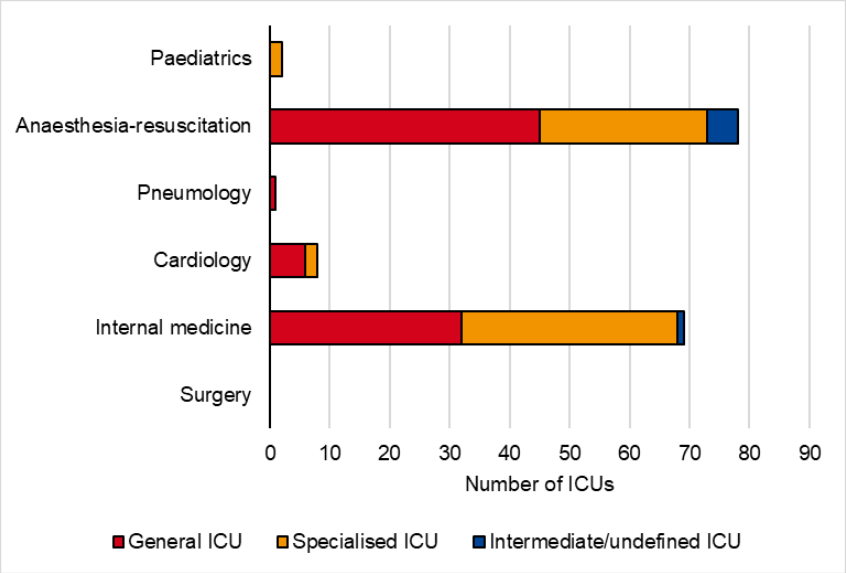
In many ICUs, the number of patients requiring invasive ventilation who can be treated at the same time, given the available staff and equipment, is equal or close to the number of operational beds in the unit. However, there are exceptions: in 28.5% of the ICUs the number of patients requiring invasive ventilation who can be treated at the same time is smaller – in general by one or two but sometimes more – than the number of operational beds (more details are available in Appendix to Chapter 7 in the Supplement).

Most ICUs (97.4%) have at least one isolation room, the median number of isolation rooms being 6 (IQR = 6 – N = 156, missing = 8). Also, a large proportion of units (86.5%) have at least one isolation room which has an anteroom (median = 2, IQR = 2.5 – N = 155, missing = 9) and 62.7% have at least one isolation room which has air pressure regulation (median = 2, IQR = 4 – N = 153, missing = 11).

INTENSIVE CARE UNITS ARE LED BY PHYSICIANS SPECIALISED IN ANAESTHESIA-RESUSCITATION OR IN INTERNAL MEDICINE

For each ICU, respondents were asked to select the main medical specialism of the physician in chief. They could select the medical specialism only once at the hospital site level, if they reported the same physician-in-chief for all ICUs at that site. As shown in Figure 89, most ICUs are led by a physician in chief who is either specialised in anaesthesia-resuscitation (*arts-specialist in de anesthesie-reanimatie / médecin spécialiste en anesthésie-réanimation* – 49.4%) or in internal medicine (43.7%). On the figure, a distinction is made between ICUs that are self-defined by the respondent as general, specialised or intermediate (or undefined if no definition was selected). General ICUs tend to be slightly more led by physicians in chief specialised in anaesthesia-resuscitation, while physicians in chief specialised in internal medicine are slightly more present in specialised ICUs .

Figure 89 – Main medical specialism of the ICU physician in chief

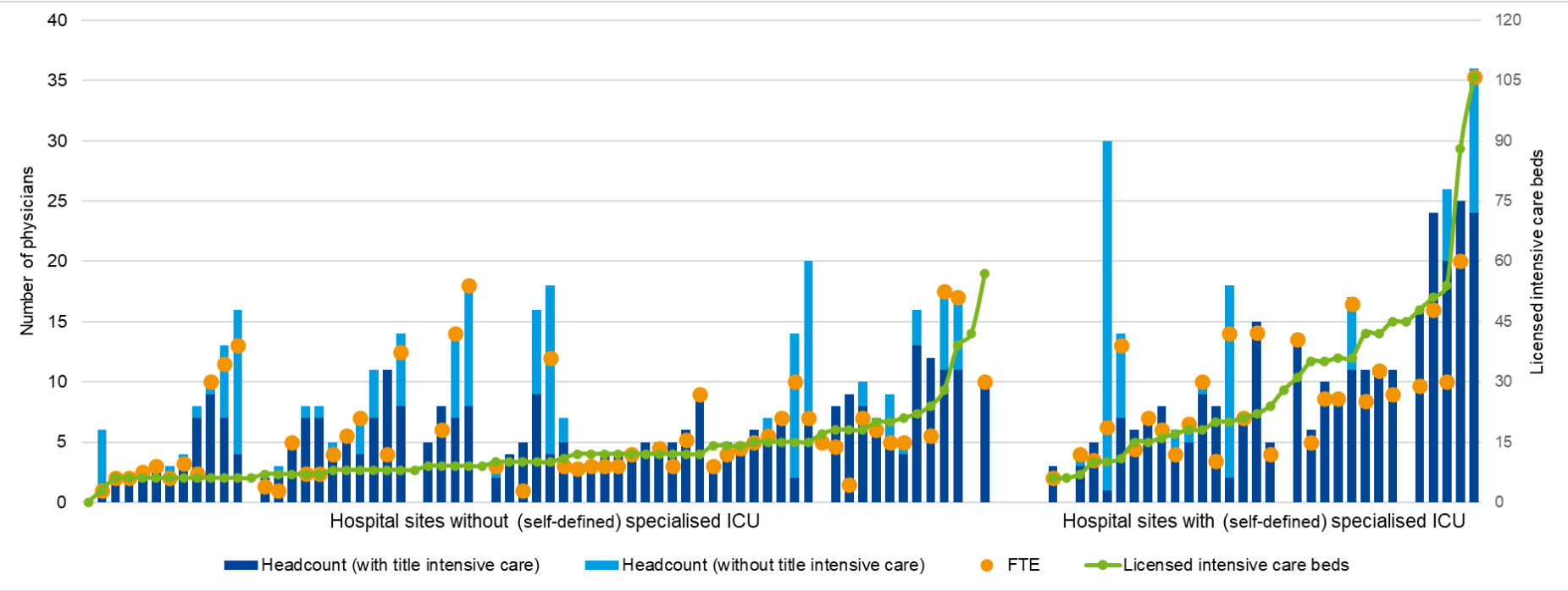


N = 158, missing = 6.

MEDICAL STAFF OF INTENSIVE CARE UNITS, IN HEADCOUNTS AND FTEs

Figure 90 presents the number of physicians (excluding physicians in training) attached to the ICU, in headcounts and FTEs, per hospital site. For headcounts, a distinction is made between physicians who have a professional title in intensive care and those who have not. Hospital sites without (self-defined) specialised ICU(s) are shown on the left and sites with (self-defined) specialised ICU(s) on the right. In each case, hospital sites are ordered by the number of licensed intensive care beds, then by the number of physicians (headcounts). Gaps are missing data. Although in many cases larger intensive care services (in terms of licensed beds) tend to deploy more physicians, it is far from systematic, even when considering only FTEs.

Figure 90 – Medical staff attached to the ICU in headcounts and FTEs, per hospital site



Headcounts: N=90, missing=9; FTEs: N=85; missing=14. Green dots show the number of licensed intensive care beds per site (right axis).

In many cases, the number of physicians is almost similar when measured in headcounts and in FTEs, meaning that most physicians attached to the ICU work full time. In a few hospital sites, however, the number of FTEs is substantially lower than the number of headcounts. In most hospital sites with (self-defined) specialised ICU, all physicians attached to the ICU have a professional title in intensive care. In two cases, however, only a minority of physicians attached to the ICU have such a title. There is also a large group of hospital sites without (self-defined) specialised ICU where all physicians attached to the ICU have a professional title in intensive care. Nevertheless, the presence of physicians without a professional title in intensive care is more common in hospital sites without specialised ICU.

MEDICAL STAFF PRESENCE IN THE INTENSIVE CARE UNIT

In most hospital sites, one physician with a title in intensive care is present in the ICU at night during weekdays, at night during the weekend, and during the day on a weekend or on a bank holiday (see the left columns of Table 37). During nights, a maximum of three physicians with a title in intensive care are present in the ICU, and this only occurs in two hospital sites. The maximum number during the day on a weekend or on a bank holiday is four, and is only observed in three hospital sites. The number of physicians with a title in intensive care who are present in the ICU tend to be larger in hospital sites with a (self-defined) specialised ICU than in hospital sites without such an ICU. For instance, in 31.0% of the hospital sites with a (self-defined) specialised ICU, two physicians with a title in intensive care are present during the day on a weekend or on a bank holiday.

In the majority of hospital sites, two to three physicians with a title in intensive care are available (present or on call) during weekdays, at night during the weekend, and during the day on a weekend or on a bank holiday (see the right columns of Table 37).

Table 37 – Presence in the ICU and on-call availability of physicians with a title in intensive care

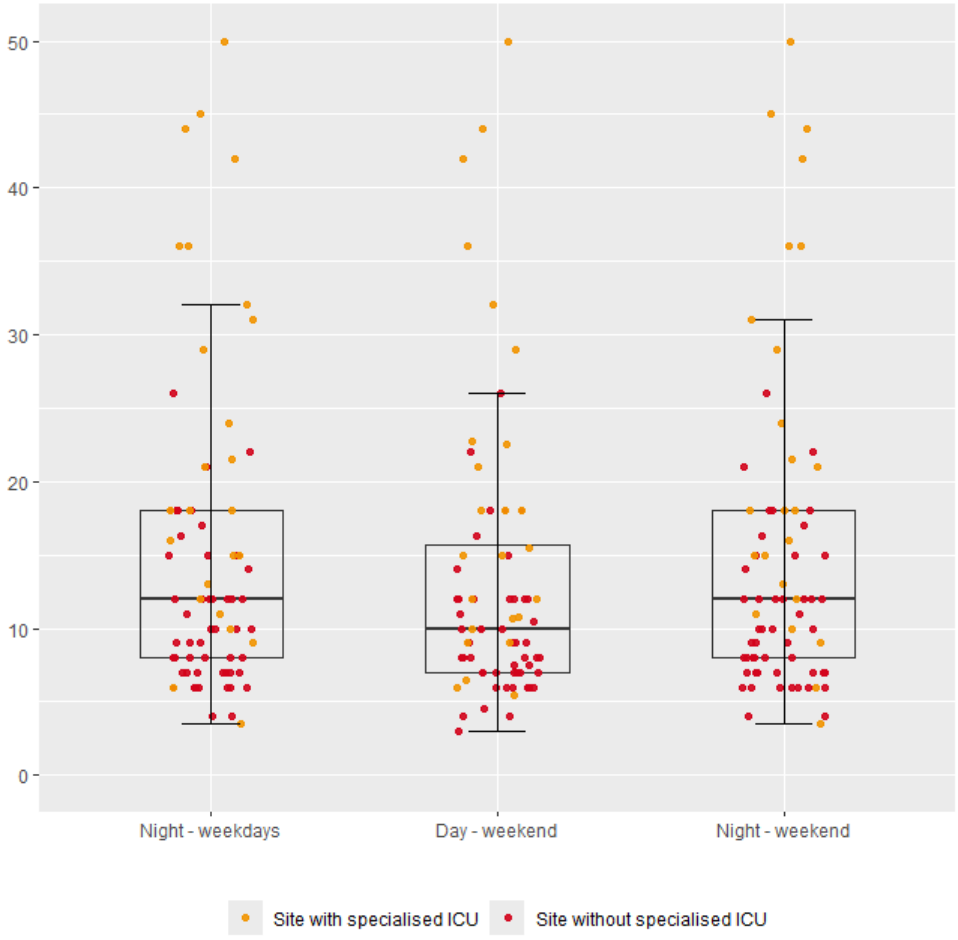
	Physicians with a title in intensive care present 24/7 in hospital						Physicians with a title in intensive care 24/7 present or available on call					
	All hospital sites		Hospital sites without (self-defined) specialised ICU		Hospital sites with (self-defined) specialised ICU		All hospital sites		Hospital sites without (self-defined) specialised ICU		Hospital sites with (self-defined) specialised ICU	
	At night during weekdays											
0	11	12.1%	8	13.1%	3	10.0%	2	2.4%	1	1.8%	1	3.4%
1	71	78.0%	50	82.0%	21	70.0%	23	27.1%	21	37.5%	2	6.9%
2	7	7.7%	1	1.6%	6	20.0%	49	57.6%	32	57.1%	17	58.6%
3	2	2.2%	2	3.3%	0	0.0%	7	8.2%	2	3.6%	5	17.2%
4	0	0.0%	0	0.0%	0	0.0%	7	8.2%	2	3.6%	5	17.2%
5+	0	0.0%	0	0.0%	0	0.0%	4	4.7%	4	7.1%	0	0.0%
N	91		61		30		92		62		30	
Missing	8		6		2		7		5		2	
	At night during weekend days											
0	12	13.2%	8	13.1%	4	13.3%	7	8.2%	6	10.7%	1	3.4%
1	70	76.9%	50	82.0%	20	66.7%	22	25.9%	14	25.0%	8	26.7%
2	7	7.7%	1	1.6%	6	20.0%	39	45.9%	27	48.2%	12	40.0%
3	2	2.2%	2	3.3%	0	0.0%	9	10.6%	6	10.7%	3	10.0%
4	0	0.0%	0	0.0%	0	0.0%	4	4.7%	2	3.6%	2	6.7%
5+	0	0.0%	0	0.0%	0	0.0%	11	12.9%	7	12.5%	4	13.3%
N	91		61		30		92		62		30	
Missing	8		6		2		7		5		2	
	During the day on a weekend or on a bank holiday											
0	9	10.1%	7	11.7%	2	6.9%	2	2.4%	1	1.8%	1	3.4%
1	58	65.2%	44	73.3%	14	48.3%	22	25.9%	19	33.9%	3	10.3%

2	16	18.0%	7	11.7%	9	31.0%	43	50.6%	31	55.4%	12	41.4%
3	3	3.4%	2	3.3%	1	3.4%	8	9.4%	3	5.4%	5	17.2%
4	3	3.4%	0	0.0%	3	10.3%	9	10.6%	4	7.1%	5	17.2%
5+	0	0.0%	0	0.0%	0	0.0%	8	9.4%	4	7.1%	4	13.8%
N	89		60		29		92		62		30	
Missing	10		7		3		7		5		2	

Note: Some answers were expressed in FTEs instead of headcounts. We transformed all values between 0 and 1 into 1 headcount and all values between 1 and 2 into 2 headcounts.

For hospital sites where at least one physician with a title in intensive care is present 24/7 in the hospital, Figure 91 shows the ratio between the number of operational beds and the number of physicians with a title in intensive care who are present, for the three out-of-hours periods: at night on a weekday, during the day on a weekend, and at night on a weekend. As these ratios are expressed in headcounts rather than in FTEs, they should be interpreted with caution. Sites with at least one (self-defined) specialised ICU are shown in orange, while the other hospital sites are shown in red. Large differences are observed between sites. The median number of beds per physician is 12 (IQR = 10) at night, both on a weekday or during the weekend and is 10 (IQR = 8.7) during the day on a weekend. Although not systematic, the number of beds per physician tends to be larger in sites with specialised ICU. A possible explanation could be that specialised ICUs rely more on physicians from other medical specialties, or on physicians who do not have acquired the title in intensive care yet.

Figure 91 – Number of operational beds per physician with a title in intensive care present 24/7 in hospital, per hospital site



Night – weekdays: N = 76, missing = 4; day – weekend: N = 76, missing = 6; night – weekend: N = 75; missing = 4. Boxes are drawn from first quartile to third quartile with the median as inside line, whiskers are drawn from the box to the most extreme point that is less than or equal to 1.5 times the IQR, and dots represent hospital sites. Outliers above 50 are not shown.

The number of other physicians present out-of-hours in the ICU is generally comprised between zero and two (see the left columns of Table 38). In around a fifth of the hospital sites, no other physicians (i.e. other than physicians with a title in intensive care) are present out-of-hours in the ICU. The number of other physicians who are available on call is larger (see the right columns of Table 38): in more than 40% of the hospital sites ten or more of these physicians are available (present or on call). Nevertheless, in 18-19% of the hospital sites, no such physician is available.



Table 38 – Presence in the ICU and on-call availability of other physicians

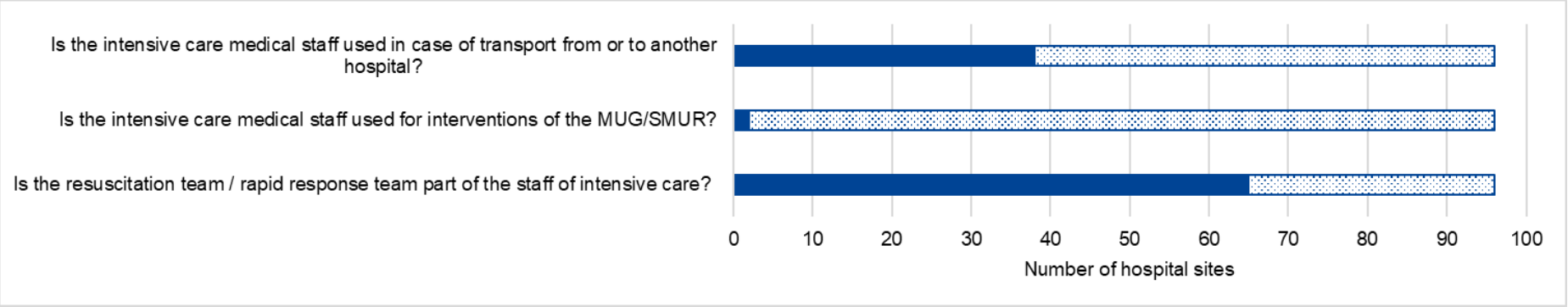
	Number of other physicians present 24/7 in hospital						Number of other physicians 24/7 present or available on call					
	All hospital sites		Hospital sites without (self-defined) specialised ICU		Hospital sites with (self-defined) specialised ICU		All hospital sites		Hospital sites without (self-defined) specialised ICU		Hospital sites with (self-defined) specialised ICU	
	At night during weekdays											
0	16	20.8%	11	20.0%	5	22.7%	13	18.3%	8	15.7%	5	25.0%
1	39	50.6%	30	54.5%	9	40.9%	11	15.5%	8	15.7%	3	15.0%
2	11	14.3%	8	14.5%	3	13.6%	16	22.5%	10	19.6%	6	30.0%
3	4	5.2%	1	1.8%	3	13.6%	3	4.2%	2	3.9%	1	5.0%
4	2	2.6%	1	1.8%	1	4.5%	0	0.0%	0	0.0%	0	0.0%
[5-10[	4	5.2%	4	7.3%	0	0.0%	6	8.5%	3	5.9%	3	15.0%
10+	1	1.3%	0	0.0%	1	4.5%	29	40.8%	24	47.1%	5	25.0%
N	77		55		22		78		55		23	
Missing	22		12		10		21		12		9	
	At night during weekend days											
0	16	20.8%	11	20.0%	5	22.7%	13	18.3%	8	15.7%	5	25.0%
1	39	50.6%	30	54.5%	9	40.9%	11	15.5%	8	15.7%	3	15.0%
2	12	15.6%	9	16.4%	3	13.6%	17	23.9%	11	21.6%	6	30.0%
3	4	5.2%	1	1.8%	3	13.6%	3	4.2%	2	3.9%	1	5.0%
4	2	2.6%	1	1.8%	1	4.5%	0	0.0%	0	0.0%	0	0.0%
[5-10[	3	3.9%	3	5.5%	0	0.0%	5	7.0%	2	3.9%	3	15.0%
10+	1	1.3%	0	0.0%	1	4.5%	29	40.8%	24	47.1%	5	25.0%
N	77		55		22		78		55		23	
Missing	22		12		10		21		12		9	
	During the day on a weekend or on a bank holiday											

0	17	22.4%	13	23.6%	4	19.0%	14	19.4%	9	17.3%	5	25.0%
1	32	42.1%	24	43.6%	8	38.1%	9	12.5%	6	11.5%	3	15.0%
2	16	21.1%	11	20.0%	5	23.8%	16	22.2%	10	19.2%	6	30.0%
3	3	3.9%	1	1.8%	2	9.5%	4	5.6%	3	5.8%	1	5.0%
4	0	0.0%	0	0.0%	0	0.0%	1	1.4%	1	1.9%	0	0.0%
[5-10[	6	7.9%	6	10.9%	0	0.0%	5	6.9%	2	3.8%	3	15.0%
10+	2	2.6%	0	0.0%	2	9.5%	29	40.3%	24	46.2%	5	25.0%
N	76		55		21		78		55		23	
Missing	23		12		11		21		12		9	

INTENSIVE CARE MEDICAL STAFF IS ALSO DEPLOYED OUTSIDE THE UNIT

Respondents were also asked, for each hospital site with an ICU, whether the medical staff of the ICU takes up additional patient care tasks outside the unit. Responses are presented in Figure 92. The resuscitation or rapid response team is part of the intensive care medical team in 67.7% of the hospital sites. In most hospital sites (60.4%) the intensive care medical staff is also deployed in case of transport from or to another hospital. However, except in two hospital sites, intensive care medical staff is not deployed for an intervention of the mobile urgency group (MUG – SMUR).

Figure 92 – Tasks of the ICU medical team outside the unit



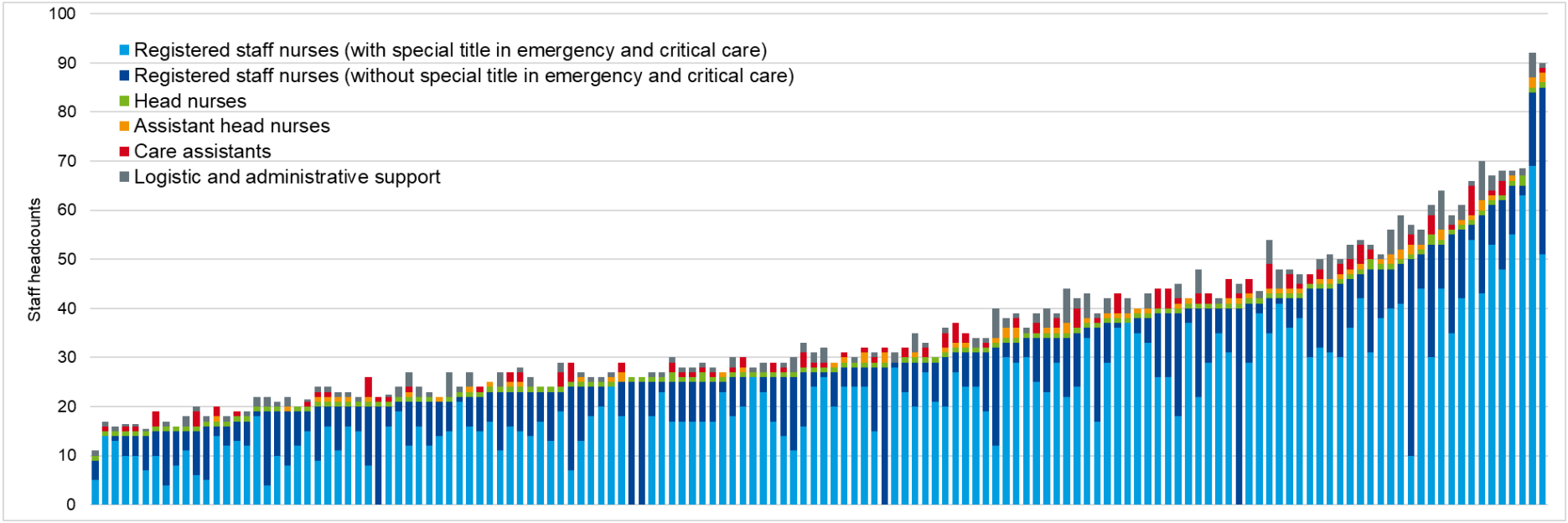
N = 96; missing = 3.

NURSING AND CARING STAFF OF INTENSIVE CARE UNITS

In Figure 93 and Figure 94, the number of nursing and caring staff attached to the ICU are shown for each unit, in headcounts and FTEs respectively. In both figures, ICUs are ordered by the number of registered staff nurses attached to the unit. It can be seen that the vast majority of ICU non-medical staff is composed of registered nurses, both in terms of headcounts as in terms of FTEs. In Figure 93 a distinction is made between registered staff nurses with and without a special title in emergency and critical care. In all units for which the information is available, part of the nursing staff has acquired such title, and in most units the share of nursing staff with this title is larger than the share of nursing staff without special title.

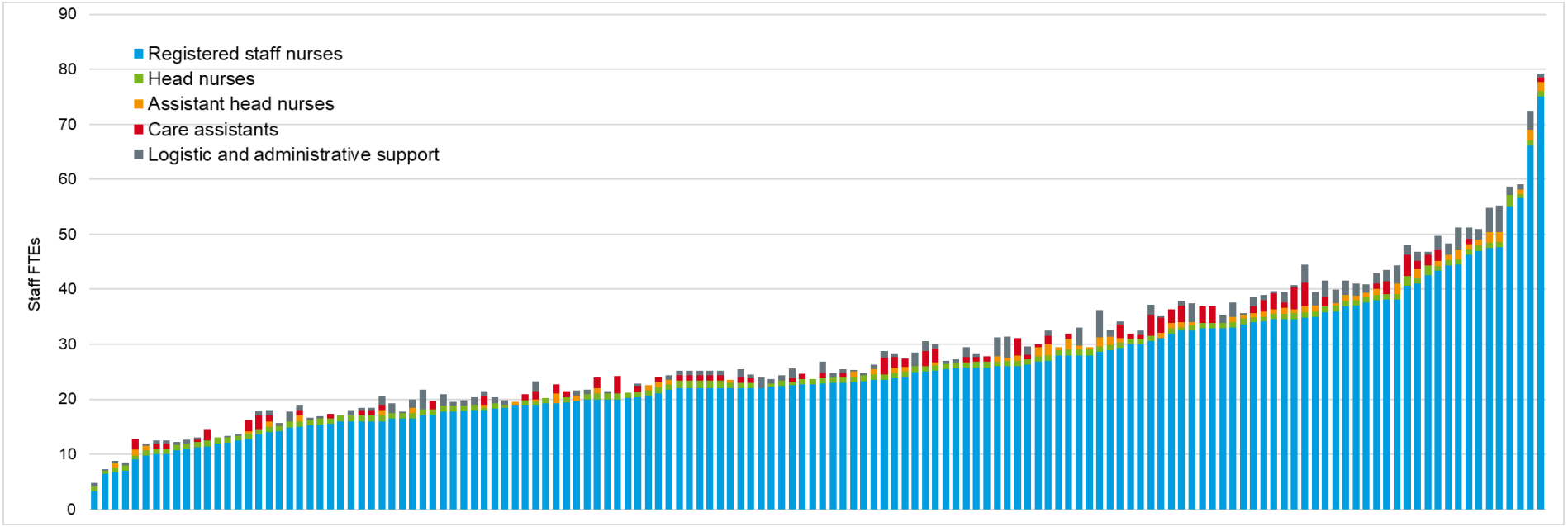
The proportion of all nurses (registered staff nurses, head nurses and assistant head nurses) who hold a special title in emergency and critical care is shown for each ICU in Figure 95. A distinction is made between (self-defined) general ICUs, specialised ICUs and intermediate or undefined ICUs. The median proportion of nurses with a special title in emergency and critical care is 75.0% (IQR = 20.0%). This proportion tends to be larger in (self-defined) specialised ICUs (median = 78.7%, IQR = 21.4%) than in general ICUs (median = 72.7%, IQR = 20.3%).

Figure 93 – Nursing and caring staff in headcounts, per ICU



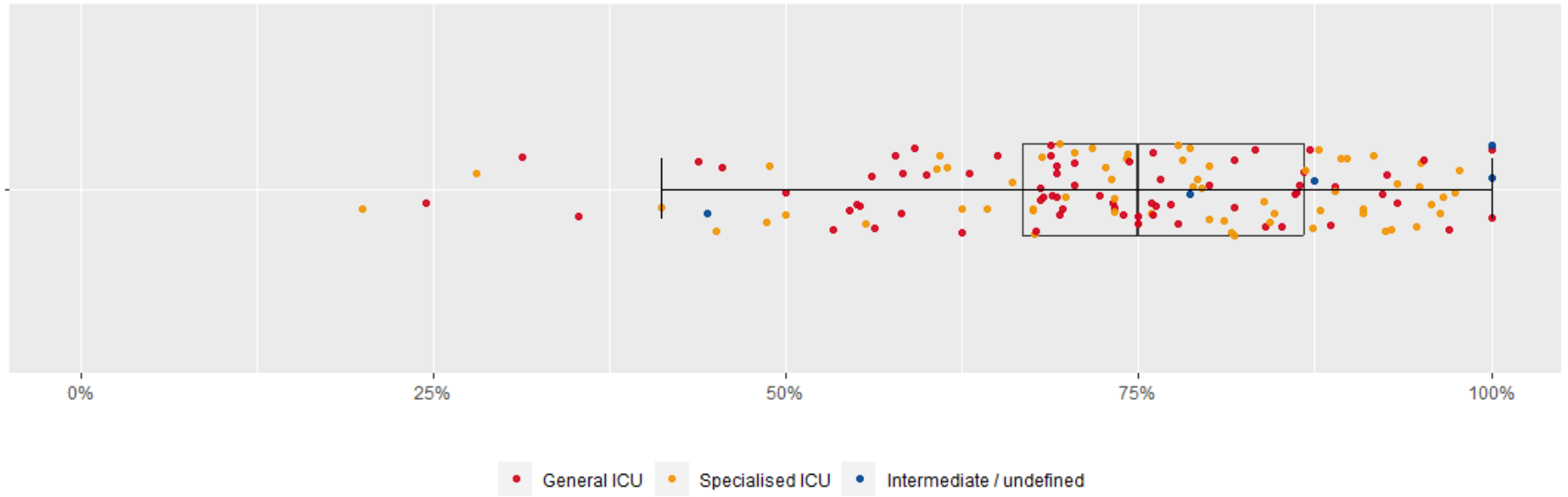
N = 144, missing = 20. Note: for five units, no response was provided for the number of nurses with a special title. This number is therefore set to 0 and all registered staff nurses of the unit are considered as nurses without special title, and are shown in dark blue.

Figure 94 – Nursing and caring staff in FTEs, per ICU



N = 142, missing = 22. For 3 ICUs, errors in the registration of FTE head nurses and care assistants were corrected.

Figure 95 – Proportion of nurses who have a special title in emergency and critical care, per ICU



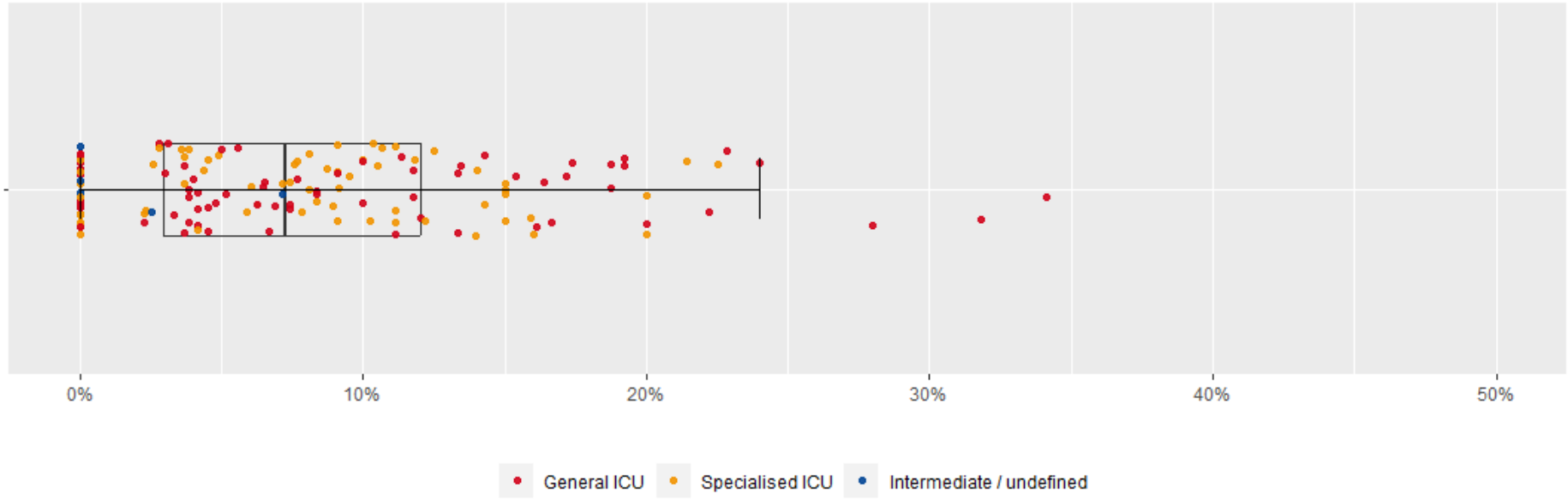
N = 139, missing = 25. Boxes are drawn from first quartile to third quartile with the median as inside line, whiskers are drawn from the box to the most extreme point that is less than or equal to 1.5 times the IQR, and dots represent ICUs.

EIGHT OUT OF TEN ICUs FACE NURSING STAFF ABSENCES

Among the 144 ICUs for which a response was provided, 115 (79.9%) reported that at least one nurse was absent at the time of the survey. Figure 96 shows the proportion of absences among all nurses (registered staff nurses, head nurses and assistant head nurses). The median proportion of absent nurses is 7.3% (IQR = 9.1%). In 11 ICUs (7.6%), 20% or more of the nurses were absent at the time of survey.

In 90.4% of 73 ICUs with at least one care assistant, no care assistant was absent at the time of the survey. For logistic and support staff (N = 111) also, a large proportion of ICUs (87.4%) did not report any absence.

Figure 96 – Proportion of nurses absent at the time of survey, per ICU



N = 144, missing = 20. Boxes are drawn from first quartile to third quartile with the median as inside line, whiskers are drawn from the box to the most extreme point that is less than or equal to 1.5 times the IQR, and dots represent ICUs.

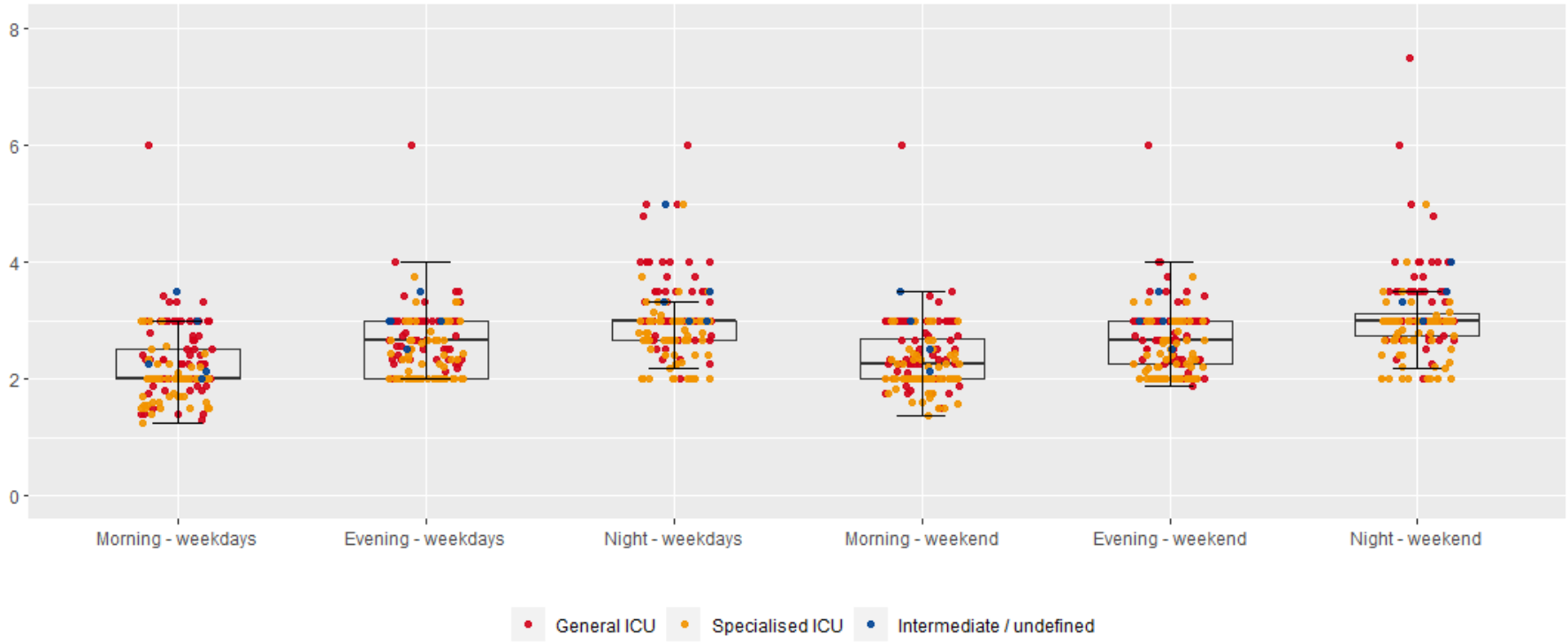
TWO TO THREE PATIENTS PER NURSE, SOMETIMES MORE

The scheduled patient-to-nurse ratio is calculated as the number of available beds divided by the number of scheduled registered nurses providing direct patient care for a specific shift. In the survey, the number of scheduled registered nurses (including for instance staff from the float pool) was asked for three shifts of a typical weekday (morning, defined as including the period from 10 am to 11 am; evening, defined as including the period from 6 pm to 7 pm; and night defined as including the period from 2 am to 3 am) and for the same three shifts of a typical day of the weekend or a bank holiday. In addition, the number of beds that are available on those typical days was also asked. Figure 97 shows the scheduled patient-to-nurse ratio per ICU for the different shifts, with a distinction between (self-defined) general and specialised ICUs. Although not visible on the figure, it should be noted that ICUs with a large patient-to-nurse ratio for one shift also tend to have large patient-to-nurse ratios for the other shifts.

In most of the ICUs, whatever the considered shift, the scheduled patient-to-nurse ratio is comprised between 2 and 3 patients per nurse. Only for the morning shifts, some ICUs have a patient-to-nurse ratio smaller than 2 – but always larger than 1 (in 21.3% of the ICUs for the morning shift of a typical weekday and in 12.8% of the ICUs for the morning shift of a typical day of a weekend or bank holiday). Also, for the morning shift, the scheduled patient-to-nurse ratio is smaller than 4 in all units except in one outlier case.

Scheduled patient-to-nurse ratios appear to be larger for the evening shifts, compared to the morning shifts and even larger for the night shifts. In the night shift of a typical weekday, in 24.7% of the ICUs the scheduled patient-to-nurse is larger than 3. For the night shift of a typical day of a weekend or bank holiday, it is larger than 3 in 25.7% of the ICUs. In contrast, scheduled patient-to-nurse is larger than 3 for the morning shift of a typical weekday in 4% of the ICUs.

Figure 97 – Scheduled patient-to-nurse ratio, per ICU



Weekdays: N = 150, missing = 14; Weekend: N= 148, missing =16. Boxes are drawn from first quartile to third quartile with the median as inside line, whiskers are drawn from the box to the most extreme point that is less than or equal to 1.5 times the IQR, and dots represent ICUs.

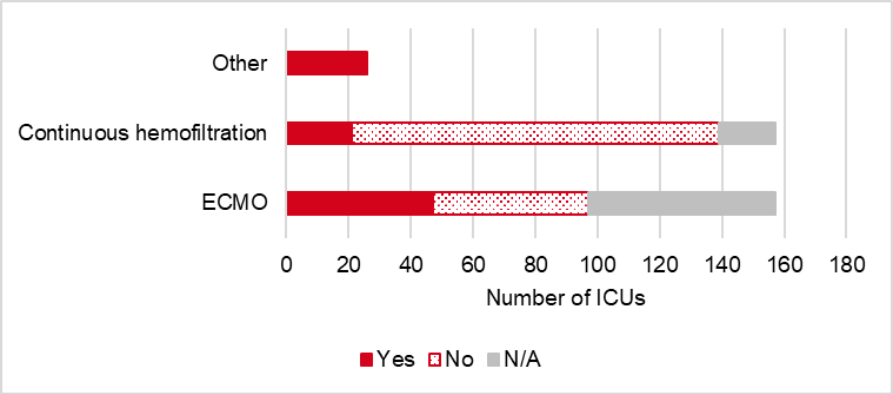
Respondents were also asked to provide the scheduled number of care assistants for the same shifts. Adding care assistants to the denominator pushes the ratio down to 1 in four ICUs, only for the morning shift of a typical weekday (see Appendix to Chapter 7 in the Supplement). In most of the ICUs, whatever the considered shift, the scheduled number of patients per nurse or care assistant is comprised between 2 and 3.

Regarding logistic and support staff, most ICUs schedule one such staff member in the morning shift of a typical weekday and zero during the other shifts (for detailed results, see Appendix to Chapter 7 in the Supplement).

REACHING A 1 TO 1 PATIENT-TO-NURSE RATIO?

Respondents were asked, for each ICU, for which indications they currently use a 1:1 patient-to-nurse ratio. Two indications were suggested (ECMO and continuous hemofiltration) for which respondents could select whether they use a 1:1 ratio in the ICU or not, or whether patients with this indication are never admitted to their ICU (N/A). In addition, they had the option to list other indications for which they currently use a 1:1 ratio in the ICU. Results are presented in Figure 98. Among the 97 ICUs for which ECMO is relevant, 48.5% use a 1:1 patient-to-nurse ratio for that indication. For continuous hemofiltration, 15.1% of the 139 ICUs for which such indication is relevant use a 1:1 ratio. Among the 26 responses in the 'other' category, 18 included a description. They concern instable or critically ill patients (12), prone positioning (2), plasmapheresis (2), microbiological reason (hospital hygiene) (1), and burn > 15% TBSA (1). Some respondents added additional comments, mostly explaining that a 1:1 ratio would be ideal but is not always or never feasible. Three explicitly mentioned using 1:2 ratios, and one said that a 1:1 ratio is reached when using student nurses.

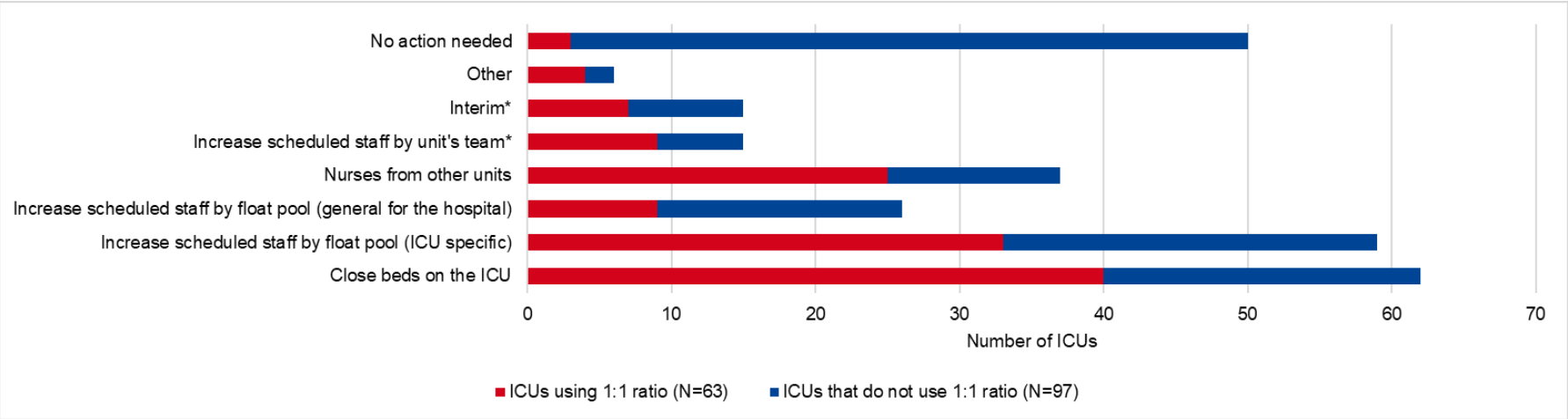
Figure 98 – Indications for which a 1:1 nurse staffing ratio is used in the ICU



N = 157, missing = 7. Note: two responses in the 'other' category were transformed into 'continuous hemofiltration' based on the additional comment given by the respondents.

Respondents were therefore asked which actions they take when patients require a 1:1 nurse staffing ratio. Figure 99 summarises the responses. On the figure, a distinction is made between ICUs that mentioned using a 1:1 ratio for at least one indication in the previous question and other ICUs. When a 1:1 ratio is required, the number of patients per nurse is decreased mainly by closing some beds (38.8% of the ICUs) and/or by increasing scheduled staff using a float pool specific to the ICU (36.9%). Relying on nurses from other units is also common (23.1%). Other strategies include relying on a float pool that is not specific to the ICU (16.3%), relying on the ICU team members that were not initially scheduled (9.4%), relying on interim staff (9.4%), deploying the head nurse to take care of patients (1.9%), redistributing patients, using external help and shifting nursing staff.

Figure 99 – Actions taken when patients require a 1:1 nurse staffing ratio



*N = 160, missing = 4. *The categories 'interim' and 'increase scheduled staff by unit's team' were not suggested in the survey, but were retrieved from the responses to the 'other' category. In addition, three answers from the 'other' category were grouped with the category 'nurses from other units' based on the comment provided by the respondents.*

Finally, respondents were requested to identify circumstances that would necessitate a 1:1 ratio, but which could not be met within their current practice. The respondents were invited to submit their answer in a text-free format. A total of 127 responses were provided. The main identified circumstances included the situation of high-instable patients (haemodynamic, respiratory, neurological) requiring numerous supportive therapies (ECMO, hemofiltration, mechanical ventilation with prone position, microbiological isolation), or patients experiencing acute deterioration with difficulties to maintain vital parameters. Other circumstances included newly-admitted highly instable patients, the management of end-of-life patients with potential for organ donation. A number of hospitals highlighted the issue of paediatric patients undergoing mechanical ventilation.

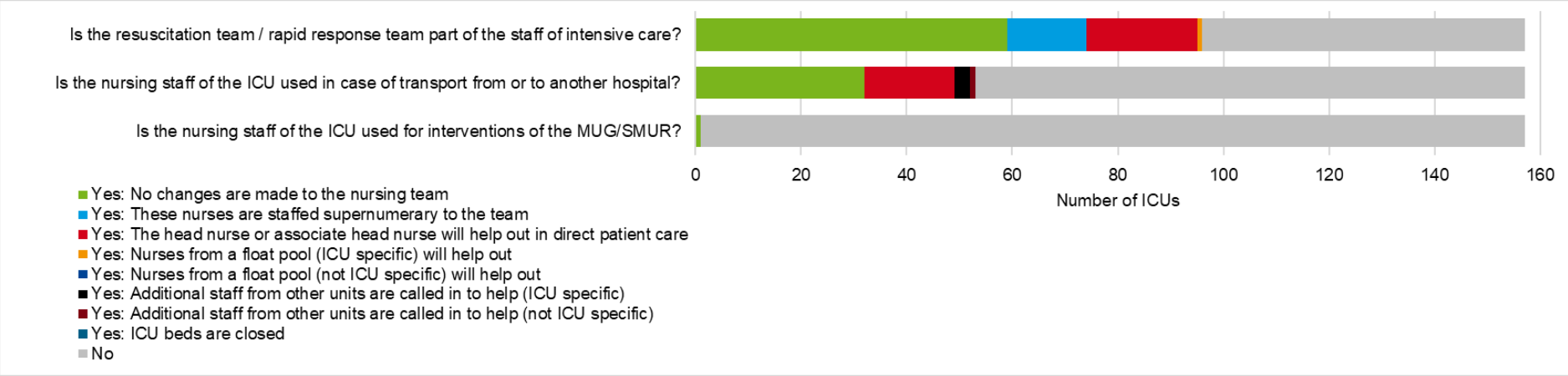
NURSING TASKS OUTSIDE THE ICU

Respondents were also asked whether the nursing staff of the ICU takes up additional patient care tasks outside the unit. Responses are presented in Figure 100. The resuscitation or rapid response team is part of the intensive care nursing team in 61.1% of the ICUs. In 33.8% of the ICUs the intensive care nursing staff is also deployed in case of transport from or to another hospital. However, only in one ICU, intensive care nursing staff is not deployed for an intervention of the mobile urgency group (MUG – SMUR). When the ICU nursing team is used outside the unit, respondents were also asked if changes were made to the nursing team in case these activities take place. In most of the cases, no changes are being made. However, in 15 units the nurses of the resuscitation or rapid response team are supernumerary to the ICU team. Also, when the resuscitation or rapid response team is used, the head nurse or associate head nurse helps out in direct patient care in 21 ICUs. This is the case when nursing staff is deployed for transport in 17 units. The option to rely on other nurses (from the float pool or other units) is only used by a few ICUs.

ALLIED HEALTHCARE STAFF AND OTHER CARE PROFESSIONALS

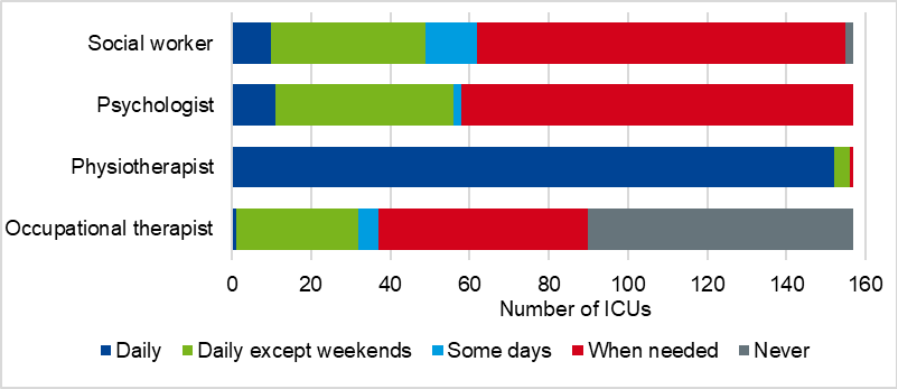
As illustrated by Figure 101, physiotherapists are available on a daily basis in almost all ICUs (96.8%). Psychologists are available in all ICUs and social workers in 98.7% but the degree of availability of these professionals varies between units. In some units (7.0% of the ICUs for psychologists and 6.4% for social workers), they are available every day. However, in most ICUs (63.1% for psychologists and 59.2% for social workers) they are available only when needed. In a fifth of the ICUs, occupational therapists are available daily (during weekdays). They are available when needed in 33.8% of the ICUs and for a large group of units (42.7%), occupational therapy is not available. Regarding the availability of physiotherapists, psychologists, social workers and occupational therapists, no strong differences are observed between (self-defined) general and specialised ICUs (see Appendix to Chapter 7 in the Supplement).

Figure 100 – Tasks of the ICU nursing team outside the unit



N = 157, missing = 7.

Figure 101 – Availability of allied healthcare staff and other care professionals in the ICU



N = 157, missing = 7.

MONITORING AND DIAGNOSTIC OPTIONS

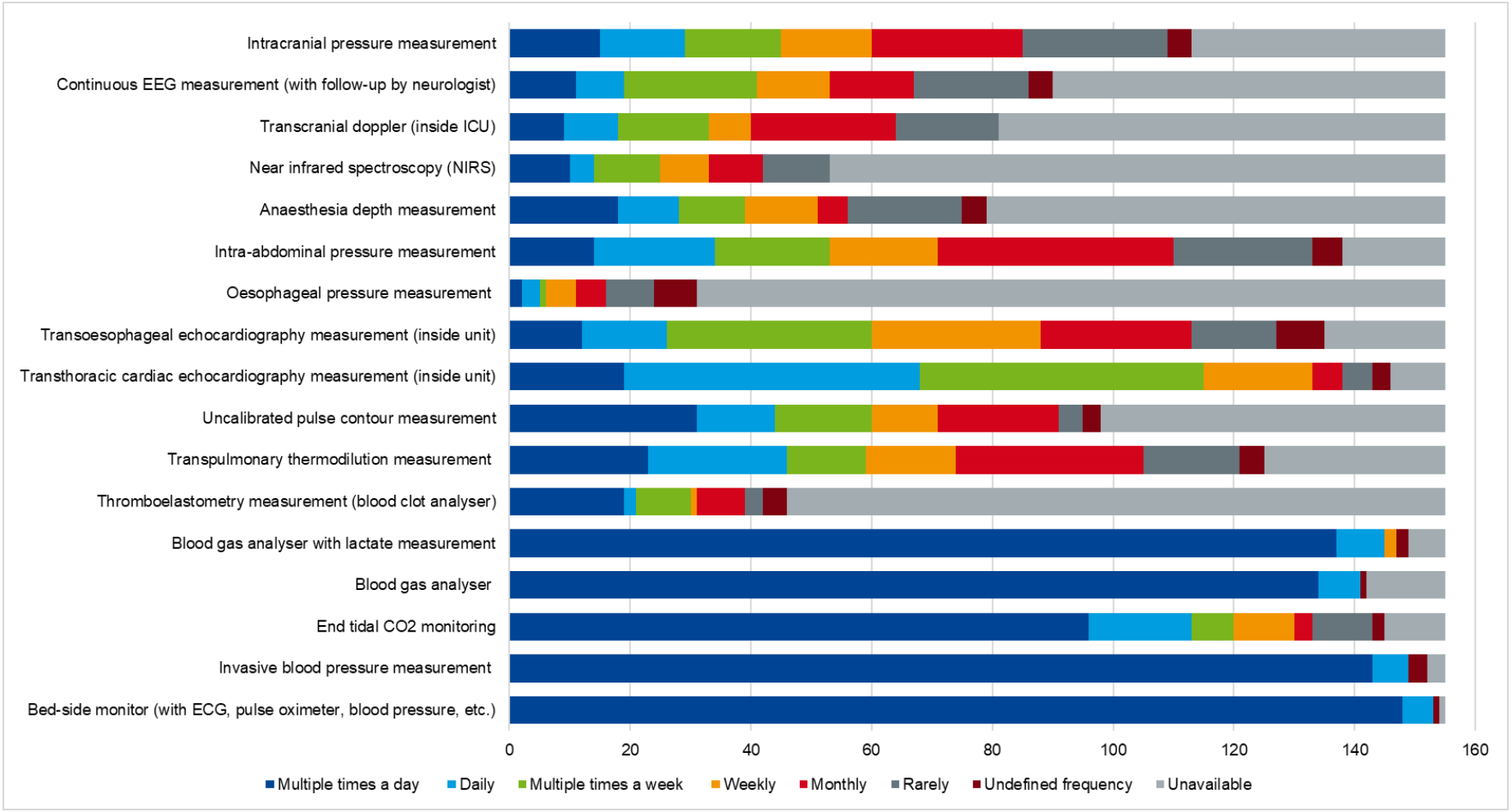
For each ICU, respondents were asked to select from a list of monitoring and diagnostic services, which ones are available in the unit. As respondents were only asked to select the options that are available in the unit, it is not possible to determine if an option is unselected because it is not available in the unit, or because the respondent did not answer. However, for nine ICUs, no options were selected for this question as well as for the following concerning therapeutic options (see later). We considered that the responses are missing for these units. Note that, for one ICU, no monitoring and diagnostic options were selected but some therapeutic options were selected. Responses for this unit are not considered as missing.

For the selected items, respondents were then asked to assess how frequently the service is used in the unit (from six possible options going from 'multiple times a day' to 'rarely'). For some options / some units, no response was selected. These options/units are not excluded but described hereafter as 'undefined frequency'.

Results are summarised in Figure 102. Some options are available, and used once or multiple times a day, in almost all ICUs: these are bed-side monitor (with ECG, pulse oximeter, blood pressure, etc.); invasive blood pressure measurement; blood gas analyser; and blood gas analyser with lactate measurement. End tidal CO_2 monitoring is also available in almost all ICUs, but not used as frequently everywhere. Some options are available in almost all ICUs, but the frequency of use varies greatly between units: transthoracic cardiac echocardiography measurement; transoesophageal echocardiography measurement; and intra-abdominal pressure measurement.

Many other options are available in at least half of the ICUs. For these options, a large variability is observed between units in the frequency of use. This concerns: transpulmonary thermodilution measurement; uncalibrated pulse contour measurement; anaesthesia depth measurement; transcranial doppler; continuous EEG measurement (with follow-up by neurologist); and intracranial pressure measurement. A few options (oesophageal pressure measurement; thromboelastometry measurement; and near infrared spectroscopy) are only available in a limited number of ICUs. There, the frequency of use also varies.

Figure 102 – Availability of monitoring and diagnostic options in the ICU



N = 155, missing = 9.

When comparing (self-defined) general and specialised ICUs (see Appendix to Chapter 7 in the Supplement), it can be seen that all suggested monitoring and therapeutic options are more commonly available among specialised ICUs. The difference is particularly marked for intracranial pressure measurement, continuous EEG measurement (with follow-up by neurologist) and transcranial doppler. For instance, continuous EEG measurement (with follow-up by neurologist) is available in 76.4% of the specialised ICUs but only in 40.2% of the general ICUs.

Respondents also had the possibility to add other options, this was done for 39 units. Among those, 8 refer to the measurement of cardiac output (7 with an arterial pulmonary catheter 'Swan Ganz'). Several cerebral monitoring systems (transcranial doppler, oxygen and metabolism cerebral measures intermittent EEG and evoked potentials and pupillometry analysis) were mentioned by 18 units. Other respondents mentioned the following items: anticoagulation monitoring (for continuous renal replacement therapy using citrate), bronchoscopy, hypothermia, indirect calorimetry, haemodialysis, and bispectral index.

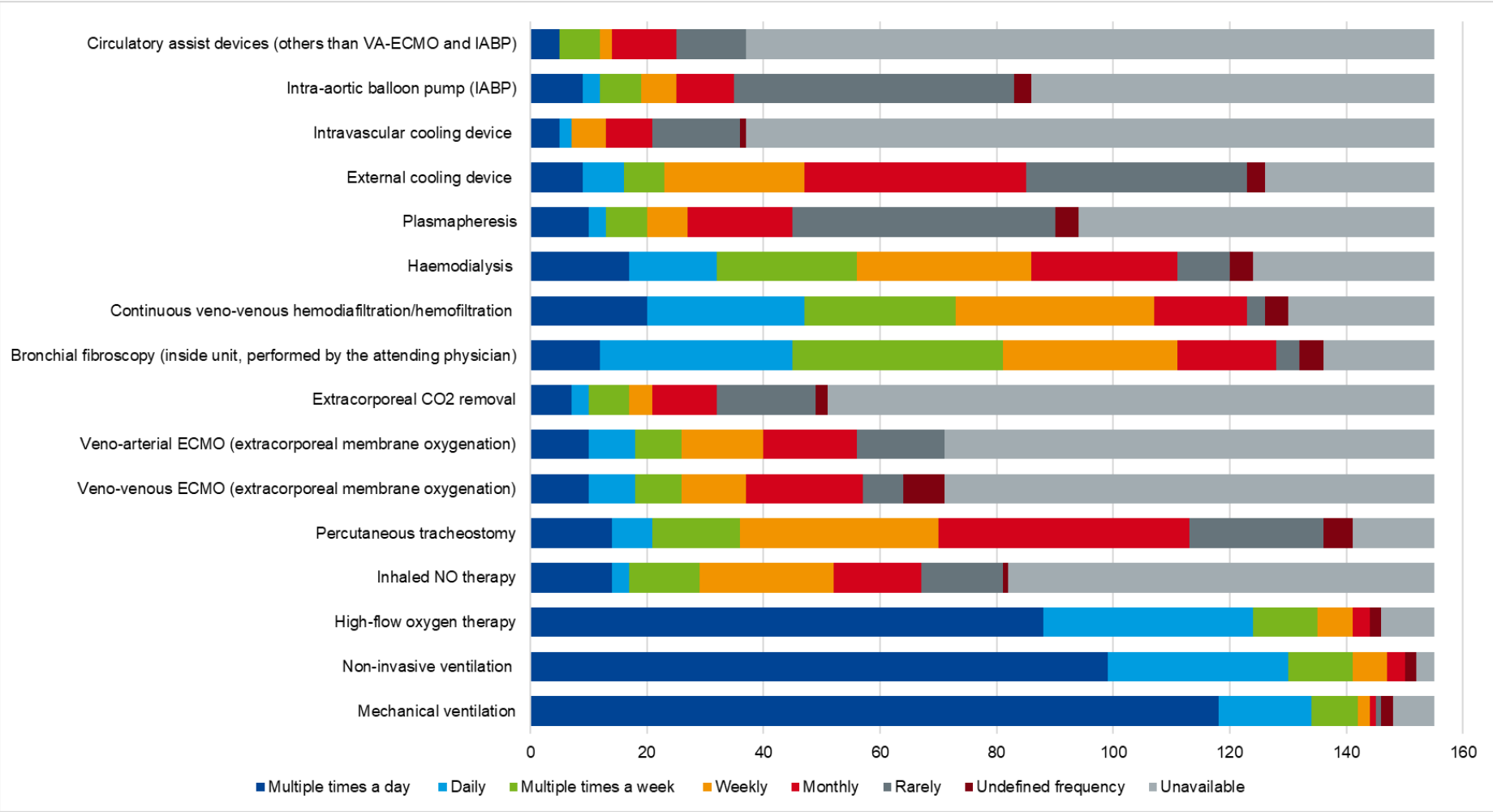
THERAPEUTIC OPTIONS

The same questions were asked for a list of therapeutic options. Missing values for Figure 103 are defined as for Figure 102. Mechanical ventilation, non-invasive ventilation and high-flow oxygen therapy are available in almost all ICUs and used multiple times a day in a large proportion of units (76.1%, 63.9% and 56.8%, respectively). Percutaneous tracheostomy, bronchial fibroscopy (inside unit, performed by the attending physician), continuous veno-venous hemodiafiltration/hemofiltration, haemodialysis and external cooling devices are also available in a large proportion of ICUs, but in most cases less frequently used. Other options (inhaled NO therapy, veno-venous ECMO, veno-arterial ECMO, extracorporeal CO_2 removal, plasmapheresis, intravascular cooling device, intra-aortic balloon pump, and other circulatory assistance devices) are only available in part of the ICUs (from 23.9% of the ICUs for intravascular cooling device and other circulatory assist devices to 60.6% for plasmapheresis). For these options, the frequency of use varies between ICUs. It is worth noting that a non-negligible group of ICUs have intra-aortic balloon pump, external cooling devices and/or the possibility of plasmapheresis, but only rarely use them.

Differences can be observed between (self-defined) general and specialised ICUs (see Appendix to Chapter 7 in the Supplement), in particular for options that are not available everywhere. These options tend to be more commonly available in specialised ICUs than in general ICUs. Except for intravascular cooling device and other circulatory assist devices, all suggested options are available in more than half of the specialised ICUs. Notable differences are visible for inhaled NO therapy, veno-venous ECMO, veno-arterial ECMO and extracorporeal CO_2 removal. These options are available in respectively 75.0%, 65.3%, 65.3% and 47.2% of the specialised ICUs while they are only available in 34.1%, 29.3%, 29.3% and 20.7% of the general ICUs.

In addition, for 17 units, other options were mentioned including: external pacemaker (7), molecular-adsorbent recirculating system (MARS) (2), high frequency oscillatory ventilation, specialised burn care, etc.

Figure 103 – Availability of therapeutic options in the ICU



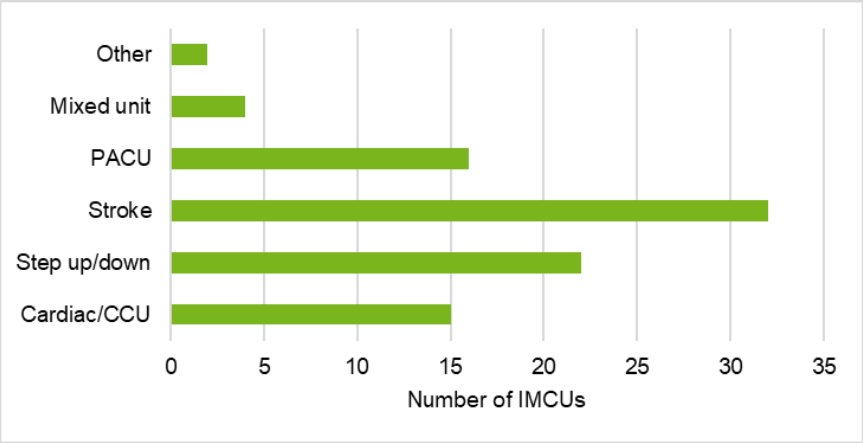
N = 155, missing = 9

7.3.3 Intermediate care units

INTERMEDIATE CARE UNITS INCLUDE STROKE, STEP-UP/DOWN, POST-ANAESTHESIA, CARDIAC AND CORONARY CARE UNITS

A total of 91 IMCUs (in 52 hospital sites) were identified in the survey. For each of them, respondents were asked to select the category that described best the unit. Figure 104 shows the responses. A large share of identified IMCUs (35.2%) are stroke units, 24.2% are (medical and/or surgical) step-up and/or step-down units, 17.6% are Post-Anaesthesia Care Units (PACUs) and 16.5% are cardiac or coronary care units. In addition, a few units mix several of these categories. Respondents were given the option to select from various types of step-up and step-down units, which are grouped together throughout the rest of the chapter. Nine step-down units were identified (among which seven surgical and two medical), four medical step-up units, and nine step-up and step-down units (five medical and surgical, one surgical, one medical).

Figure 104 – Types of IMCUs



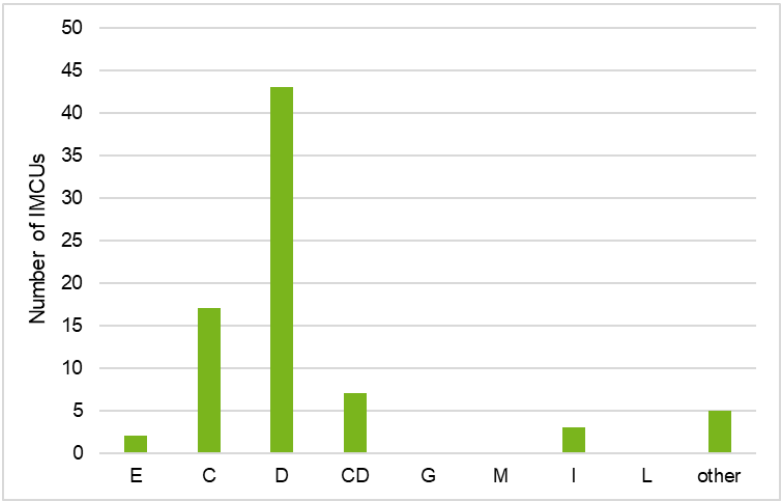
N = 91, missing = 0. Based on the description given by the respondent, four units described as 'other' were requalified as 'PACU', and two were requalified as 'Step up/down'. For four units described as 'other' by the respondents, a new category 'mixed unit' was created based on the description given by the respondent. Four units with missing values were requalified (3 stroke units, 1 CCU) based on the name of the unit. One unit described as 'respiratory intermediate care unit' was grouped in the category 'other'.

Children can be admitted in these units. However, for 69.0% of the IMCUs (N = 87, missing = 4), the respondent stated that children are never admitted in the unit. Children are occasionally admitted in 19.5% of the IMCUs and regularly admitted in 9.2% of them. Two IMCUs (2.3%) exclusively admit children.

BEDS IN INTERMEDIATE CARE UNITS

As for ICUs, respondents were asked to provide the number and type of licensed beds, per IMCU. Due to recording errors and missing values, the responses regarding the number of beds are only exploitable for 72 IMCUs (missing = 19) and those regarding the type of beds for 73 IMCUs (missing = 18). The median number of licensed beds in an IMCU is 6 (IQR = 5.8). Figure 105 shows the number of IMCUs with a given type of licensed bed. Most IMCUs (58.9%) include licensed D-beds, 23.3% include licensed C-beds.

Figure 105 – Number of IMCUs with a given type of licensed bed



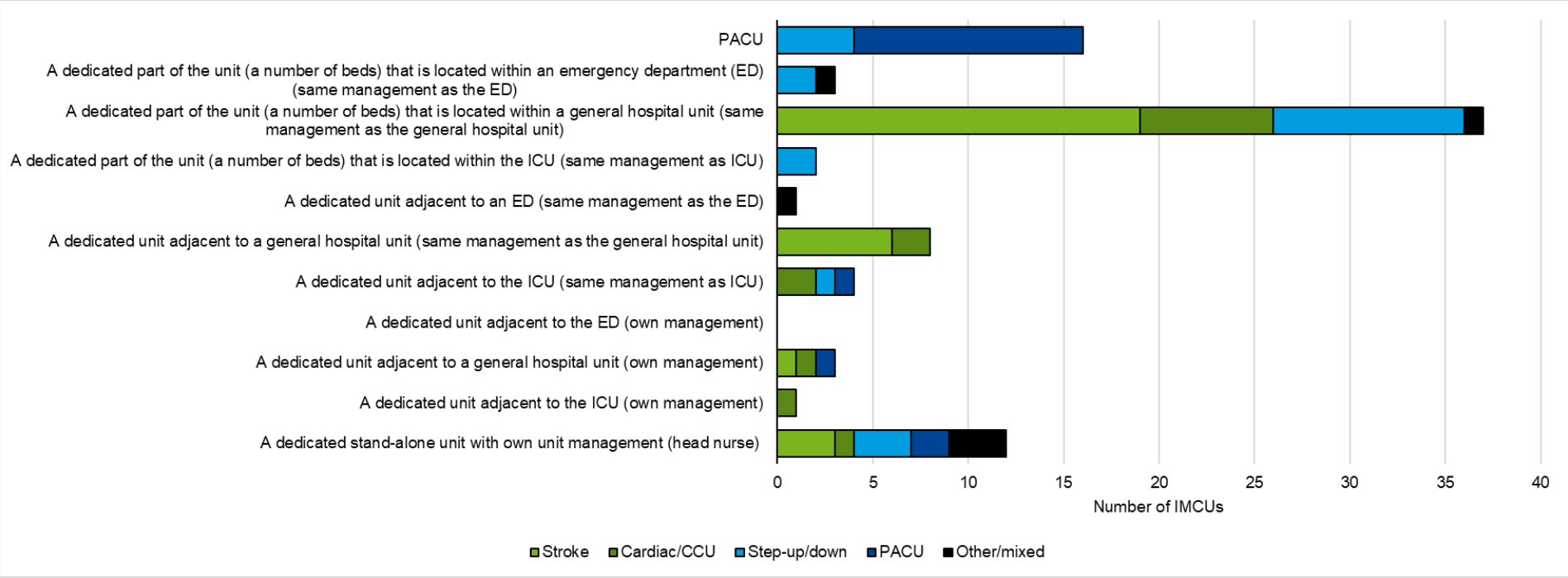
N = 73, missing = 18.

As the number of operational beds (beds that are effectively deployable – with the necessary staff – in the unit) may differ from the number of licensed beds, respondents were also asked to provide the number of operational beds per IMCU (N = 83, missing = 8). The median number of operational beds in an IMCU is 6 (IQR = 4.5). Also, among these units, only 23 IMCUs (27.7%) have at least one bed with the possibility of invasive ventilation. Eight IMCUs (9.6%) reported that at least one bed was closed at the time of the survey.

MOST IMCUs ARE LOCATED WITHIN A GENERAL HOSPITAL UNIT

Regarding the organisation of the IMCU, respondents were asked to select the statement that best described each unit. The suggested options included whether the IMCU is a dedicated part of another unit (ICU, ED or general unit), a dedicated unit adjacent to another one (ICU, ED or general unit), or a stand-alone unit. In case of a unit adjacent to another a distinction was suggested between units with their own management or the same management as the other unit. PACUs were treated separately. Results are shown in Figure 106. Except for PACUs (18.4%), most IMCUs (42.5%) are organised as a dedicated part within a general hospital unit. When adjacent to another unit, IMCUs are also more likely to be adjacent to a general hospital unit than to an ICU or emergency department. Twelve IMCUs (13.8%) are stand-alone units with their own management.

Figure 106 – Organisation of the IMCU



N = 87, missing = 4.

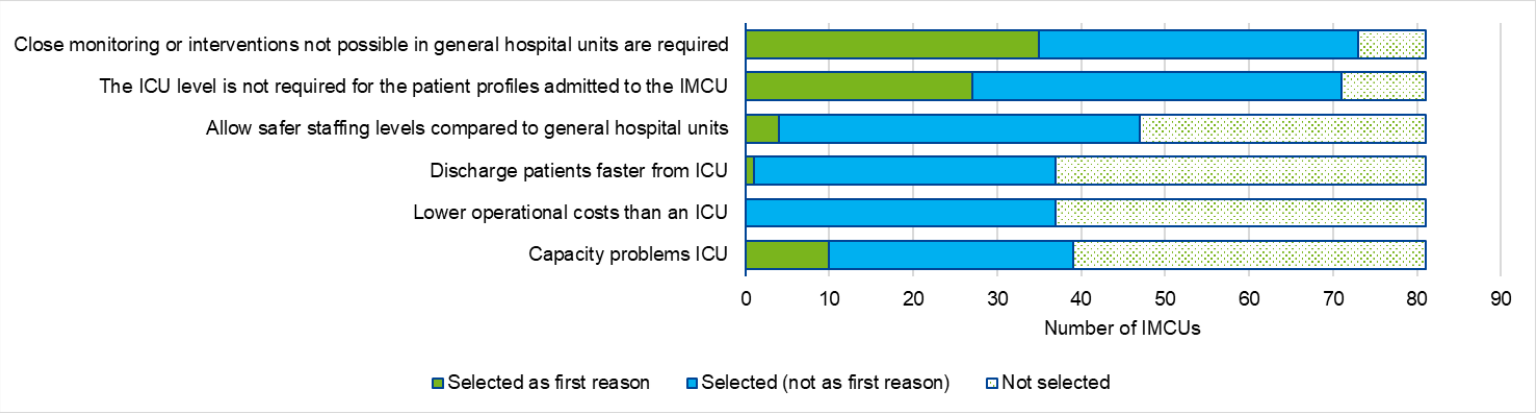
INTERMEDIATE LEVEL BETWEEN ICU AND GENERAL HOSPITAL UNITS

Among several propositions, respondents were asked to select the reason(s) to set-up the IMCU. They also had the possibility to add other reasons, but no respondent used this option. Next, they had to rank the reasons by degree of importance. On Figure 107, reasons ranked as first are shown separately from other reasons. In 43.2% of the IMCUs, the most important reason to set up the unit was that a close monitoring of the patients or some interventions are required that are not possible in a general hospital unit. This reason was selected, not necessarily as the most important, for nine out of ten IMCUs. For another large group of IMCUs (33.3%), the most important reason to set up the unit was that intensive care is not required for the patients admitted to the IMCU. This reason was also selected, not always as first reason, for almost nine out of ten IMCUs. Capacity issues at the ICU was the most important reason to set up the IMCU for 12.3% of the units (and *a* reason for almost half of the units). The possibility to discharge patients faster from the ICU and the lower operational costs compared to the ICU are two reasons that were selected for almost half of the IMCU, but almost never as the most important reason.

INTERMEDIATE CARE UNITS ARE MAINLY FINANCED VIA THE HOSPITAL BUDGET

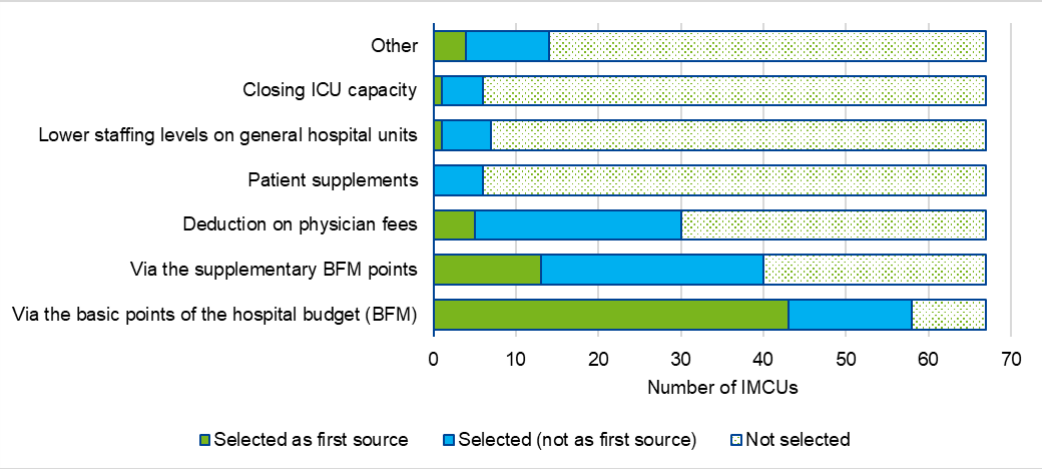
Intermediate care units are not formally licensed nor financed in Belgium. It was therefore asked how the hospital finances each of the IMCUs. The respondents had to select one or more sources among the ones suggested and then to rank them by degree of importance. On Figure 108, sources ranked as the most important are shown separately from other sources. The respondents also had the opportunity to add additional sources. For 64.2% of the IMCUs, the most important source of financing is coming from basic points of the hospital budget (see Chapter 3). This source is selected as one of the financing sources for 86.6% of the IMCUs. Supplementary points of the hospital budget are seen as the most important source of financing for 19.4% of the IMCUs and as one of the financing sources in 59.7% of the IMCUs. Another important source of financing is coming from deductions on physician fees (selected for 44.8% of the IMCUs, but ranked as the most important for only 7.5%). Other suggested sources (using patient supplements, lowering staffing levels on general hospital units or closing ICU capacity) were only selected for a few IMCUs. For 14 IMCUs, additional sources were mentioned including closing other beds, a solidarity fund that consists of a pooling of deductions on physician fees, using the hospital's own funds or profits from medical-technical services, or using financing of the stroke programme.

Figure 107 – Reasons to set up the IMCU



N = 81, missing = 10

Figure 108 – Financing of the IMCU

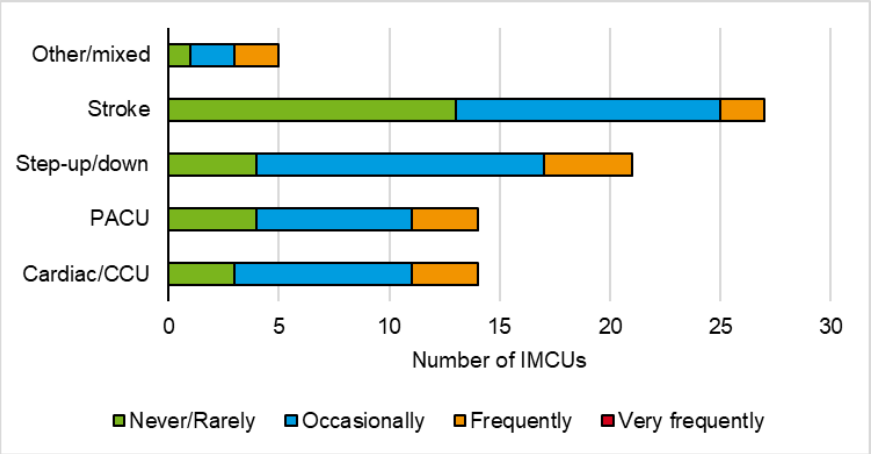


N = 67, missing = 24..

OCCASIONAL ESCALATION TO THE ICU

Based on their own personal observations, respondents had to evaluate, for each IMCU, how often patients require unplanned escalation to the ICU within 24 hours of admission to the IMCU. For most of the IMCUs (51.9%) it occurs occasionally and for 30.9% it occurs rarely or never. Although the response 'very frequently' was not selected for any IMCU, frequent escalation occurs in 17.3% of the IMCUs. Also, frequency of escalation to the ICU is lower in stroke units than in other types of IMCUs.

Figure 109 – Unplanned escalation to the ICU within 24 hours of admission to the IMCU

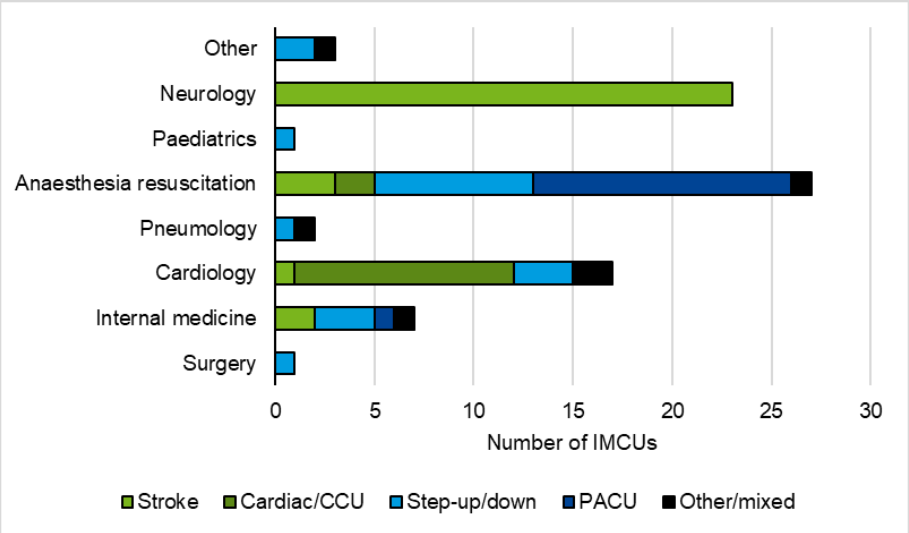


N = 81, missing = 10.

MEDICAL STAFF OF INTERMEDIATE CARE UNITS

As for ICUs, respondents were asked to select the main medical specialism of the physician in chief for each IMCU. As shown in Figure 110, a large group (33.3%) of IMCUs are led by a physician in chief who is specialised in anaesthesia-resuscitation (*arts-specialist in de anesthesie-reanimatie / médecin spécialiste en anesthésie-réanimation*). This concerns different types of IMCUs, but almost all PACUs are led by a specialist in anaesthesia-resuscitation. Another large group of IMCUs (28.4%) are led by a neurologist but this concerns exclusively stroke units. Most cardiac units or CCUs are led by a cardiologist, but this also occurs in other types of IMCUs. Contrary to ICUs (see Figure 89), only 8.6% of the IMCUs are led by a physician specialised in internal medicine.

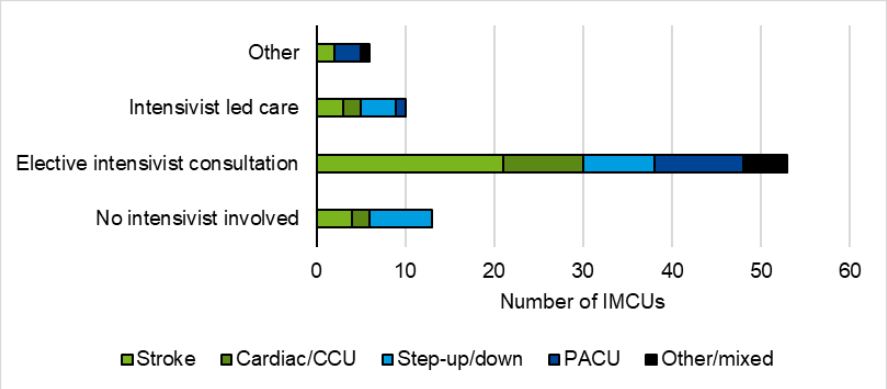
Figure 110 – Main medical specialism of the IMCU physician in chief



N = 81, missing = 10. Note: Neurology was not one of the suggested categories, but was retrieved from the 'other' category.

Regarding the staffing model of the IMCUs (see Figure 111), in a large majority of them, intensivists are involved but mainly for elective consultations (64.6%). In only 12.2% of IMCUs care is led by an intensivist. Also, in 15.9% of the IMCUs (none of them being a PACU), no intensivist is involved.

Figure 111 – Staffing model of the IMCU

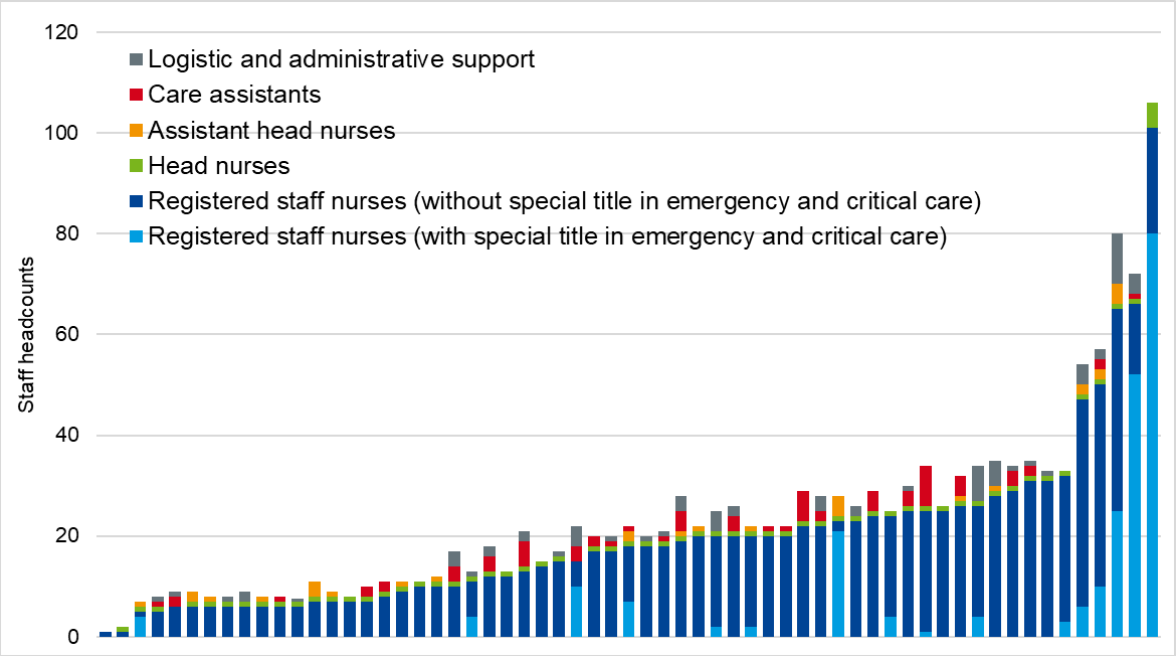


N = 82, missing = 9.

NURSING AND CARING STAFF OF INTERMEDIATE CARE UNITS

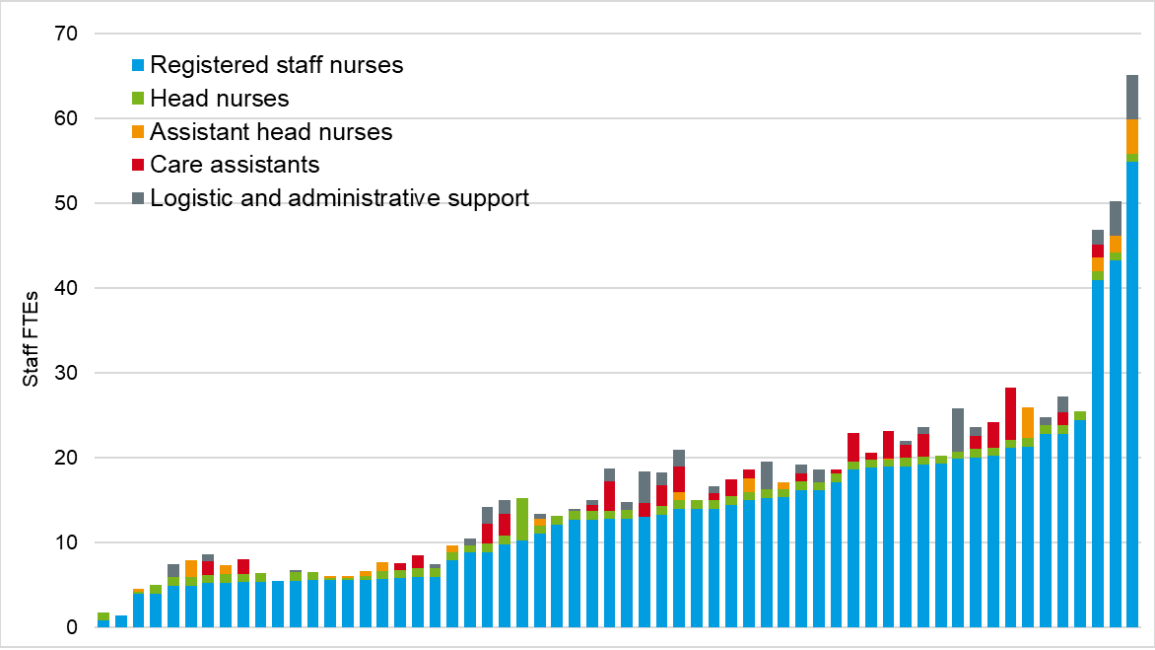
In Figure 112 and Figure 113, the number of nursing and caring staff attached to the IMCU are shown for each unit, in headcounts and FTEs, respectively. In each case, IMCUs are ordered by the number of registered staff nurses attached to the unit. As for ICUs, the majority of non-medical staff of IMCUs is composed of registered nurses, both in terms of headcounts as in terms of FTEs. However, in opposition to ICUs, in most of the IMCUs, the vast majority of registered nurses do not hold a special title in emergency and critical care. Only in 16 IMCUs (6 step-up/down units, 6 PACUs, 3 mixed or other units and 1 cardiac/CCU) part of the registered nurses hold this title, and only in five IMCUs (2 step-up/down units, 2 mixed or other units and 1 cardiac/CCU), the share of nursing staff with this title is larger than the share of nursing staff without a special title (see Figure 112). The proportion of all nurses (registered staff nurses, head nurses and assistant head nurses) who hold a special title in emergency and critical care is between 0% and 92.9% (median = 0%; IQR = 12.5%).

Figure 112 – Nursing and caring staff in headcounts, per IMCU



N = 61, missing = 30.

Figure 113 – Nursing and caring staff in FTEs, per IMCU



N = 60, missing = 31.

ONE IN TWO IMCUs FACE NURSING STAFF ABSENCES

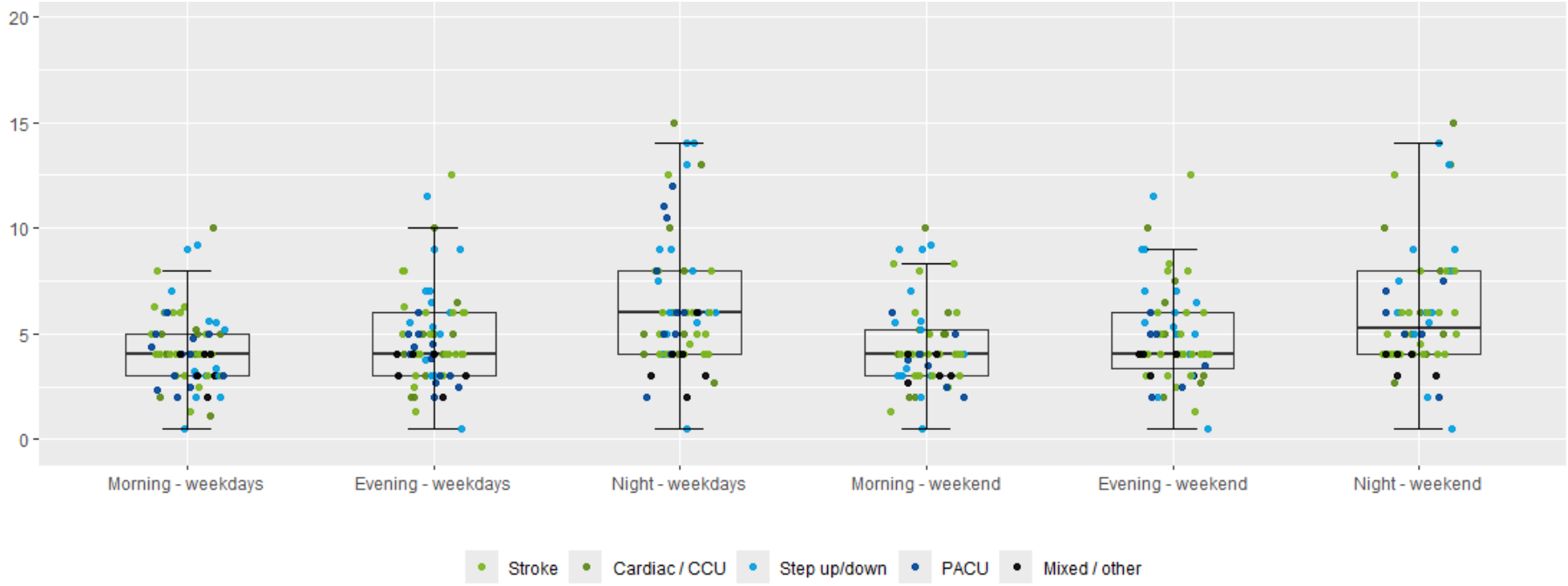
Among the 61 IMCUs for which a response was provided, 31 (50.8%) reported at least one nurse who was absent at the time of the survey. The proportion of absences among all nurses (registered staff nurses, head nurses and assistant head nurses) varies between 0% and 33.3% (median = 3.1%, IQR = 10.5%).

In 85.2% of 27 IMCUs with at least one care assistant, no care assistant was absent at the time of the survey. For logistic and support staff (N = 32) also, a large proportion of IMCUs (81.3%) did not report any absence.

LARGE VARIATION OF PATIENT-TO-NURSE RATIO BETWEEN INTERMEDIATE CARE UNITS

As for ICUs, the scheduled patient-to-nurse ratio is defined as the number of available beds divided by the number of scheduled registered nurses (including for instance staff from the float pool) providing direct patient care for a specific shift. Both types of information were asked in the survey, so that the scheduled patient-to-nurse ratio can be calculated for each IMCU for three shifts of a typical weekday (morning, defined as including the period from 10 am to 11 am; evening, defined as including the period from 6 pm to 7 pm; and night defined as including the period from 2 am to 3 am) and for the same three shifts of a typical day of the weekend or bank holiday. Figure 114 shows the scheduled patient-to-nurse ratio for the different shifts per IMCU, with a distinction between types of IMCUs. For the morning shift of a typical weekday, the median scheduled number of patients per nurse is 4 (IQR = 2). Scheduled patient-to-nurse ratios appear to be larger for the evening shifts, compared to the morning shifts and even larger for the night shifts. In the night shift of a typical day of a weekend or bank holiday, the median scheduled patient-to-nurse ratio is 5.25 (IQR = 4).

Figure 114 – Scheduled patient-to-nurse ratio, per IMCU



Weekdays: N = 69, missing = 22; Weekend: N= 61, closed = 10, missing = 20. Boxes are drawn from first quartile to third quartile with the median as inside line, whiskers are drawn from the box to the most extreme point that is less than or equal to 1.5 times the IQR, and dots represent IMCUs. Outliers > 20 are not shown.

Results regarding scheduled care assistants and logistic and support staff are available in Appendix to Chapter 7 in the Supplement.

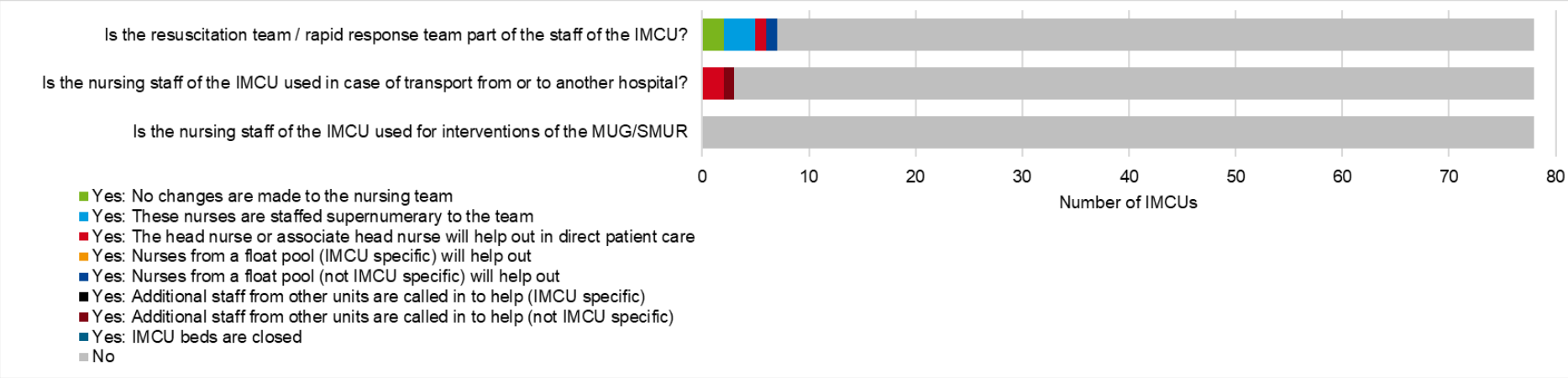
SOME INTERMEDIATE CARE UNITS CLOSE DURING THE WEEKEND

For 10 IMCUs (including 8 PACUs), the respondent explicitly recorded 0 available beds, and 0 scheduled staff, during a typical day of the weekend or bank holiday, meaning that these units are closed during these days. These units are not shown on the last three plots of Figure 114 as no patient-to-nurse ratio can be calculated for the weekend shifts.

NURSING TASKS OUTSIDE THE IMCU

Respondents were also asked whether the nursing staff of the IMCU takes up additional patient care tasks outside the unit. As shown in Figure 115, it is generally not the case. Staff from the IMCU nursing team is part of the resuscitation or rapid response team in only 7 units (9.0%) and in 3 of them the nurses of the resuscitation or rapid response team are supernumerary to the IMCU team. In only 3 IMCUs, the nursing staff is also deployed in case of transport from or to another hospital. In none of the IMCUs the nursing staff is deployed for intervention of the mobile urgency group (MUG – SMUR).

Figure 115 – Tasks of the IMCU nursing team outside the unit

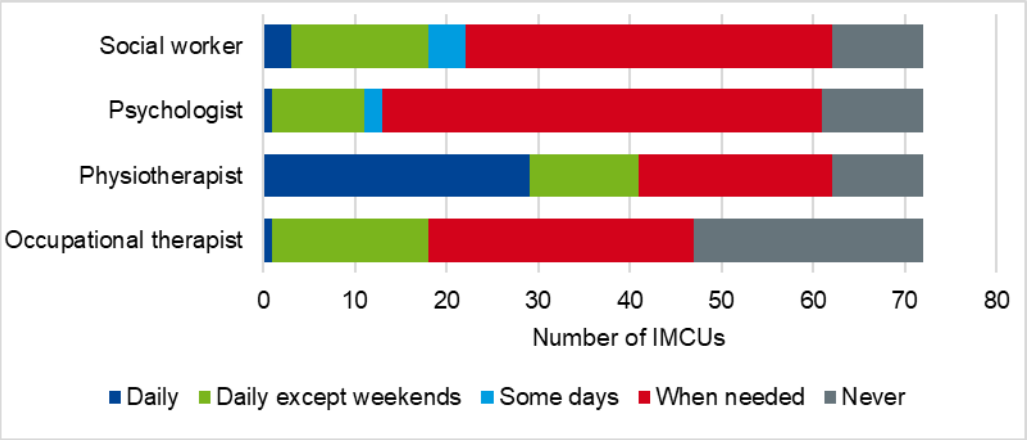


N = 78, missing = 13.

ALLIED HEALTHCARE STAFF AND OTHER CARE PROFESSIONALS

As illustrated by Figure 116, physiotherapists are available on a daily basis in 40.3% of the IMCUs, much less than for ICUs. Psychologists and social workers are available in most IMCUs (84.7% and 86.1% respectively) but in most of the cases, only when needed. Occupational therapists are available in 65.3% of the IMCUs, which is slightly more than for ICUs. This concerns mainly stroke units and step-up/step-down units. In 25.0% of the IMCUs an occupational therapist is available daily, in most of the cases not during the weekend. Globally, PACUs appear to have a lower availability of physiotherapists, psychologists, social workers and occupational therapists, compared to other types of IMCUs (see Appendix to Chapter 7 in the Supplement).

Figure 116 – Availability of allied healthcare staff and other care professionals in the IMCU



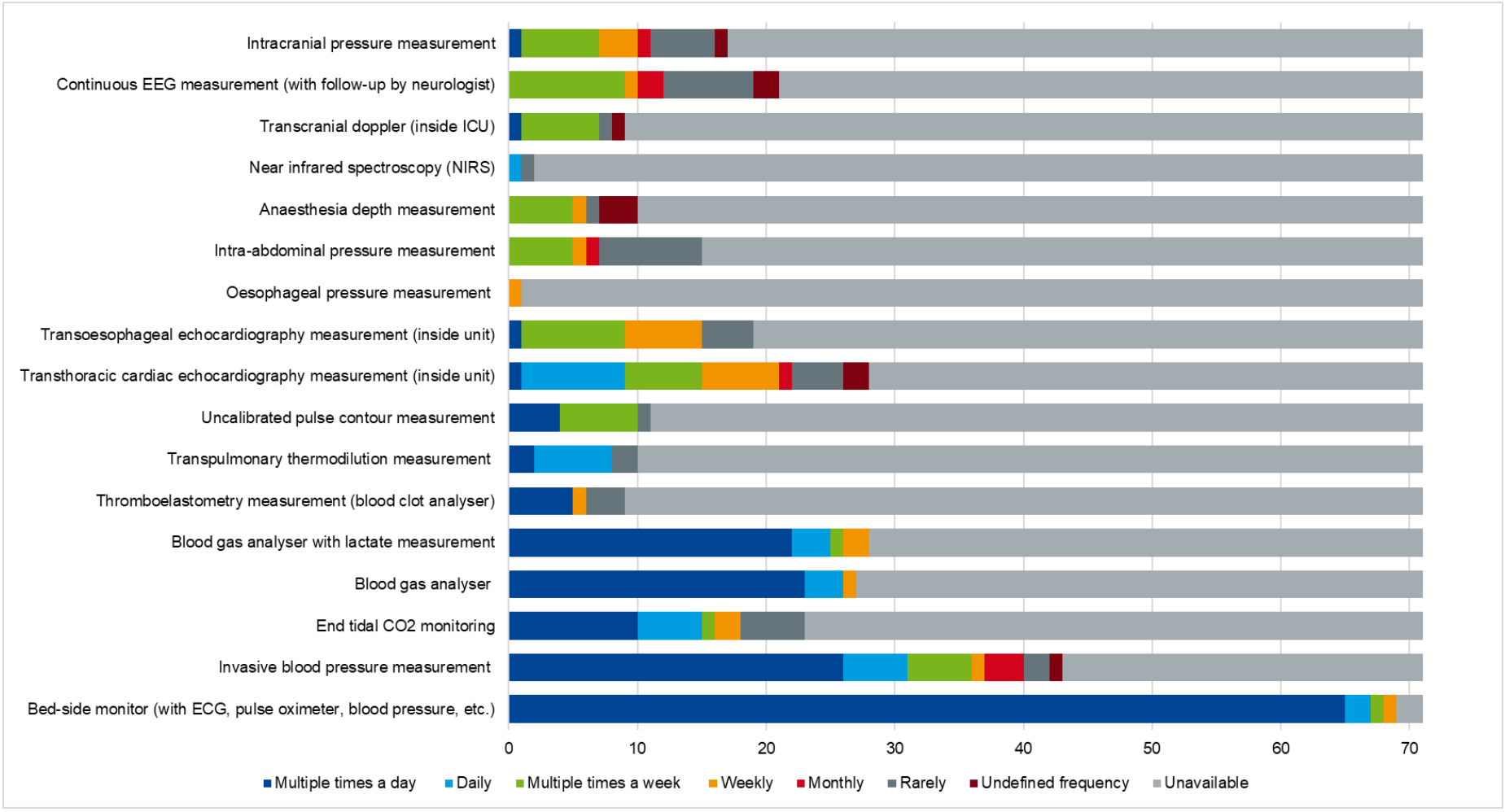
N = 72, missing = 19.

MONITORING AND DIAGNOSTIC OPTIONS

For each IMCU, respondents were asked to select, from a list of monitoring and diagnostic services and from a list of therapeutic options, which ones are available in the unit. As for ICUs, if no options were selected from both lists, we consider the responses to be missing for that unit, although it may also indicate that none of the options are available in the unit. This concerns 20 IMCUs. Figure 117 shows the results for available monitoring and diagnostic options, along with the frequency of use. Differences between types of IMCUs are presented in Appendix to Chapter 7 in the Supplement.

Bed-side monitoring (with ECG, pulse oximeter, blood pressure, etc.) is available in almost all IMCUs (97.2%), and mostly used multiple times a day (91.5%). Other options are less frequently available. Nevertheless, invasive blood pressure measurement; blood gas analyser; and blood gas analyser with lactate measurement are available and used multiple times a day in 36.6%, 32.4% and 31.0% of the IMCUs, respectively. This concerns mainly PACUs and, to a smaller extent also step-up and -down units. End tidal CO_2 monitoring is available in 32.4% of the IMCUs, but used multiple times a day in only 14.1%. In PACUs specifically, these proportions are 53.8% and 38.5% respectively. Transpulmonary thermodilution measurement and thromboelastometry measurement are only available in a limited number of IMCUs, but when available, tend to be used at least daily. The other suggested options are available in less than half of the IMCUs and a large variability is observed between units in the frequency of use. Oesophageal pressure measurement and near infrared spectroscopy are almost never available in IMCUs.

Figure 117 – Availability of monitoring and diagnostic options in the IMCU



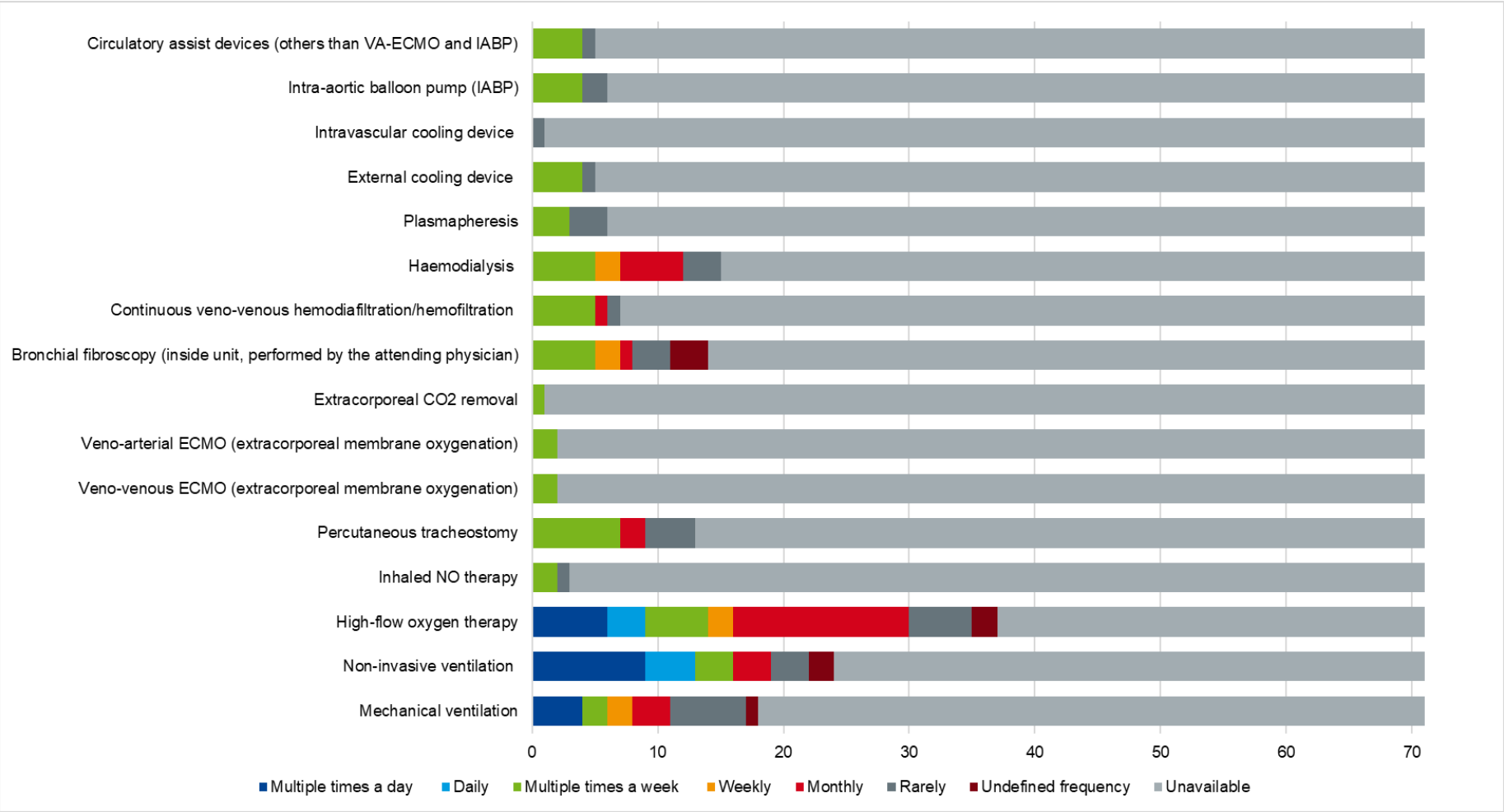
N = 71, missing = 20.

THERAPEUTIC OPTIONS

Availability and frequency of use in IMCUs for the suggested therapeutic options are presented in Figure 118. Mechanical ventilation, non-invasive ventilation and high-flow oxygen therapy are available in 25.6%, 33.8% and 52.1% of the IMCUs, respectively but the frequency of use varies largely between units. In contrast with ICUs, other suggested therapeutic options are available in less than 25% of the IMCUs and never used on a daily basis. Also, external pacemaker was mentioned as additional option for 4 units.

Differences can be observed between types of IMCUs (see Appendix to Chapter 7 in the Supplement). For instance, mechanical ventilation is never available in stroke units or CCU/cardiac units. Globally, the suggested options tend to be more commonly available in PACUs and step-up/step-down units than in stroke units or CCU/cardiac units.

Figure 118 – Availability of therapeutic options in the IMCU



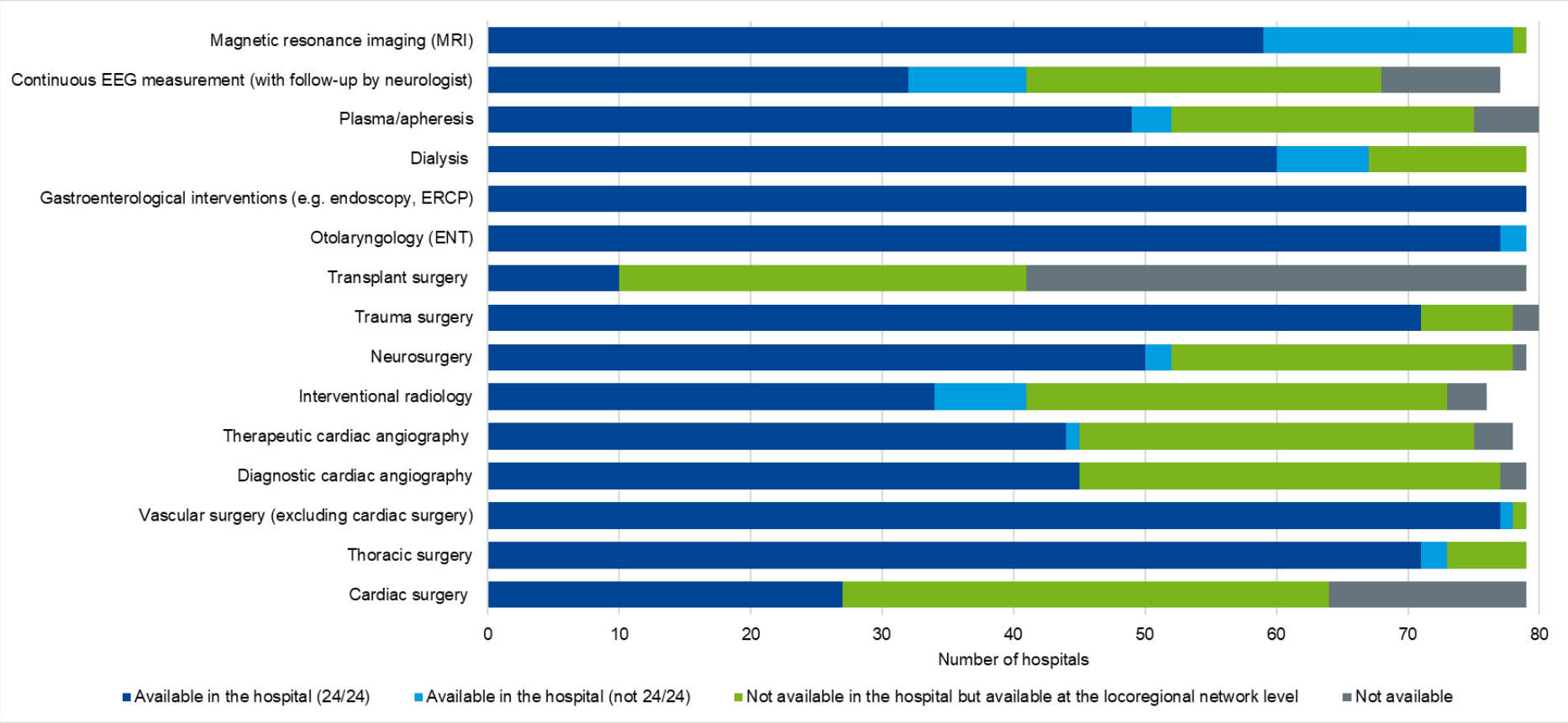
N = 71, missing = 20.

7.3.4 Interconnections with other hospital services and collaborations with other hospitals

MANY SERVICES ARE AVAILABLE, SOME WITHIN THE HOSPITAL, OTHERS AT THE LOCOREGIONAL NETWORK LEVEL

In order to grasp how intensive care services are connected to other hospital services, we asked respondents to select, among a predefined list, the services that are available in their hospital and those that are not available in their hospital but available at the locoregional hospital network level. For the services available in the hospital it was further requested to identify those available 24/7. For this question and for the following ones, responses were asked at the hospital level (not at the unit or site level). Results are presented in Figure 119. Thoracic surgery, vascular surgery, trauma surgery, otolaryngology, gastroenterological interventions and magnetic resonance imaging are available, within the hospital, in almost all responding hospitals. Except MRI, these services are largely available 24/7. Dialysis is available within 85.0% of the responding hospitals, but is available at the network level for all of them. A group of services (diagnostic cardiac angiography, therapeutic cardiac angiography, interventional radiology, neurosurgery, plasma/apheresis and continuous EEG measurement) are available in around half of the hospitals. If not available within the hospitals, they are largely available via the hospital network. Cardiac surgery is available in 34.2% of the responding hospitals, but is accessible for 81.0% at the network level. Note that in the six university hospitals that participated to the survey, all suggested services are available 24/7 within the hospital.

Figure 119 – Availability of other hospital services



80 responding hospitals. Missing values for each item can be identified on the figure.

TRANSFERS OF ICU-PATIENTS

Respondents were also asked to indicate if their hospital was mainly receiving ICU-patients from other hospitals or mainly referring patients to other hospitals. They also had the option to state their hospital was neither a receiving nor a referring hospital. Results are presented in Table 39, for all hospitals and by type of hospital (university, university like and general hospitals). The largest group of hospitals was qualified as neither receiving neither referring hospitals. However, an almost equally large group was qualified as receiving hospital by the respondents. All university hospitals are receiving ICU-patients. Among general hospitals, however, only 25% define themselves as receiving hospitals.

Table 39 – Receiving and referring hospitals

	All hospitals (N=80)		University hospitals (N=6)		University like hospitals (N=14)		General hospitals (N=60)	
Receiving	29	36.3%	6	100.0%	8	57.1%	15	25.0%
Referring	20	25.0%	0	0.0%	2	14.3%	18	30.0%
Neither	31	38.8%	0	0.0%	4	28.6%	27	45.0%

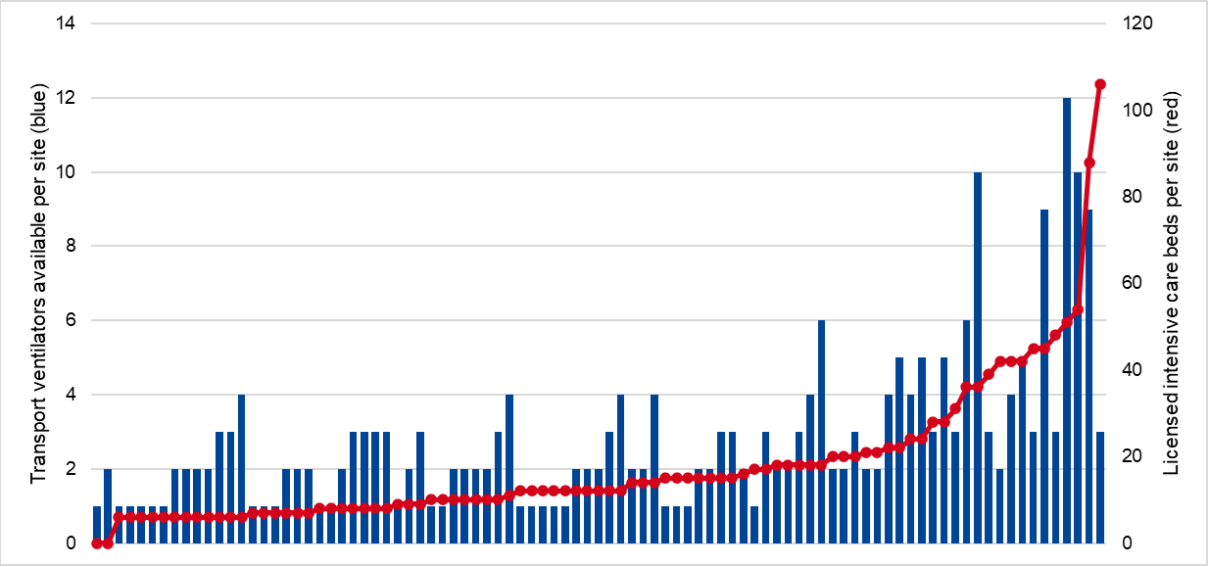
Missing = 0.

Respondents from referring hospitals (N = 20) were then asked to select the main reason for referring patients. For ten of them, patients are mainly referred because appropriate medical expertise is lacking at the ICU or within the hospital (e.g. neurosurgery, cardiac surgery, coronary angiography, burn care). In five hospitals, the absence of interventional radiology is the main reason for referring ICU-patients. Capacity issues were also mentioned: insufficient beds (two hospitals) and insufficient staffed beds (one hospital). Two hospitals mentioned other reasons including referral for ECMO, transplantation, very specific care or too severe pathology.

For all hospitals (N = 80), it was also asked if the transfers of critically-ill patients was structurally organised via a dedicated transport team, rather than done on an ad-hoc basis. The transfer is structurally organised in 34 hospitals (42.5%). For 32 of them (94.1%) this service is available 24/7. Note that in all but one (83.3%) university hospitals transfers are structurally organised 24/7.

Figure 120 shows the number of transport ventilators that are available, per hospital site (ordered by the number of licensed intensive care beds). The number of transport ventilators ranges from to 1 to 12 (median = 2, IQR = 1.5).

Figure 120 – Transport ventilators, per hospital site



N = 91, missing = 9. Red dots show the number of licensed intensive care beds per site (right axis).

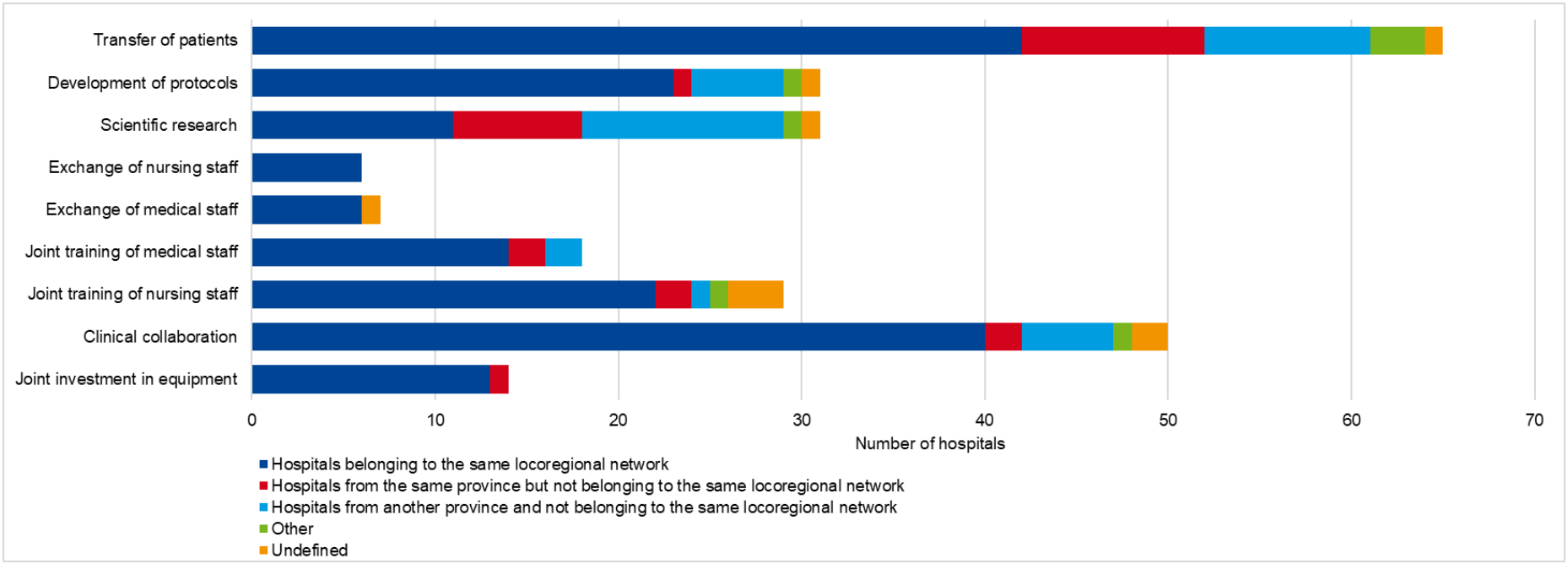
COLLABORATION INITIATIVES WITH OTHER HOSPITALS FOR INTENSIVE CARE

At the level of the hospital, respondents had to select, from a given list, which collaboration initiatives for intensive care exist with other hospitals. For each initiative selected they had to indicate with which hospitals (of the same locoregional network, of the same province but not the same network, or of another province and network) they collaborate the most. Results are shown in Figure 121. When a specific collaboration initiative is not selected, it is not possible to determine whether it is because such collaboration does not exist or whether the respondent chose not to answer. Nevertheless, there are only 9 out of 80 hospitals for which none of the possible collaborations were selected.

Most hospitals (81.3%) collaborate with others for the transfer of ICU-patients. After that, clinical collaboration is the most common collaboration initiative between hospitals (62.3%). Collaborations regarding scientific research and development of protocols are also common (38.8% of the hospitals in each case). Regarding joint training, more collaboration takes place for the training of nursing staff (36.3%) than for the training of medical staff (22.5%). Joint investment in equipment and exchanges of medical or nursing staff are much less common. In addition, four respondents detailed further collaboration (i.e. full collaboration between two parts (with a different license number) of the same hospital, or merger of two services from two different hospitals). One respondent added a collaboration with hospitals from the same province but different network regarding organ donation.

The collaboration initiatives shown in Figure 121 take place mainly between hospitals of the same locoregional network, except for collaborations on scientific research that take place with all types of hospitals. Also, a non-negligible part of transfers collaboration occur beyond the network. The ‘other’ category (in green on the figure) was selected by respondents for larger collaborations (for instance inside *and* outside the network), to mention a specific (university) hospital, or to make reference to international collaborations.

Figure 121 – Collaboration initiatives with other hospitals for intensive care



N = 80. For 9 hospitals no option was selected.

TELEMEDICAL PLATFORMS FOR INTENSIVE CARE

Respondents were also asked if their hospital belongs to a telemedical platform for intensive care. Among the 77 hospitals for which an answer was provided (missing = 3), only 2 (2.6%) belonged to such a platform. When asked how this network is organised, one of them answered that the data are transmitted through the IT system, and the other referred to the Euroregional platform for the intensive care departments of Belgian and Dutch Limburg LICHO.[w]

7.3.5 Organisation of intensive care services in levels of care

OPINIONS ABOUT THE ORGANISATION IN LEVELS OF CARE ARE MIXED…

While it is currently not the case in Belgium, in several other countries intensive care is organised in levels (see Chapter 9). In the survey, respondents were asked whether they were in favour of a reform of intensive care which introduces levels of care. Half of them answered positively and half of them negatively (see Figure 122). Respondents from university hospitals tend to be more favourable to such an organisation in levels as well as hospitals with a (self-defined) specialised ICU and hospitals without an IMCU. Also among very small hospitals (less than 200 beds), more respondents answered positively. However, this last result must be interpreted with caution as only five of the participating hospitals have less than 200 beds.

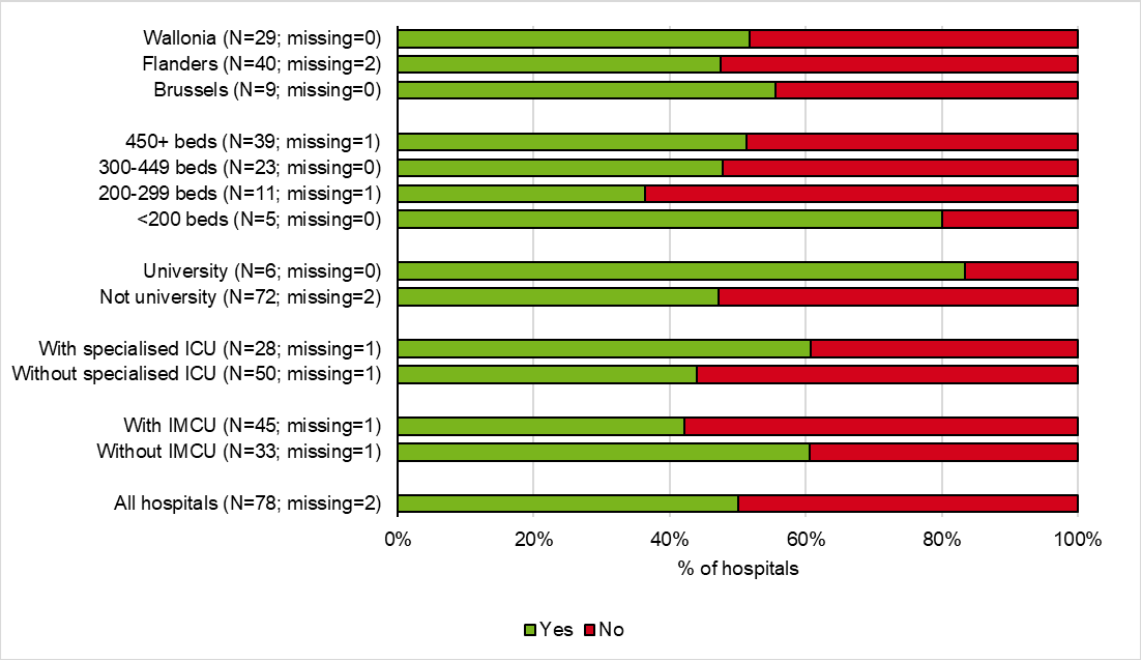
Both opponents and proponents use arguments on quality of care and the staffing perspectives to motivate their position on levels of care. The opponents argue that an introduction of levels of care (apart from some very rare specialisation areas such as burn care, organ transplant, etc. requiring 1:1 patient-to-nurse ratios) is not good for the quality of patient care. After all, the condition of critically ill patients can evolve rapidly and it is therefore important that all ICUs can up- or downscale care flexibly. This is not possible in case of formal levels of care, as it requires transfers, which is costly and labour intensive. Patients are also treated by different teams in another setting which is not good in terms of continuity of care. Moreover, they state that introducing levels of care will make the lower levels of care less attractive areas to work in for both doctors and nurses. This is not only problematic in terms of the tight labour market, it will also 'de-skill' the nurses and physicians which might make upscaling care even more difficult in case of sanitary crises (i.e. less nurses and physicians have the versatile expertise needed to take care of critically ill patients).

According to the advocates, the quality of care will improve when introducing levels of care. They state that the care for the most complex patients (e.g. major trauma surgery, ECMO, neurosurgery.) requires a critical mass of patients to build up and maintain expertise. Proponents of levels of care argue that it will facilitate the efficient allocation of the scarcely available expertise in critical care among nurses and physicians. Yet, when levels of care are introduced also the financing has to be adapted so that a differentiation in staffing is possible (e.g. adapted patient-to-nurse ratios).

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[w] https://www.licho.be/

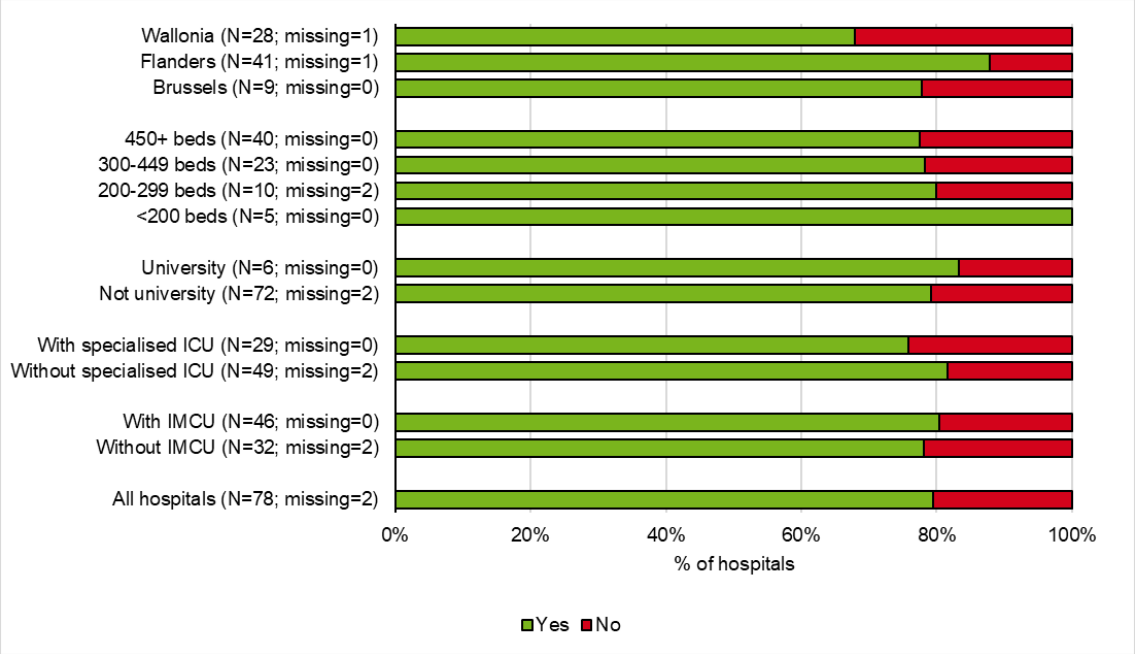
Figure 122 – Attitude towards an organisation of intensive care in levels, per hospital



… BUT INTERMEDIATE CARE SHOULD BE PART OF THE CARE SUPPLY

If the intensive care landscape in Belgium is reformed, 79.5% of the respondents are in favour of intermediate care units to be part of the care offer (see Figure 123). No strong differences are observed between respondents from university or non-university hospitals, between hospitals with or without a (self-defined) specialised ICU and between hospitals with or without an IMCU. The preference towards IMCUs as part of the care landscape is more marked in Flanders than in Brussels and Wallonia. Among very small hospitals (less than 200 beds), all respondents prefer to have IMCUs as part of the future ICU landscape. Nevertheless, this should be interpreted with caution as there are only five participating hospitals in that category.

Figure 123 – Attitude towards intermediate care units as part of the intensive care landscape, per hospital

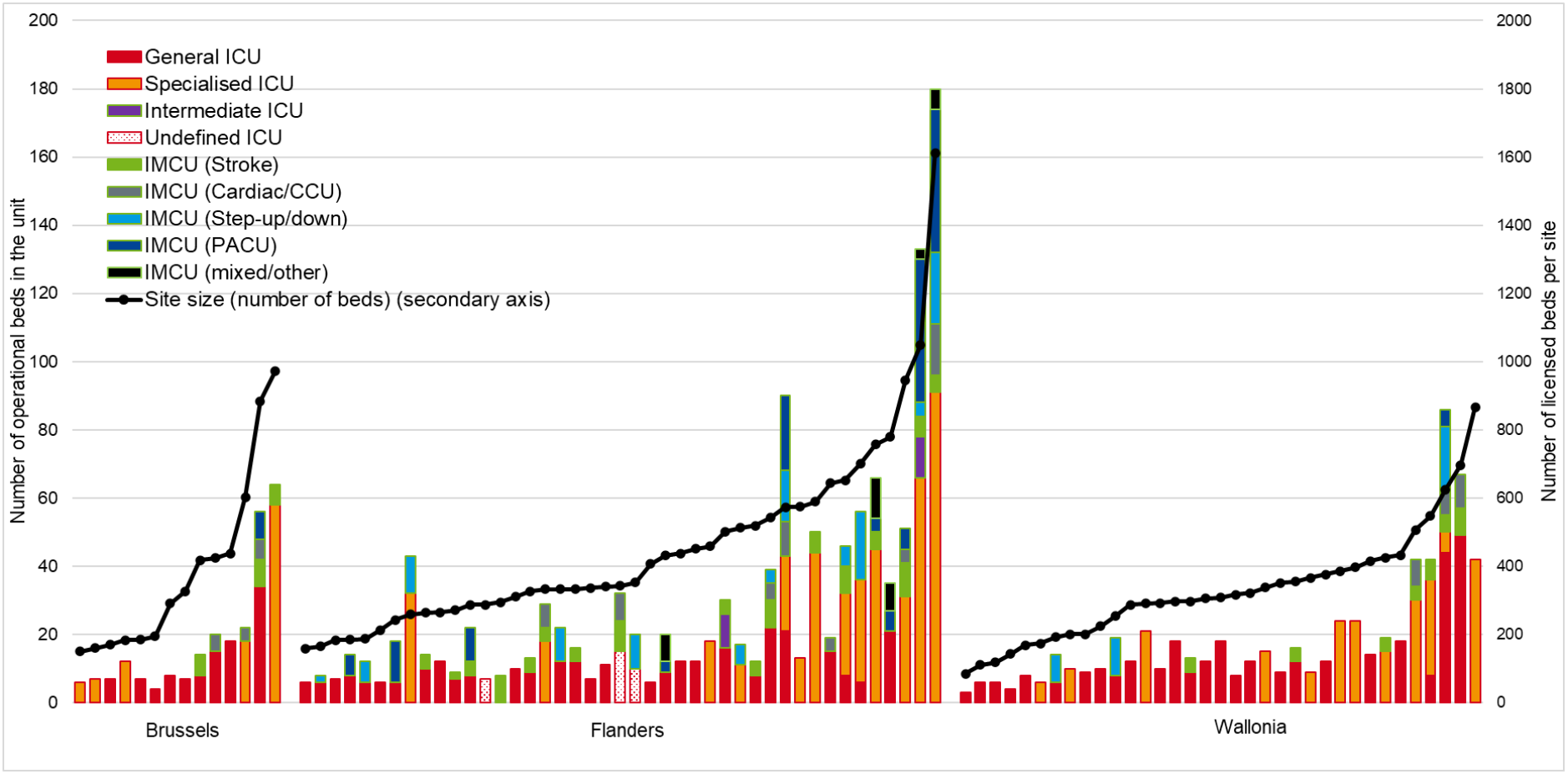


CURRENT ORGANISATION OF INTENSIVE AND INTERMEDIATE CARE IS VERY DIVERSE AND DIFFERS BETWEEN REGIONS

Although levels of intensive care are not formally defined in Belgium, in the survey respondents were asked to differentiate units not only between ICUs and IMCUs but also between different types of these units. As described in section 7.3.2, they had to categorise each ICU into 'general ICU' defined as '*ICU managing patients with multiple organ dysfunctions',* 'specialised ICU' defined as *'ICU with complex management of organ dysfunctions requiring highly specialised techniques or populations of patients with specific or rare conditions'*, and 'intermediate care'. An 'undefined' category was created for missing answers. They also had to categorise each IMCU (see section 7.3.3 and Figure 104) into the following types: 'stroke', 'step-up/down', 'PACU' and 'cardiac and coronary care units'. An additional 'mixed/other' category was created based on the respondent's comments. As described in the previous sections, respondents also provided unit-specific information such as the number of licensed beds and the number of operational beds. Figure 124 draws the Belgian intensive care landscape based on these answers. On the figure, each bar represents a hospital site (ordered by region and by total number of licensed beds in the hospital site). The size of the bar shows the number of operational beds in the identified units of each hospital site, differentiated by type of unit. A similar figure with the number of licensed beds is available in Appendix to Chapter 7 in the Supplement.

The organisation of intensive care largely differs between hospital sites. The number of operational intensive or intermediate care beds is increasing with the size of the hospital site (in terms of total number of licensed beds) but there are some exceptions. Although some hospital sites combine general and specialised ICUs, in most cases, the site has either a general or a specialised service. Specialised ICUs are not necessarily located in the largest hospital sites (in terms of total number of licensed beds) and are not necessarily larger (in terms of number of operational beds in the service). Nevertheless, it should be kept in mind that respondents may have interpreted 'specialised ICU' as an ICU that is specific to a given organ rather than one that provides highly specialised care. Also, IMCUs are not necessarily located in larger hospital sites or hospitals, nor are they always integrated with general or specialised ICUs. The size of the IMCUs (in terms of operational beds in the unit) does not seem to be related to the size of ICUs in the hospital site. Finally, IMCUs are more common in Flanders than in the other regions.

Figure 124 – Number of operational beds in ICUs and IMCUs, per hospital site



N = 92, missing = 8. The hospital sites are ordered by region (Brussels – Flanders – Wallonia) and total number of licensed beds (all types) in September 2022 (data FOD – SPF), shown by the black dots. As soon as the number of operational beds is missing for one unit of the hospital site, the hospital site is considered missing.

CURRENT ORGANISATION IS CHARACTERISED BY MANY HIGH LEVEL SERVICES

The World Federation of Societies of Intensive and Critical Care Medicine defines an ICU as '*an organised system for the provision of care to critically ill patients that provides intensive and specialised medical and nursing care, an enhanced capacity for monitoring, and multiple modalities of physiologic organ support to sustain life during a period of life-threatening organ system insufficiency*'.[7] It also stratifies ICU care in three levels, as follows:

- A level 1 ICU is capable of providing oxygen, non-invasive monitoring, and more intensive nursing care than on a ward;
- A level 2 ICU can provide invasive monitoring and basic life support for a short period;
- A level 3 ICU provides a full spectrum of monitoring and life support technologies, serves as a regional resource for the care of critically ill patients, and may play an active role in developing the specialty of intensive care through research and education.

The World Federation of Societies of Intensive and Critical Care Medicine proposed a descriptive framework to classify ICUs into these three levels, based on criteria related to therapeutic capacity, personnel, monitoring capacity, unit design and organ support, integration within the hospital, research and education, and responsiveness to regional and societal needs. Although not all criteria were explored in the survey, we translated part of them into information that could be retrieved from the answers to the survey. Doing so, we categorised Belgian hospital intensive care services into three levels. The analysis is carried out at the hospital site level. The criteria used are detailed in Table 40. As not all criteria defined by the World Federation of Societies of Intensive and Critical Care Medicine could be explored, the following analysis should be interpreted with caution.



Table 40 – Criteria for ICU levels classification

Level 1	Level 2	Level 3
	Number of **physicians** (with a title in intensive care) *present or available on call* on nights during weekdays ≥ 1	Number of **physicians** (with a title in intensive care) *present* on nights during weekdays ≥ 1
	Number of **nurses with a special title** in emergency and intensive care ≥ 1*	Number of **nurses with a special title** in emergency and intensive care ≥ 1*
	Physiotherapy available daily OR daily except weekends OR some days	**Physiotherapy** available daily
Scheduled patient-to-nurse ratio on weekday (morning shift) ≤ 4	**Scheduled patient-to-nurse ratio** on weekday (morning shift) **≤** 3	**Scheduled patient-to-nurse ratio** on weekday (morning shift) **≤** 2
Availability of the following **monitoring and diagnostic** options: - Bed-side monitor (with ECG, pulse oximeter, blood pressure, etc.)	Availability of the following **monitoring and diagnostic** options: - Bed-side monitor (with ECG, pulse oximeter, blood pressure, etc.) - Invasive blood pressure measurement - Blood gas analyser	Availability of the following **monitoring and diagnostic** options: - Bed-side monitor (with ECG, pulse oximeter, blood pressure, etc.) - Invasive blood pressure measurement - Blood gas analyser + Availability of at least one of the following advanced haemodynamic monitoring options: - Transpulmonary thermodilution measurement - Uncalibrated pulse contour measurement - Transthoracic cardiac echocardiography measurement (inside unit) - Transoesophageal echocardiography measurement (inside unit) - Oesophageal pressure measurement + Availability of at least one of the following advanced monitoring options: - Transcranial doppler (inside ICU) - Continuous EEG measurement (with follow-up by neurologist) - Intracranial pressure measurement - Intra-abdominal pressure measurement - Anaesthesia depth measurement - Near infrared spectroscopy (NIRS)

Availability of the following **therapeutic** options: - Non-invasive ventilation - High-flow oxygen therapy	Availability of the following **therapeutic** options: - Non-invasive ventilation - High-flow oxygen therapy - Mechanical ventilation	Availability of the following **therapeutic** options: - Non-invasive ventilation - High-flow oxygen therapy - Mechanical ventilation - Continuous veno-venous hemodiafiltration/hemofiltration - Percutaneous tracheostomy + Availability of at least one of the following advanced respiratory and haemodynamic support options: - Veno-venous ECMO (extracorporeal membrane oxygenation) - Veno-arterial ECMO (extracorporeal membrane oxygenation) - Circulatory assist devices (others than VA-ECMO and IABP)

Source: Adapted from Marshall et al. (2017)[7]

** The number of nurses with a special title in emergency and intensive care is missing for 16 hospitals. In all but one other hospitals, this number is greater or equal to 1. In a previous KCE survey (Van den Heede et al. (2022)) it was estimated that 80% the nurses working in ICUs had such special title.[10] Therefore, we considered that the number of nurses with a special title in emergency and intensive care is greater than or equal to 1 in all hospitals for which these data are missing.*

Using responses from the survey, if all criteria for level 3 are fulfilled, the hospital site is categorised as level 3; otherwise, if all criteria for level 2 are fulfilled, the site is categorised as level 2, etc. If not all criteria for level 1 are fulfilled, the site is categorised as level 0. Due to missing information in the survey, only 87 hospital sites could be categorised (missing = 13). Results are presented in Table 41. Most hospital sites (participating in the survey) can be categorised as level 2 according to the criteria in Table 40 while 15 hospital sites can be categorised as level 3. Most of those level 3 sites are sites with at least one (self-defined) specialised ICU. They are not necessarily located in university hospitals.

Table 41 – Classification of hospital sites

	All sites (N=87)	Sites with at least one specialised ICU (as defined by the respondent) (N=30)	Sites with at least one general ICU but no specialised ICU (as defined by the respondent) (N=54)	Sites in university hospitals (N=5)
Level 3	15 (17.2%)	12 (40.0%)	3 (5.6%)	3 (60.0%)
Level 2	52 (59.8%)	13 (43.3%)	38 (70.4%)	2 (40.0%)
Level 1	19 (21.3%)	5 (16.7%)	12 (22.2%)	0 (0.0%)
Level 0	1 (1.1%)	0 (0.0%)	1 (1.9%)	0 (0.0%)

The 19 hospital sites classified as level 1 satisfy some, but not all criteria to be classified as level 2. For instance, all but one of them have a patient-to-nurse ratio in the morning shift of a weekday smaller or equal to 3. Also all but one of them have physiotherapy available and in all but two of them, non-invasive ventilation, high-flow oxygen therapy and mechanical ventilation are available. However, the availability during the night of a physician with the title in intensive care is only satisfied in 11 of the 19 level 1 sites. Similarly, the availability of invasive blood pressure measurement and blood gas analyser is only satisfied in 8 of the 19 level 1 hospital sites.

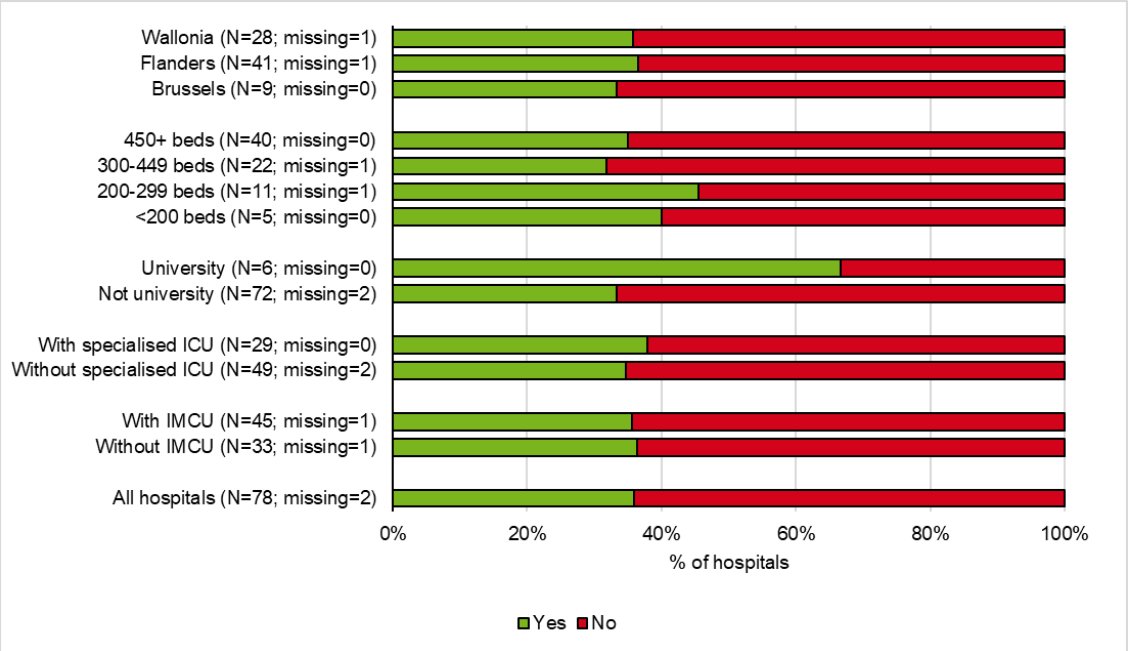
Among hospital sites classified in level 2, most of them satisfy the level 3 criterion regarding physiotherapy (50/52) and the level 3 criterion regarding monitoring and diagnostic options (48/52). Also, the presence during the night of a physician with the title in intensive care is satisfied in 34 of the 52 level 2 hospital sites. However, the patient-to-nurse ratio criterion for level 3 is only satisfied in 18 of the 52 level 2 hospital sites and the level 3 criterion regarding therapeutic options is only satisfied in 14 of the 52 level 2 hospital sites. Regarding the two university hospital sites classified as level 2, one of them does not have any physician with a title in intensive care present on nights during weekdays and the other one does not satisfy the criterion for therapeutic options. Except from that, these hospital sites satisfy all criteria for level 3.

7.3.6 Future priorities regarding intermediate care

A THIRD OF HOSPITALS CONSIDER EXTENDING THEIR INTERMEDIATE CARE CAPACITY

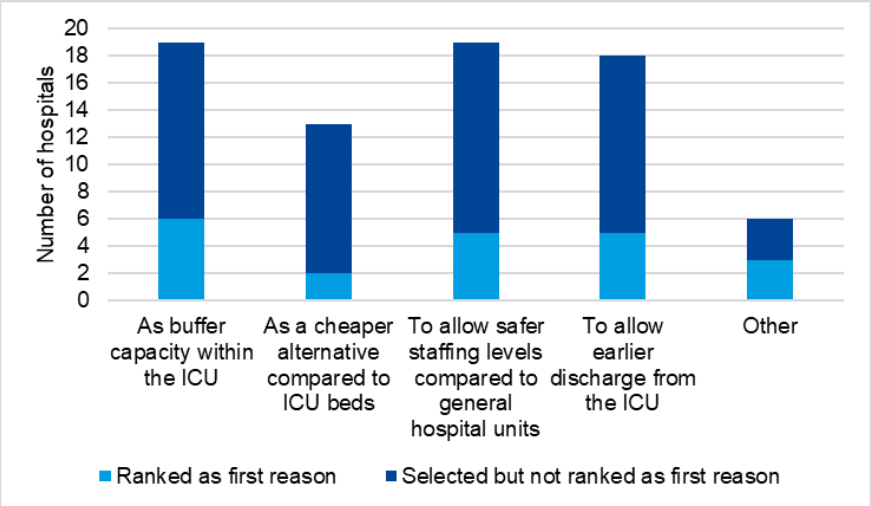
When asked whether they were considering to open (additional) intermediate care units or beds in their hospital, 35.9% of the respondents answered positively. As shown in Figure 125, there are no strong differences between regions, between hospitals of different sizes, between hospitals with or without (self-defined) specialised ICU and between hospitals that already have an IMCU or not. However, 66.7% of the respondents from university hospitals consider to open additional IMCUs, compared to 33.3% in non-university hospitals, although these results should be interpreted with caution due to the small number of university hospitals.

Figure 125 – Hospitals considering to open (additional) intermediate care units or beds



Respondents who answered they consider to open (additional) IMCUs or beds were then asked to select which reasons apply (from a list of suggested reasons) and to rank the selected reasons from the most to the least important. As shown in Figure 126, the most important reason varies largely between hospitals. Nevertheless, three of the suggested reasons apply in most cases: 70.4% of the respondents would use the IMCU as buffer capacity within the ICU, 70.4% would use it to allow safer staffing levels compared to general hospital units and 66.7% would use it to allow earlier discharge from the ICU. For 48.1% of the respondents, an IMCU is a cheaper alternative than an ICU. Other mentioned reasons include: to avoid unnecessary admissions to ICU through early monitoring and intervention; to increase capacity for patients requiring monitoring or to regroup existing close monitoring capacities, and to improve quality of care and patient safety. One respondent mentioned that a clear separate definition is needed between IMCU and ICU beds, in terms of admission and discharge criteria, necessary equipment and necessary staffing. According to the respondent, many intermediate care beds are currently considered as ICU beds.

Figure 126 – Reasons to open (additional) intermediate care units or beds

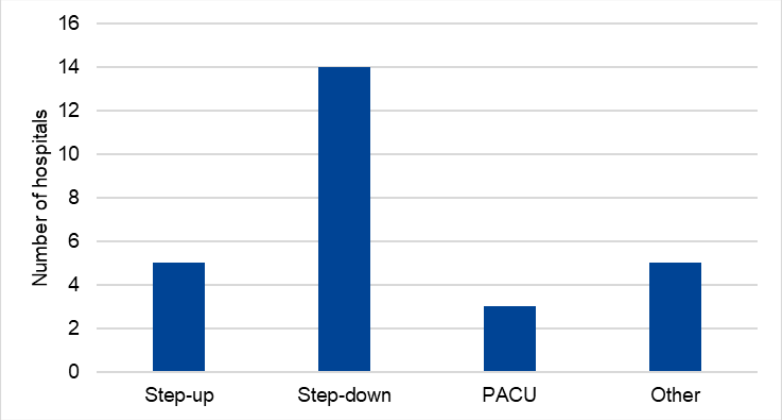


N = 27, missing = 1.

PRIORITY TOWARDS STEP-DOWN UNITS, LINKED TO THE ICU

The same respondents were also asked what type of IMCU would be a priority in their hospital. Responses are shown in Figure 127. In most of the cases (51.9% of the respondents), the priority would go to a step-down unit. No further details were asked, so that it cannot be identified whether respondents refer to a medical or a surgical step-down unit. Step-up units and PACU were chosen by respectively 18.5% and 11.1% of the respondents. Respondents who selected the 'other' option, mainly describe mixed units (e.g. step-up, step-down and PACU, or intermediate and intensive care).

Figure 127 – Type of IMCU that would be a priority in the hospital



N = 27, missing = 1.

Respondents who answered that they consider to open (additional) IMCUs or beds were also asked how they would organise it. The answer options were the same as for existing IMCUs (see Figure 106). In contrast to existing IMCUs, most of the respondents would organise the future IMCU linked to the ICU: 28.6% as a unit adjacent to the ICU with the same management as the ICU, 17.9% as a part of the ICU, and 10.7% as a unit adjacent to the ICU with its own management (see figure in Appendix to Chapter 7 in the Supplement). For 17.9% of the respondents it would be a part of a general hospital unit and for 14.3% it would be a dedicated stand-alone unit.

DELIBERATE CHOICE NOT TO SEPARATE INTERMEDIATE AND INTENSIVE CARE, OR STAFF CONSTRAINT

The large group of respondents who stated they did not consider to open (additional) IMCUs or beds in the future were also asked to clarify their choice (see figure in Appendix to Chapter 7 in the Supplement). For most of them (53.2%) it is preferable to include intermediate care patients within the ICU. Also, for a large group of respondents (42.6%), there is not enough staff available to organise intermediate care. Many hospitals mentioned other reasons including costs/financing issues and an already large existing IMCU capacity.

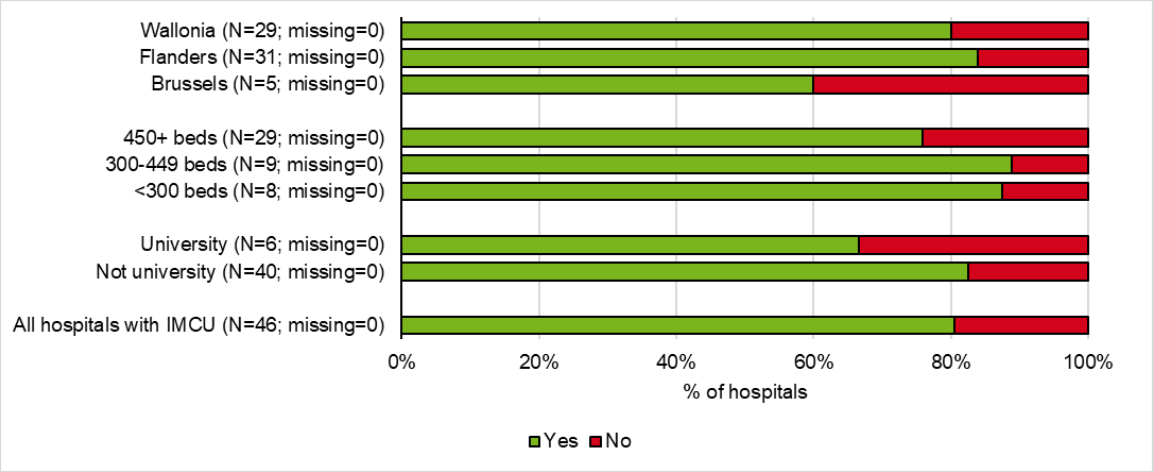
7.3.7 Upscaling of intermediate care units in case of pandemic

MOST HOSPITALS SCALED UP INTERMEDIATE CARE UNITS DURING THE COVID-19 PANDEMIC

The last part of the questionnaire concerned the role of intermediate care units in case of a pandemic like COVID-19. First, respondents were asked whether intermediate care units were scaled up to an intensive care unit during the COVID-19 pandemic. This question was asked for all hospitals, including those that do not currently have an IMCU. For about half of the hospitals without IMCU, the respondent stated anyway that IMCUs were scaled up during the COVID-19 pandemic. It is possible that the respondents interpreted this question in general terms rather than specifically for their hospital. Therefore, Figure 128 shows the results only for the 46 hospitals with at least one IMCU. In 80.4% of them, IMCUs were scaled up to an ICU during the COVID-19 pandemic. This share is smaller among

university hospitals and large hospitals (450+ beds). It was also smaller in Brussels compared to Flanders and Wallonia.

Figure 128 – Upscaling of intermediate care units during the COVID-19 pandemic



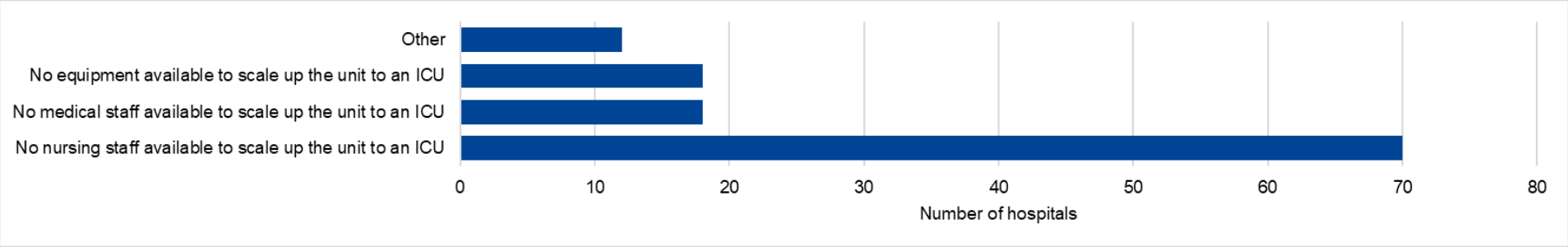
MANY STRATEGIES TO SCALE UP INTERMEDIATE CARE UNITS IN CASE OF A FUTURE PANDEMIC

In case of a future pandemic similar to COVID-19, all respondents were asked to select all strategies they would use to scale up intermediate care units (see figure in Appendix to Chapter 7 in the Supplement). Three out of four hospitals (74.0%) would mix the nursing teams of the IMCUs with ICU teams to scale up overall ICU expertise. General hospital units would be transformed into IMCUs (51.9%) or the number of beds would be reduced to free up staff (63.6%). Additional nursing staff would be mobilised outside the team (50.0%) and within the team (39.0%). Fast training in intensive care for nurses would be used by half (46.8%) of the hospitals. Finally, less than a third (28.6%) would close some intermediate care beds to increase the staff available for the remaining beds. Also, many hospitals suggested additional strategies including increasing the support of ICU nurses (e.g. more supporting staff on ICUs), opening intermediate care units to ensure that ICU capacity is dedicated to the care of very critically ill patients only, using teams with expertise related to ICU (e.g. PACU, pulmonology, emergency care) to staff the ICUs, etc.

LACK OF NURSING STAFF IS THE MAIN BARRIER TO SCALE UP INTERMEDIATE CARE UNITS IN CASE OF A FUTURE PANDEMIC

Respondents were also asked to select all barriers to scale up intermediate care units in their hospital. From Figure 129 it can be seen that the most important obstacle is the lack of available nursing staff. This option was selected by 90.9% of the respondents. In contrast, the lack of medical staff and the lack of equipment were only selected by 23.4% of the respondents. It was also mentioned that ICU expertise is scarce and in addition it is not something that can be acquired overnight, it demands years of experience and training. Others stated that the lack of an intermediate care unit hampered them to scale up units. Introducing permanent IMCUs would help in case of future pandemics as this would increase the capacity to scale up non-ICU units (i.e. IMCUs have more potential to scale up to ICU compared to general units).

Figure 129 – Barriers to scale up intermediate care units



N = 77, missing = 3.

STRATEGIES FOR SUFFICIENT INTENSIVE CARE CAPACITY IN CASE OF CRISIS

Finally, respondents were asked to describe the policy measures that should be taken in order to provide sufficient intensive care capacity in the future during a crisis such as the COVID-19 crisis. To enhance ICU capacity and better prepare for future health crises in Belgium, several essential measures are recommended by hospitals. The main suggested measures were staffing related including a revalorisation of the nursing profession in general and ICU nurses in specific, better staffing standards in ICU (e.g. 2:1 instead of 3:1 patient-to-nurse ratios), regular rotation of non-ICU staff in ICUs outside crisis periods, lower taxes on overwork during crisis periods, creating a personnel reserve for crisis response, etc.

Hospitals also emphasise the importance of avoiding the rationalisation of acute beds (ICU beds in particular) and investing in intermediate care units that can be upgraded as needed. Other measures include optimising patient flow by favouring early discharge from ICUs to intermediate units, imposing targeted closures or reductions of non-essential medical activities, a central organisation of bed utilisation during crisis to obtain a maximum use of bed capacity across the Belgian territory, etc. Also setting clear admission criteria for ICU (by some linked to levels of care and transport) were seen as part of the solution. This also includes an ethical dimension since some linked it to a DNR-policy and advanced care planning. Some also mentioned that investments in (centralised) strategic stocks (medication and material) are needed.

Overall, a strategic approach involving financial reinforcement, staffing flexibility, and clear communication is essential to navigate future healthcare challenges effectively.

7.3.8 Additional elements

Some respondents wanted to give some last important messages which KCE should incorporate in the study including that:

- Currently, adequate funding for specialised nursing and medical staff in ICUs and intermediate care units (IMCUs) is lacking.
- The crisis highlighted the necessity of retaining properly funded general intensive care units across hospitals to ensure qualitative care.
- The shortage of specialised nurses poses significant challenges and there is a need for a substantial improvement in the working conditions of healthcare personnel, coupled with an increase in the number of ICU beds.
- A transparent policy regarding the acquisition and maintenance of licensed intensive care beds is needed.

8 ANALYSIS OF INTERVIEWS WITH KEY INFORMANTS

KEY POINTS

- The ICU capacity in Belgium is characterised by a high density of ICU beds. Yet, exact numbers are uncertain as ICU beds are part (as a hospital function) of surgical, internal medicine and paediatric beds. Different concepts (financed, licensed, and operational beds) result in different figures.
- The interpretation of the high number of ICU beds per 100 000 inhabitants in Belgium requires a comprehensive analysis of the capacity use (case-mix, length of stay, patient acuity), expertise, and staff numbers. This evaluation is interconnected with a broader analysis of the hospital landscape.
- In Belgium, formalised intermediate care units currently do not exist. As a result, there are more patients with intermediate care profiles (e.g. less stringent criteria for ICU admission and longer length of stay) staying in Belgian ICUs compared to countries with separate intermediate care capacity. This is linked to high patient-to-nurse ratios in Belgian ICUs.
- The ICU capacity is influenced by the dense and fragmented hospital system in Belgium, resulting in many small ICUs in relatively small hospitals. ICUs are, after all, an essential service for the provision of various acute services (e.g. safety net for complications after surgery). The lack of a formalised system for ICU care levels potentially leads to quality issues. While an implicit system of centralisation exists (i.e. sending more complex cases to tertiary care hospitals), very critically ill patients with complex medical problems might not or too late be transferred to tertiary care.
- There is a debate on introducing formal levels of ICU care. The highest level of ICU care is seen by most as a supra-regional care assignment where typically ICU patients with a 1:1 patient-to-nurse ratio are admitted (e.g. ECMO as most given example).
- Next to the debate about the concentration of highly complex ICU care in tertiary care centres, there is also a more general debate about better aligning the allocated budgets and staffing levels of ICUs to their patient profiles. While in Belgium the hospital payment system, in principle, takes into account differences in case-mix and intensity of nursing care, it is perceived as insufficient. Indeed, respondents stated that while the variation of case-mix and patient acuity across hospitals is large, the variation in allocated budgets is much more restricted. To improve this situation, ICU-specific measurement tools that accurately capture differences in severity of illness and patient acuity are needed.
- Respondents stated that it is surprising that despite the considerable budget for ICUs, little is known about activity and outcomes due to insufficiently ICU-specific data systems. They state that an ICU-specific registry is required and some suggest that the MICA registry could meet this need (e.g. validated ICU-specific scales about severity of illness, patient acuity and outcomes). But they also state that adoption hurdles need to be overcome (e.g. issues of trust, transparency, financing, registration, burden).
- The introduction of a formal system of intermediate care has opponents and proponents. The proponents argue that it will increase efficiency in the system (e.g. replacing ICU capacity by intermediate care will liberate budgets to invest in better staffed high-level ICUs), offers a buffer capacity that can be upscaled in crisis periods (under the condition that staff of intermediate care units is regularly deployed in ICUs to maintain their skills) and is better in terms of quality of care.
- The opponents argue that the mix of patients with an intermediate and intensive care profile in ICUs makes working in ICUs manageable. Moreover, they fear that intermediate care units will fail to attract nurses and physicians with ICU expertise. In addition, it is unclear who should be in charge of the medical management: organ-specific specialists or ICU physicians. Finally, they state that the current legislative framework does not limit the setup of intermediate care units (e.g. in larger hospitals organ-specific intermediate care units like CCUs already exist). Several respondents advocate that hospitals should maintain sufficient autonomy in the

decision to set up intermediate care units but also in its modalities (e.g. medical responsibility, integrated in ICU, dedicated units, etc.).

- Reforming the ICU landscape in Belgium involves addressing transport challenges, especially with more concentrated care. Changes in staffing requirements, payment mechanisms, and data collection must align with an overall vision for successful implementation of intermediate care units or levels of care.
- The impact of a reform of the ICU landscape on the general functioning of the hospital is huge. It should therefore be embedded in a clear strategy and vision on the hospital landscape. Several options to guide this reform need to be considered: a policy based on quality measurement and transparency or rather on standards and regulation?

8.1 Objective

8.1.1 Aim of the interviews

The main aim of the interviews is to get a general view on the organisation and payment of the ICU landscape in Belgian hospitals as perceived by the hospital sector and other key stakeholders.

8.2 Methods

8.2.1 Field map

We employed a purposive sampling design in our recruitment process, targeting individuals likely to offer the most pertinent information aligned with our research questions. The identification of key informants with a specific interest in the studied problem, representing diverse perspectives, was facilitated through field mapping. To comprehensively address the variability surrounding the organisation and payment of Belgian ICUs, we developed a field map that encompassed:

- Hospital umbrella organisations
- Hospital sector:
  - Hospital management (Chief Medical Officers (CMOs); Chief Nursing Officers (CNOs); Chief Financial Officers (CFOs))
- Public authorities
- ICU-specific field experts:
  - Physician organisations
  - Nurse organisations
  - Data experts.

Utilising desk research and selective information gathered from our established network, we defined an extensive list of key informants deemed relevant to our study. These individuals possess notable policy influence or are recognised as experts/professionals known for their outspoken perspectives on the organisation of intensive care in Belgium. Subsequently, invitations for in-depth interviews were extended to a subset of individuals from this list such that all targeted profiles were sufficiently included in the sample.

8.2.2 Recruitment and data collection process

From the long list, 15 individuals were selected for participation in the in-depth interviews. This group included 3 representatives from federal public authorities, 3 from hospital umbrella organisations, 3 hospital managers (CMO, CNO, CFO), 4 ICU-physicians (including data experts) and 2 ICU-nurse experts. All 15 invited stakeholders, comprising 10 Dutch speakers and 5 French speakers, willingly agreed to participate. The face-to-face interviews occurred between 22 May 2023 and 9 June 2023,

were conducted via video-conference and lasted between 1 and 2 hours each. All interviews were recorded and transcribed verbatim. Prior to commencing the interviews, the research team elucidated the objectives, ensured the confidentiality of discussions, and sought permission for audio recording. Each interview involved two team members, with one leading the discussion and the other posing additional questions. A total of three researchers conducted the interviews.

8.2.3 Data collection tools

An interview guide was developed for the in-depth interviews (available upon request). The research team based the questions on previous experience with research about organisation and financing of the ICU sector, discussions during informal contacts with stakeholders and content experts. The general themes addressed were: the lessons learned about the organisation of ICU care during the COVID-19 pandemic, the organisation of ICU in levels of care, the potential role of intermediate care units, the payment model, data systems about ICU care and outcomes, implementation prerequisites.

8.2.4 Analysis

We conducted a thematic inductive qualitative analysis on the transcripts of the in-depth interviews using QSR NVivo 12. Initially, one researcher established a basic node structure through open coding of three transcripts, selecting interviews from respondents with diverse profiles to encompass a broad range of ideas in this preliminary node structure. Subsequently, the researchers who conducted the interviews continued the open coding process for the remaining transcripts, leading to the ongoing development of the node structure.

In the next phase, one researcher performed axial coding, identifying overarching themes and relationships between nodes. The final step involved selective coding, where concepts were linked together, contributing to the reflective process necessary for crafting initial drafts of the chapter. Results derived from the interviews were substantiated by selected original text fragments in Dutch/French. To enhance readability, not all statements were accompanied by quotes in the final chapter, although they are available upon request. Throughout the text fragments, the viewpoint (stakeholder group) is explicitly stated.

Disclaimer. The reader should be aware that this chapter is based on the opinions of the consulted key informants. Hence, statements are not based on research reports or data sources but are solely based on opinions stated during the interviews and not on verified facts.

8.3 Current Belgian ICU capacity

8.3.1 Number of ICU beds

THE DENSITY OF ICU BEDS IN BELGIUM IS HIGH BUT THE EXACT NUMBER OF AVAILABLE BEDS IS UNKNOWN

The interviewees emphasised the need to contextualise the high density of ICU beds (see Chapter 9) in Belgium. They highlighted the challenge in determining the exact number of ICU beds, as intensive care encompasses C-, D-, and E-beds, and there are no officially designated 'licensed' ICU beds. During the COVID-19 crisis, a number of beds per hospital was defined by the federated entities. Yet, uncertainty persists regarding which metric has to be used for quantifying ICU bed numbers: financed beds, licensed beds or operational beds?

> *Quelle est la bonne tapée si je puis dire par rapport au nombre de lits ? Vous imaginez bien que ce n'est pas toujours si évident que cela. Est-ce que ce sont des lits financés ? Est-ce que ce sont des lits agréés ? Est-ce que ce sont des lits vraiment disponibles ? Est-ce qu'il y a un nombre de respirateurs qui correspond au nombre de lits de soins intensifs ? (ICU physician)*

THE NUMBER OF ICU BEDS HAS TO BE INTERPRETED IN THE LARGER CONTEXT OF THE ORGANISATION OF HOSPITAL SERVICES

Respondents underscored that the term 'ICU' merely serves as a label for a bed or unit, encompassing diverse realities. Consequently, it is crucial to interpret capacity considering the expertise both within and outside the ICU. Notably, Belgium lacks a formal system of intermediate care (as detailed in section 8.3.2), leading to a higher proportion of patients with an intermediate care profile in ICUs compared to other countries like the Netherlands and England. This pertains to both admissions (e.g. patients requiring enhanced monitoring post-surgery) and length of stay on the ICU (e.g. patients no longer needing invasive ventilation but still requiring monitoring). The relatively high average ICU length of stay in Belgium primarily results from outliers – patients retained on ICUs for an extended duration due to the absence of alternative options for enhanced care and follow-up. Moreover, respondents indicated that ICUs in smaller hospitals often function almost exclusively as intermediate care units. Given the high prevalence of smaller hospitals in Belgium, this factor contributes to an inflation of the total number of ICU beds in the country. In the context of international comparisons of ICU bed numbers, it is overly simplistic to conclude that Belgium has an excess of ICU beds. Nevertheless respondents also point to overuse in a context of therapeutic obstinacy for which ethical/therapeutic guidelines abroad (e.g. the Netherlands) are more strict, resulting in less admissions on ICU. In any case, a thorough analysis of available capacity, including medical, nursing, and allied health professional expertise, as well as activity profiles (i.e. severity of illness and intensity of care) and outcomes, is essential. Importantly, the experience of the COVID-19 pandemic has underscored the necessity for a buffer of ICU beds in anticipation of public health crises.

> *Dus dat wil zeggen dat 70% van onze patiënten daar minder dan drie dagen ligt. Dus als de gemiddelde length of stay op intensieve zorgen 3,9 is dat vooral aan de langliggers te wijten uiteraard. Waarom blijven die patiënten liggen op intensieve zorgen? Omdat ze een verhoogde verzorging nodig hebben, omdat ze een beetje ICU afhankelijk zijn? Dat zijn allemaal kleine zaken, die iets verhoogde monitoring, die kiné, … al die zaken. Patiënten die soms een beetje delirant zijn en nog niet naar de kamer kunnen. … omdat de zorg die geboden wordt in de ziekenhuizen op de normale verdiepingen niet voldoende intensief is. (ICU physician)*

8.3.2 No formal differentiation in ICU levels

NO OUTSPOKEN DIFFERENTIATION IN THE PAYMENT SYSTEM

The computation of the basic payment for ICUs within the Budget of Financial Means (BFM) lacks differentiation between different levels of ICU. According to respondents, nurse staffing standards, maintaining a maximum of 3 patients per nurse, are more or less uniformly applied to all financed ICU beds. However, these staffing levels were reported to be inadequate for high-intensity care ICUs, particularly when a majority of patients on the unit exhibit a high-intensity profile. Furthermore, respondents conveyed that the current payment system inadequately considers the variation in case-mix, encompassing both severity of illness and intensity of care. Despite acknowledging the role of case-mix, medical activity, and intensity of care in the system of financed ICU beds (as explored in Chapter 3), respondents deemed this differentiation to be insufficient.

> *En dan, als u naar financiering verwijst …. Of ge uw verpleegkundig kader moet maken op een low grade, ik zal het zo maar eventjes noemen, of op een high grade, dat kader is op eenzelfde manier gefinancierd. .. je moet evenveel verpleegkundigen opstellen voor een shift bij iemand waar dat een verpleegkundige vaststaat aan bed omdat het zo complex is, voor medicatie en om opvolging van de machinerie en noem maar op te doen, als iemand die daar … zijn roes ligt uit te slapen. En natuurlijk middelt dat een beetje uit, dat weet ik. Maar als uw gemiddelde van zwaarte en complexiteit lager ligt, heb je nog altijd datzelfde kader als dat gemiddelde van complexiteit en zwaarte hoger ligt. Dan zal je wel zeggen: ja, je krijgt meer verantwoorde bedden… Maar ja, als je ze opstelt, zit je wel in dezelfde normering van verpleegkundige per schijf die je open doet. (hospital management)*

Furthermore, critiques were raised regarding the (opaque) methodology employed for financing ICU beds, as well as the limitation of BFM points to 5 points per bed (see Chapter 3 Respondents

expressed reservations about these aspects. However, they proposed an assessment of the correlation between licensed and financed beds. The suggestion was to explore whether hospitals having a higher number of financed beds compared to their licensed bed capacity could be identified as higher-level ICUs.

DYNAMIC BED MANAGEMENT TO DEAL WITH HIGH-INTENSITY CARE PATIENTS

Given the restricted staffing standards within the existing payment system, respondents stated that challenges arise when high-intensity patients predominate a unit. While it is feasible to create bed availability for critically ill patients by transferring less critically ill patients to general wards, accommodating one or more newly admitted patients necessitating a 1-1 staffing ratio requires additional measures. In such instances, options include either closing down beds or reducing staffing levels for other patients.

> *Er zijn twee mogelijkheden om met zware pathologie om te gaan, ofwel ben je in staat in uw centrum om effectief te gaan naar die differentiatie waarbij je sommige patiënten aan een lagere bestaffing laat verzorgen. En op die manier middelen recupereert om die één op één bestaffing te realiseren. Ofwel sluit je bedden. Dat zijn de twee mogelijkheden en die worden toegepast omwille van het feit dat er nu niet onmiddellijk een heel duidelijk beeld is: wanneer is iemand een step down of een high level? Die criteria zijn voor mij niet zo helder. (hospital management)*

IMPLICIT LEVELS DO ALREADY EXIST

Despite the absence of a formal regulatory system defining ICU levels, an implicit hierarchy is observed in practice. Some ICUs (both within the same hospital as across hospitals) predominantly handle patients with a less intensive care profile, while others predominantly care for critically ill patients. Despite the absence of formal levels, some hospitals have ICUs that function as tertiary care ICUs and have invested in staff (medical and nursing), infrastructure, equipment, etc. According to respondents, certain general wards in an academic centre more closely resemble an ICU than a general ward in non-academic hospitals, and vice versa do ICUs in smaller general hospitals sometimes more resemble a general ward of an academic hospital. Others refer to the high proportion of patients with a medium care profile on some ICU's. A concern highlighted is that these units sometimes admit more complex cases for which they lack the necessary experience and expertise. There is a delay or failure to promptly refer these complex cases to ICUs, which are better equipped to handle such situations.

> *Ce sont des patients qui sont extrêmement légers, qui ne devraient pas être aux soins intensifs. Imaginez que dans ces services-là… et je pense que cela arrive dans certains… on vient mettre une ECMO quatre fois par an, quelle est encore l'expertise des infirmiers de prendre des patients aussi aigus quand 60 % de vos patients n'ont rien à faire entre guillemets aux soins intensifs ? Je pense qu'il y a déjà des niveaux différents de soins intensifs pour avoir travaillé dans différentes unités, toutes les unités de soins intensifs n'ont pas le même level de patients mais à l'heure actuelle, tout ce qui est normes, encadrements, etc. sont pareils que vous ayez 60 % de patients de type medium care ou que vous en ayez 20 %. (ICU nurse)*

SEVERITY AND INTENSITY VARY ACROSS UNITS AND HOSPITALS

Patients admitted to Belgian ICUs represent a spectrum in terms of severity of illness and intensity of care, ranging from low-intensity care, which involves enhanced monitoring not feasible on general units, to standard ICU care and high-level ICU care, which may involve Extracorporeal Membrane Oxygenation (ECMO) and other indications requiring 1:1 staffing. While respondents acknowledged variations in this case-mix across hospitals and ICUs, there is limited clarity on the specific activities and outcomes within the ICU beds. Multiple interviewees pointed out that ICUs in smaller hospitals may at times resemble Post-Anaesthesia Care Units (PACUs) more than traditional ICUs.

> *We stellen grote verschillen vast tussen ziekenhuizen. We zien dat dat in bepaalde ziekenhuizen eerder beperkt is tot postoperatieve zorg, omdat het kan zijn dat die bedden gevuld worden of omdat er op de acute afdelingen onvoldoende skills zijn om dat op te vangen. Anderzijds zien we intensieve zorgen afdelingen waar dat de expertise toch wel zeer groot moet zijn om die patiënten*

op te vangen, waar er langdurige beademing is, toch heel wat meer apparatuur en kennis nodig is. (hospital umbrella organisation)

The existing datasets, such as the Belgian Hospital Discharge Dataset and the Belgian Nursing Minimum Data Set, lack sufficient specificity for ICU-related information and are vulnerable to potential upcoding issues. To gain a comprehensive understanding of medical and nursing activities and outcomes in ICUs, it is imperative to have data that are explicitly ICU-specific. It is crucial to convey a clear message during the establishment of data systems that severity of illness and intensity of care are distinct concepts. For instance, a critically ill patient in recovery, no longer in need of mechanical ventilation, may require increased nursing care compared to the period when ventilation was still necessary. This includes aspects like emotional support and mobilisation.

Patiënten waarvan dat je zegt dat die minder zorgnood hebben op een intensieve, die zijn wakker bijvoorbeeld, dat die qua nursing soms toch ook nog wel een grote zorgnood hebben, al is die misschien helemaal anders dan al die spuitpompen, die ECMO, dialyse, beademingsmachine, whatever… … Ge kijkt dan vaak naar de beademingen en zo, maar vaak zijn de patiënten die net niet aan de beademing zijn, die daar rondzweven van moeten we ze intuberen of niet, naar workload voor de verpleging en ook voor de aanwezigheid en checks door artsen, vaak veel zwaarder. …diegene waar dat je moet gaan kijken: zou ik hem intuberen? Moet ik de tube eruit halen? Dat zijn mensen die veel meer workload creëren en veel meer aandacht nodig hebben dan diegene die… Ik vind het echt wel een hele uitdaging om dat te wegen. (hospital management)

8.4 Need to formalise levels of care

Several respondents stated that there is a need for two levels of ICU care: general intensive care and specialised intensive care. Besides these two levels, the opinions on intermediate care (see section 8.7) diverged. In this section we discuss the level of care for patients with a high-intensity profile.

CENTRALISATION OF HIGH-INTENSITY CARE PROFILES AND PROCEDURES

In Belgium, high-intensity medical procedures and patients are distributed across almost all ICUs. Many respondents expressed a clear necessity for a more formalised multilevel system, primarily motivated by quality concerns linked to expertise and experience. Indeed, especially the high-complex critically ill patients require specific infrastructure, equipment and staff (e.g. 24/7 availability on the ICU of a physician with ICU expertise; possibility for 1:1 nurse staffing). However, respondents acknowledged the complexity of assigning patient groups to specific levels, recognising the difficulty in such categorisation. A commonly suggested measure among respondents is to restrict high-intensity procedures, like ECMO, to the higher levels of ICUs, making it a mandatory practice. While ECMO was cited as an example, respondents emphasised the need to extend this approach to other patient types and therapeutic or diagnostic procedures, reserving them for centres equipped with the requisite expertise. Presently, the indications warranting a 1:1 patient-to-nurse ratio in Belgium are notably limited compared to other EU countries.

L'ECMO évidemment, il faut centraliser, ce n'est pas possible, c'est ingérable et les coûts sont en train d'exploser aussi à cause de cela, je veux dire ce n'est pas possible. (ICU nurse)

Dat wij in België vrij conservatief zijn in het toewijzen van één op één bestaffing, terwijl als je dat Europees bekijkt is dat voor een aantal landen een evidentie. Dan is onmiddellijk de vraag… Want ook die landen hebben niet altijd een goede tool: waar zit bij hen dan die differentiatie? Als je zegt zware IZ is één op één, wanneer schakel je over, en dan merk je dat daar de instrumenten niet altijd bestaan, behalve het gebruik van bepaalde invasieve ondersteuningen. Het zou toch een iets meer gevalideerd instrument kunnen zijn om dat te beheren. (hospital management)

QUALITY IS THE MAIN ARGUMENT TO CENTRALISE THE CARE FOR CERTAIN PATIENT PROFILES

The primary rationale for advocating a formalised system of levelling is rooted in the pursuit of quality improvement. Respondents emphasised that the transfer of patients with high-intensity profiles to

tertiary care centres is not consistently executed or, at times, not done promptly. Some respondents alluded to financial considerations, suggesting that certain transfers are delayed until day 21[x] when the ICU on duty fee can no longer be billed at the same rate. When patients with a high-intensity profile are not transferred or are transferred belatedly to specialised centres, respondents highlighted the emergence of quality issues. Some respondents also pointed to the higher observed mortality during the first wave of COVID-19 in centres with the highest proportion of surge capacity beds as an example of variation in expertise levels across Belgian ICUs.

While ECMO was frequently cited as an example illustrating potential quality gains through centralisation of care, respondents also underscored the quality benefits associated with concentrating specialised care (neurology, PICU, cardiology, specialised dialysis, etc.) in high-level ICUs. They argued that building up expertise necessitates treating a critical mass of patients consistently, rather than sporadically.

> *Dus als u het mij vraagt: ja, we zullen niet naar nivellering maar naar levels moeten gaan, en daaraan zorgprogramma's koppelen of mogelijkheden van bepaalde technische akten, als ik het zo mag zeggen. (ICU physician)*

IDENTIFY AND CENTRALISE CARE FOR PATIENTS WITH A HIGH-INTENSITY PROFILE

Respondents who were advocating for a more formal system of ICU levels held diverse opinions on how to implement. According to several respondents, differentiation should occur at the patient rather than the hospital level. This necessitates the development of an ICU-specific measurement system that discriminates based on both severity of illness and intensity of care. Respondents argued that establishing formal levels, linked to financing and licensing standards, should be grounded in the severity profile of patients, with clear admission and mandatory referral criteria.

This approach implies that more severe cases cannot be admitted to all types of ICUs, while higher-level ICUs can still admit patients with a lower intensity profile. Respondents posited that this arrangement would be welcomed by the nursing and medical staff of higher-level ICUs, as it allows them to occasionally care for patients with a less severe profile. This flexibility was seen as valuable in helping them manage the stressful ICU environment.

> *Maak het op patiëntniveau en maak een instrument dat die differentiatie prikkelt. Dat je op die manier ook weet: als je zoveel van die patiënten hebt die voldoen aan die criteria, dan weet je dat je daar die middelen tegenover hebt. En die categorie heb je die middelen en dat zet ons aan om in uw intensieve zorgen afdeling te classificeren en uw bestaffing aan te passen. Nu gebeurt het op basis van druk op de bedden. (hospital management)*

ICU LEVELS ARE RELATED TO THE HOSPITAL TYPE

Respondents suggested that the number of levels would likely be associated with the size of the hospital, implying that small to mid-sized hospitals may not accommodate high-care levels. Broadly, patients can be categorised into two groups: those who are critically ill and require numerous therapeutic interventions, and those who need close monitoring to prevent deterioration. Interviewees expressed a concern that when the option of clear admission criteria is taken, criteria based on diagnostic or therapeutic needs pose challenges, as they may inadvertently encourage overuse.

> *…denk ik dat het beter zou zijn als zo'n systeem van levels in heel België zou georganiseerd worden en dat er gekeken wordt naar niet alleen intensieve zorgen maar naar de hele organisatie van het ziekenhuis, waarin een intensieve zorgen afdeling ingebed is. Maar ook: wat kan daar aangeboden worden? Het is evident dat een kleine intensieve zorgen afdelingen met zes bedden waar maar een beperkt aantal intensivisten werkt, niet 24/7 continu een intensivist misschien*

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[x] Billing code 211665 refers to an additional fee for the fees 211584, 211606 of 211621 when at least 1 of the following techniques is applied: 1° controlled or assisted continuous ventilation; 2° 'nCPAP' or 'BiPAP'; 3° invasive intra-arterial catheter; 4° central veneous catheter - day 1 until day 21, per day.

aanwezig is, waar dat misschien ook niet altijd dialyse opgestart kan worden, waar een ECMO kan… (ICU physician)

SUPRA-REGIONAL LEVEL: REFERENCE CENTRES WITH HIGH-LEVEL ICU

While certain respondents perceived potential benefits in collaborative efforts within locoregional networks (especially in the context of hospital mergers), others argued that the number of hospitals with intensive care units meeting the criteria for 'high-care ICU' will be lower than the number of locoregional networks. Consequently, they contended that this is not a function best served at the locoregional level. Instead, high-care ICUs are seen as more appropriately functioning as reference centres designated at a supra-regional level (but not necessarily limited to academic hospitals). Respondents emphasised that the designation of reference centres should not solely be confined to academic institutions. The operationalisation of high-level ICUs, including determining their number and locations, should be grounded in data that objectively assess the need. Additionally, clinicians could identify, as part of a care programme, the patients and estimated durations for which care on these high-care ICUs is deemed necessary.

Moi je pense que cela doit être dans un cadre de centres de référence parce qu'aujourd'hui vous avez de tout gros hôpitaux avec 30, 40, 50 lits de soins intensifs qui ne sont pas des hôpitaux académiques et qui ont aujourd'hui la capacité en tout cas de faire correctement avec des expertises suffisantes ce type de traitement de type ECMO. Je pense qu'on doit aller vers des centres de référence, mais pas spécialement uniquement dans des centres académiques. Il faut une centralisation, pour moi c'est clair pour cela, mais pas nécessairement une centralisation qui est affectée au centre académique comme on a, par exemple, le cas pour les greffes d'organes qui sont un peu spécialisés dans les centres académiques, sauf exception. (hospital umbrella organisation)

The identification of hospitals with high-care ICUs is anticipated to be closely tied to the care programmes they provide. For example, major trauma centres necessitate a 24/7 presence of ICU physicians. It is reasonable to associate this requirement, encompassing not only regulatory aspects but also the establishment of a differentiated payment system, to adequately address these specific needs.

8.5 Small ICUs in small hospitals: what is their role or justification?

DO SMALLER-SIZED ICUs TAKE CARE OF PATIENTS WHO ARE CRITICALLY ILL?

In Belgium, the presence of numerous hospitals has led to a proliferation of ICUs, with smaller hospitals typically hosting ICUs comprising 6 to 10 beds. This has resulted in a fragmented overall ICU capacity. Many respondents expressed reservations about the sustainability of this model and argue that reducing the number of ICUs would not compromise geographical accessibility. Maintaining expertise at an optimal level was identified as a challenge in small ICUs with a limited number of critically ill patients. Respondents highlighted that these smaller ICUs often function primarily as PACUs, representing an inefficient use of the scarce resources of nursing staff with ICU expertise.

Furthermore, respondents emphasised that smaller ICUs necessitate proportionally more medical resources, particularly in organising 24/7 on-call services. This setup not only leads to a deskilling of acquired expertise but also diminishes the attractiveness of these environments for nurses and physicians with ICU expertise.

… maar de vraag is dan: moeten we daar dan 6, 7, 8 bedden voor voorzien die voor 90% gevuld worden met postoperatieve medium care, en voor een aantal keren voor iemand die dan slecht gaat en toch op korte termijn verwezen wordt. Dat is een beetje de vraag. Moeten we niet proberen te zeggen: we moeten die IZ concentreren, en maak daar uw eerste opvang en stabilisatiefase om dan goed te oordelen 'kunnen we dat hier op dat niveau aan of moeten we zelf verwijzen?' veel van die kleine intensieve zorgen afdelingen… zijn een PAZA. Grotendeels zijn dat postoperatieve opvolgingen die daar gebeuren. … De kleinere ziekenhuizen struggelen daar echt mee, die hebben niet echt een intensieve. … we noemen het wel allemaal intensieve.

En nog een keer, het gaat vooral over… waar dat de schaalgrootte klein is. Ik spreek over de kleine units van 7… minder dan 10 bedden. … Ik heb het niet over de medium en de grote ziekenhuizen.… (hospital management)

WITHOUT AN ICU NO GENERAL ACUTE HOSPITAL

According to respondents, general hospitals are heavily reliant on the presence of an ICU. The absence of an ICU poses a significant threat to the viability of these hospitals, particularly as they rely on the capacity to stabilise critically ill patients, preventing the development of complications during and after surgeries. The essential components of an acute hospital, including an emergency department and an operating theatre, necessitate the presence of an ICU. Even smaller acute hospitals depend on ICU capacity to effectively manage complications. Others contest this and state that this capacity to stabilise critically ill patients in small hospitals should be integrated in the emergency departments of smaller hospitals rather than having an ICU of 6-8 beds. In addition, this would require arrangements to transfer critically ill patients in case of (rare) events to an ICU within or outside (in case of need for tertiary care) the locoregional network.

The closure of services in small hospitals is often equated with the closure of the hospitals themselves, leading to a perceived threat. According to some respondents, hospitals, regardless of size, require an ICU not only to conduct essential surgeries but also to sustain financial viability by facilitating spin-off services such as laboratory testing and medical imaging.

Wat is een acuut ziekenhuis? Als er een spoed, een intensieve en een OK is. Dat zijn de 'bare essentials', de Heilige Drievuldigheid die er altijd moeten zijn. Ik denk dat ook wel, want je moet ergens een plaats hebben waarin ofwel complicaties ofwel onverwachte situaties op een vakkundige manier gestabiliseerd en geobserveerd kunnen worden. Dus als er een spoedgeval is met alle reglementeringen … waar iedereen naar toe rijdt… Je weet dat goed genoeg, er komen mensen binnengewandeld die zeggen dat ze zich niet goed voelen en neerstorten. En waar je de hele full monty moet opentrekken om ze erdoor te halen. Als je er nergens mee naartoe kunt, er crasht iemand op een zaal/afdeling… Die mensen moeten daar weg kunnen, die moeten in een omgeving… en dat is het moeilijke denk ik. Tot welk level heb je daar een equipe die dat kan opvangen, stabiliseren, evalueren en zeggen: we houden het hier of het moet getransfereerd worden. (hospital management)

SMALL ICUs FOR GENERAL INTENSIVE CARE

Eliminating ICUs in smaller hospitals is, according to several respondents, not a viable solution, as they serve a crucial role and act as an essential safety net. Respondents stated that there is a perceived lack of understanding among physicians accustomed to larger ICUs who may not fully appreciate the significance of smaller ICUs due to unfamiliarity with their operational reality. Additionally, such a move would necessitate an excessive number of inter-hospital transfers. Furthermore, absorbing the capacity of smaller ICUs into larger ones (e.g. those with more than 25 beds) would present significant challenges. It would require substantial investments, such as streamlining medical 24/7 on-call services, in these larger hospitals. This process of consolidation could be intricate and resource-intensive.

… mais je pense qu'il faut garder des unités et il faut garder des unités suffisamment opérationnelles avec une capacité en tout cas de faire malgré tout des soins intensifs de base. Est-ce que les soins intensifs de base vont être les mêmes que les soins intensifs de base dans des hôpitaux moyens ? Là, peut-être pas. Je vous donne un exemple, on ne va peut-être pas dialyser les malades dans une plus petite unité de soins intensifs avec un malade ventilé bien sûr, pas un malade standard de dialyse. Et là, il va peut-être être transféré dans une unité un petit plus importante, pas spécialement dans une unité tertiaire. Je pense que, pour aller au bout de ma pensée, il faut se méfier, … d'une centralisation qui serait outrancière je veux dire. Il faut se méfier d'une trop rapide ou trop grande centralisation. Il faut garder à mon avis des unités de soins intensifs suffisamment décentralisés, c'est-à-dire dans tous les hôpitaux finalement. En général, dans ces hôpitaux-là, ils n'ont pas beaucoup de lits reconnus comme soins intensifs.

Cela pose le problème du financement. À la limite, cela pose aussi le problème de qui fait la garde dans ces hôpitaux-là. Si on va vers une solution qui est de dire dans les plus petits hôpitaux, on doit mettre en branle des solutions de transfert, mais, à ce moment-là, on va mettre en branle des solutions de transfert pour beaucoup de choses ; pour les brûlés, pour les traumatisés, pour les soins intensifs à ventiler. Je pense qu'il faut faire un choix dans ces options de transfert et le choix, à mon avis, je parle de mon avis à moi, c'est de garder des unités de soins intensifs de base dans les plus petits hôpitaux aussi. (hospital umbrella organisation)

But also proponents of smaller ICUs recognised the necessity for expedited transfers to more specialised ICUs. A respondent proposed to work with ICU-specific patient classification systems and oblige physicians in smaller hospitals, from a certain threshold, to consult a physician in a more specialised ICU to see if a transfer is needed. Furthermore, some proposed a model (e.g. to prevent overuse of ICU-type of activities like ventilation for patients who are not critically ill but are in need of enhanced care compared to what can be provided on general units) where the capacity of intensive care is reorganised with an overall increase in capacity but with more intermediate care than ICU care.

Dat is ook niet zo gemakkelijk, want ja, als ge maar een heel beperkte intensieve capaciteit hebt en u wordt verondersteld als ziekenhuis die open en beschikbaar te houden, moeten de mensen ook wel hun skills blijven houden. Dan is de neiging misschien wel groter om iets minder zorgbehoevende patiënten daar te leggen, al is het maar om uw skills te blijven trainen. Ik zeg niet dat dat bewust gebeurt, zo van 'we gaan nu nog een keer oefenen op een intubatie', dat niet, maar als ge een heel strikt beleid voert van die patiënt hoort niet thuis op intensieve en die en die ook niet, zou je wel eens kunnen overblijven met een intensieve waar heel weinig patiënten komen en dat is waar de skills van de mensen verloren gaan. En dat is ook niet de bedoeling. Ik denk dat we daarin een compromis zouden kunnen vinden voor die hele kleintjes, want nu ligt die intensieve functie op minimum zes bedden per ziekenhuis, dat je dat een beetje optrekt bijvoorbeeld naar acht en dat je daar dan vier intensieve en vier medium care. (hospital management)

8.6 Crisis and buffer capacity

ICU CAPACITY: ALLOW SOME INEFFICIENCIES IN THE SYSTEM TO ABSORB FUTURE CRISES?

In light of the COVID-19 pandemic, respondents raised concerns about the buffer capacity of ICUs. Although acknowledging the already high ICU capacity in Belgium, respondents emphasised the importance for policymakers to exercise caution when contemplating a reduction in the number of ICU beds as part of a reform. Moreover, some questioned whether it is acceptable to allow some 'inefficiencies' (buffer, flexibility for staff to take care for some patients with a lower caseload on a high-level ICU) within the system that can be mobilised during crisis periods. Nevertheless, this does not imply that all small ICUs need to be maintained as some question if this capacity is very useful in case of a public health crisis, given that these units probably lack the necessary expertise.

C'est vrai qu'on pouvait imaginer se dire là on met une unité tampon prête à faire feu si je puis dire dans une unité de 30 lits par exemple dans les unités dans les réseaux locorégionaux et dans lequel on affecterait une partie de ces unités pour faire des soins intensifs. Je ne suis pas hyper favorable. Pourquoi ? Parce qu'il faudrait les staffer et les staffer en période de crise, déjà vous avez un quart des infirmières qui sont malades et qui ne viennent pas, et donc c'est hyper compliqué. J'aurai tendance à dire qu'il vaut mieux utiliser les ressources qui existent normalement dans un hôpital en ne les diminuant pas trop. On pourrait très bien dire que dans les hôpitaux leader, par exemple d'un réseau locorégional, faisons attention d'avoir suffisamment de lits possibles, en tout cas disponibles en soins intensifs. (hospital umbrella organisation)

SCARCE STAFFING RESOURCES REQUIRE EFFICIENT USE

On the other hand, staffing problems are so severe and widespread that it is not appropriate to deploy staff in an inefficient way. After all, many surgical interventions are nowadays cancelled due to staff shortages (e.g. on ICU). Therefore the option of 'a permanent buffer capacity in ICUs' was considered as not realistic. Some respondents stated that they see intermediate care units as part of a solution.

These units can serve as a 'buffer capacity' that can be upgraded during crisis periods. Nevertheless, the COVID-crisis and surge capacity strategies taught us that ICU staff requires specific expertise and skills that cannot be learned overnight. A possibility is to rotate staff across intermediate and ICU units, so that they continue to practice their ICU skills.

> *Er moet een bepaald rotatiesysteem komen dat intensieve zorgen verpleegkundigen van een basis intensieve zorgen afdeling ook een keer op een intermediaire of hoge intensieve zorgen afdeling, om die kennis/expertise uit te breiden en in stand te houden. Dat dat heel duidelijk is. En dat daardoor, als er iets zou gebeuren – een nieuwe crisis - erop die manier niet terug de super basis verpleegkundigen van op een verblijfsafdeling moet inschakelen op intensieve zorgen, maar dat je eerst kan beroepen op die intermediaire en basis intensieve zorgen verpleegkundigen, wetende dat dat nog niet de optimale intensieve zorgen verpleegkundige 'an sich' zal zijn die hoog gespecialiseerde zorg zal kunnen uitvoeren, maar dan vertrekken we vanuit een ander startpunt. (ICU nurse)*

BUFFER CAPACITY

The Belgian ICU capacity is amongst the higher end of OECD countries. Yet, this capacity has to be put into perspective (e.g. no formal system to treat intermediate care patients) and has proven its value during the COVID-19 crisis. Therefore, several respondents warned that reforms should not result in downsizing the current ICU capacity and some inefficiency in the system has to be tolerated. On the other hand, it was pointed out that having a buffer capacity is not realistic, nor desirable in light of the shortages on the labour market. Upscaling intermediate care (with a permanent rotating of staff to ICUs outside of crisis periods to maintain ICU expertise) is considered as a more realistic alternative to foresee a buffer capacity.

> *En matière de nombre de lits à caractère intensif ou de nombre de lits agréés de soins intensifs ou de lits disponibles de soins intensifs, il faut toujours faire attention au fait du dimensionnement des unités de soins intensifs. Comme on a vu avec l'épisode Covid, on a eu des moments où on était bien contents d'avoir suffisamment de lits. (hospital umbrella organisation)*

8.7 Intermediate care

8.7.1 Intermediate care patients are mostly admitted to an ICU

INTERMEDIATE CARE PATIENTS HAVE A DIFFERENT PROFILE COMPARED TO CRITICALLY ILL PATIENTS

It is clear that patients who qualify for intermediate care have a different profile compared to ICU patients. In general, intermediate care patients require enhanced follow-up that cannot be offered in general units but do not require as much highly-technical care (e.g. specific catheterisation, mechanical ventilation) compared to critically ill patients. This does not automatically mean that the care in intermediate care units demands less nursing time as some of the nursing activities (e.g. communication, mobilisation, etc.) will require more nursing time compared to an ICU patient. On the other hand, a stay on an ICU will generate additional workload for patients (e.g. they will be monitored for a longer time period) with a medium care profile who may not need it. According to the respondents, it is clear that variation of case-mix across hospitals and ICUs is high. While in some hospitals and ICUs most patients are critically ill, in other hospitals the majority of ICU patients has in fact an intermediate care profile.

> *… prennent beaucoup de temps parce qu'avec l'organisation des soins intensifs en fait ces patients ils demandent beaucoup de temps et donc je pense que c'est quelque chose qu'il faut sortir. Un patient qui reste accroché au monitoring où il n'y a pas de toilette, où il n'y a rien pour gérer, ces patients demandent beaucoup de temps malgré tout à des infirmiers de soins intensifs. (ICU nurse)*

OBJECTIVE MEASUREMENT OF PATIENT ACUITY INDICATED

Independent of the decision to organise the care for patients with an intermediate care profile on separate units or to integrate them in ICUs, it is clear that there is a need to measure patient acuity in an objective way. This is not only required in the context of a fair payment system but also for the clinical follow-up and to make staffing decisions within hospitals.

> *Je moet er wel wat harde criteria insteken om te zeggen: die patiënt zit nu in die categorie, en dan moet je er op die manier naar handelen. En dan spreek ik over bestaffing, maar ook over de graad van opvolging. Een step down voor mij betekent ook dat je een lagere toezicht frequentie houdt. Dat betekent niet elk uur alle parameters nemen. Je moet dan ook consequent zijn. Dat maakt het duidelijk voor al uw zorgverleners dat het gaat over een step down en niet over zoiets hybride dat misschien toch nog alle toezicht nodig heeft, maar dat er niet een onmiddellijke beademing is. Versta je wat ik bedoel? Dat zich dat een beetje veruitwendigt in een medisch beleid dat step down is en niet enkel gekoppeld aan is het een invasieve therapie of niet. (hospital management)*

8.7.2 Proponents of intermediate care see quality and efficiency gains

According to the proponents, intermediate care units are needed to admit patients that are now admitted to an ICU but do not require ICU care since they require more follow-up than can be provided in a general unit. The proponents of dedicated intermediate care units focused on the quality of care and efficiency gains as well as its potential to serve as surge capacity in case of an unexpected increase in the need of ICU capacity.

QUALITY OF CARE IMPROVES: STEP-DOWN UNITS PREVENT PREMATURE DISCHARGE FROM THE ICU TO A GENERAL UNIT

Several respondents said there are also quite a lot of advantages to work with dedicated intermediate care units. One example is that step-down units can be staffed and designed to offer more possibilities to do rehabilitation activities (e.g. mobilisation). This care is more challenging to provide to the same extent for patients admitted to an ICU. In addition, the focus of the intermediate care team can be more on discharge preparation and post-discharge care planning compared to ICU teams.

Others stated that mixing intermediate care patients with patients who are critically ill dilutes the case-mix and risks to impact the expertise and skill development of the ICU nurses. This is particularly concerning in the smaller ICUs in our country, which admit proportionally more intermediate care than ICU patients and have insufficient ‘real critically ill patients’ to ensure staff can maintain ICU specific expertise.

> *Maar anderzijds heb je ook wel potentiële voordelen voor de chronische ICU patiënt, want als je die opneemt en onderbrengt op een step down unit, waar dat er meer mogelijkheden zijn revalidatie… Nu als een patiënt uit zijn bed gaat en die wil rondgaan, wandelt die op de eenheid tussen de andere patiënten. Je kan die moeilijk wat meer intensief begeleiden qua kinesitherapie en dergelijke meer. Daar zitten mogelijkheden om dat dan toch apart te doen, omdat het ook wel goed gekend is dat kinesitherapie voor die intensieve zorgen patiënten een zeer belangrijke is om die up en running te krijgen. Dus ik denk dat daar toch wel een forse verbetering zou kunnen zijn voor die chronische ICU patiënten, als je daar intensiever mee aan de slag gaat, het revalidatietraject, nog voor de verdieping. (ICU physician)*

Another example is the assumed reduction in ICU and hospital readmissions. Intermediate care patients nowadays often block ICU capacity. Respondents stated that in absence of dedicated intermediate care capacity, patients risk to be discharged prematurely to the general hospital units (e.g. during peak demands for ICU capacity). This could jeopardise quality of care and induce ICU readmissions. When there are dedicated (step-down) intermediate care units, it is expected that this would reduce such ICU readmissions. After all, the level of follow-up when discharged from the ICU is not so drastically reduced compared to a discharge to a general ward since staffing levels of intermediate care units are situated between those of general wards and ICUs.

Pour la qualité des soins de ces patients-là, le middle care je pense va améliorer la qualité des soins. Ce qui va vraiment changer avec le middle care ce sont les réadmissions je pense. On sait que quand un patient est réadmis aux soins intensifs, qu'il sort et qu'il est réadmis, cela augmente sa mortalité de manière significative. Il faut diminuer le nombre de réadmissions. Quand il y a un taux d'occupation qui est élevé, des fois les médecins doivent prendre des décisions avec des patients qu'on doit remonter très rapidement, des fois même la nuit, c'est peut-être mauvais, et les patients passent d'un ratio infirmière par patient de soins intensifs à directement une unité de soins alors qu'on sait qu'ils vont prendre une charge de travail à augmenter et en fait, ces middle care pourraient permettre à ces patients qui sont middle comme c'est le cas de le dire, de diminuer à mon avis de manière significative les réadmissions et pour moi, je parlais de la satisfaction tout à l'heure mais pour la qualité des soins, je pense que c'est vraiment cela aussi qui est intéressant. (ICU nurse)

STEP-UP UNITS COULD BE AN ANSWER TO LIMIT THE GAP BETWEEN GENERAL UNITS AND ICUS: PREVENTION OF ICU ADMISSIONS

Intermediate care also holds the potential to prevent ICU admissions. Patients who require enhanced care (e.g. monitoring) but do not require ICU resources can be admitted to an intermediate care unit. Although organising this within general units of a specific type (e.g. oncology, neurology) can be challenging due to factors like a limited number of intermediate care beds per unit, it appears, according to respondents, advisable to establish mixed intermediate care units (i.e. not organ specific) for this purpose.

Je pense qu'aujourd'hui il y a toute une série de patients qui se trouvent dans les services d'hospitalisation qui pourraient se retrouver dans ces services-là aussi, je pense que c'est une chose qu'il faut aussi évaluer parce qu'on a de moins en moins de lits de soins intensifs et une pression de plus en plus importante et donc on fait sortir des patients de plus en plus lourds. (ICU nurse)

EFFICIENCY WITHIN THE SYSTEM: REPLACING PART OF ICUs BY INTERMEDIATE CARE CAPACITY FREES UP BUDGET THAT CAN BE USED TO INSTALL HIGH-LEVEL ICUs

The introduction of levels of ICU cannot be realised without the introduction of intermediate care capacity in parallel. In budgetary terms it is unrealistic to introduce intermediate care capacity in addition to the existing ICU capacity. Moreover, when high-level ICUs are employed (with higher and more costly staffing levels) it is necessary to downgrade some of the ICU capacity to the intermediate care level (with somewhat lower staffing levels). This is, according to respondents, not an unrealistic scenario since many (smaller) ICUs, mostly located in small hospitals, treat predominantly patients with an intermediate care profile.

Die nood aan differentiatie lijkt mij redelijk groot bij de introductie van high-care intensieve zorgen… Vooral vanuit deze bekommernis zal medium care capaciteit nodig zijn, want het andere alternatief is iedereen upgraden, meer geven en dat is niet haalbaar. (hospital management)

INTERMEDIATE CARE CAN BE UPGRADED TO ICU IN CASE OF CAPACITY NEEDS

Several respondents stated that intermediate care acts as buffer capacity that can be mobilised during crisis periods. Yet, to scale intermediate care units up to the level of an ICU in case of surge capacity needs, several conditions need to be taken into account. An example is that the intermediate care staff is only used for dedicated well-defined patient groups on the ICU and/or are teamed-up with experienced ICU nurses. Another precondition is to keep their ICU skills up-to-date when working on intermediate care units. This would generally require them to rotate between units and also work sufficient time in ICUs.

Hoe gaan we die intensieve zorgen bedden met een high-care profiel t.o.v. die intermediaire en low-care intensieve zorgen bedden positioneren? Is dat in de regio of in onderlinge samenwerking? Dat je via een afdwingend karakter kan zeggen: er moet een bepaald rotatiesysteem komen dat intensieve zorgen verpleegkundigen van een basis intensieve zorgen

afdeling ook een keer op een intermediaire of hoge intensieve zorgen afdeling, om die kennis/expertise uit te breiden en in stand te houden. Dat dat heel duidelijk is. En dat daardoor, als er iets zou gebeuren – een nieuwe crisis – erop die manier niet terug de super basis verpleegkundigen van op een verblijfsafdeling moet inschakelen op intensieve zorgen, maar dat je eerst kan beroepen op die intermediaire en basis intensieve zorgen verpleegkundigen, wetende dat dat nog niet de optimale intensieve zorgen verpleegkundige an sich zal zijn die hoog gespecialiseerde zorg zal kunnen uitvoeren, maar dan vertrekken we vanuit een ander startpunt. Dan gaat er terug meer gedilueerd moeten worden en er gezegd wordt: nu bestaffen we één op drie hoog gespecialiseerde intensieve zorgen verpleegkundigen en in een universitaire context misschien één op één op patiënten niveau. Dat het dan gaat, oké, omwille van de crisis hebben we zoveel extra bedden nodig, dan gaan we meer dilueren, en gaat bijvoorbeeld een hoog intensieve zorgen verpleegkundige, als die dagdagelijks één op één opvolgt, dat die dan misschien naar één op twee of één op drie gaat, aangevuld met dan één of twee intermediaire of basis intensieve zorgen verpleegkundigen. Maar ik denk dat die kost onhoudbaar is om daar een permanente hoog gespecialiseerde bestaffing te voorzien… dat is onbetaalbaar denk ik… (ICU nurse)

8.7.3 Critical reflections on nationwide implementation of intermediate care

8.7.3.1 Intermediate care profiles on the ICU: feasible mix for ICU staff?

It is unclear how the care for patients with an intermediate care profile should be organised: dedicated unit, organ-specific or polyvalent? Dedicated part of an ICU or general unit? Part of ICU? The opinions of the interviewed stakeholders clearly diverged on the matter.

WHILE INTERMEDIATE CARE FOR ORGAN-SPECIFIC CONDITIONS IN HIGH-VOLUME HOSPITALS SEEMS OBVIOUS, THERE IS NO CONSENSUS ABOUT THE ORGANISATION OF NON-ORGAN SPECIFIC INTERMEDIATE CARE UNITS

Respondents agreed that all ICUs have to a greater or lesser extent patients with intermediate care profiles on their units. While for organ-specific patient profiles with a certain critical mass (mostly in larger hospitals) there is not much debate to organise care in separate units (e.g. stroke units, coronary care units), opinions among respondents about the desirability and necessity to set up polyvalent intermediate care units differed. Nevertheless, one respondent expressed concerns about the capacity requirements for organ-specific medium care, such as post-coronary care units, that are driven by an activity-based system where some surgeries might not be appropriate.

Est-ce qu'il faut nécessairement avoir une unité de medium care adjacente aux soins intensifs ou quelque chose qui soit un peu plus mélangé parce que cela pose un autre problème. Si on fait du medium care polyvalent adjacent à une unité de soins intensifs et qu'on va l'encadrer différemment, donc un peu plus qu'une unité standard et un peu moins qu'une unité de soins intensifs, à ce moment-là, attention quand même à l'aspect pénurie d'infirmières, etc. Il faut voir comment cela se met. (hospital umbrella organisation)

PATIENTS WITH AN INTERMEDIATE CARE PROFILE WITHIN AN ICU ALLOW FLEXIBILITY IN MEDICAL AND NURSING CARE

Admitting patients with an intermediate care profile to the ICU provides a level of adaptability for both nurses and physicians. This flexibility allows for the dynamic adjustment of bed capacity in response to demand, accommodating fluctuations in the distribution of critically ill and moderately ill patients. Additionally, the medical responsibility remains within the purview of intensivists. The diversity of patients in ICUs necessitates the implementation of an objective measurement system for patient classification and determining staffing requirements. Furthermore, admitting intermediate care patients to the ICU helps in avoiding the overhead associated with a dedicated intermediate care unit, including mitigating tasks such as hand-over procedures and bed management.

Het ander element van dat allemaal te koppelen en onder het beheer van IZ te steken, ik zie dat nu ook wel een stukje… Het heeft zeker als voordeel dat je een zekere flexibiliteit inbouwt. Dat is

niet altijd zo rigide in zoveel bedden step down, zoveel high level… Soms fluctueert dat een beetje. (hospital management)

8.7.3.2 *Medical responsibility for separate intermediate care units is challenging: intensivists or organ-specific physicians?*

ICU PHYSICIANS HAVE A BROAD TRAINING WHICH MIGHT BE BENEFICIAL FOR NON-ORGAN SPECIFIC INTERMEDIATE CARE UNITS

Patients admitted to intermediate care units often present with multiple organ-related issues concurrently. These patients benefit from the involvement of physicians with a comprehensive perspective and broad expertise. Moreover, the scale of most hospitals poses challenges for establishing organ-specific intermediate care units, leading to a scenario where intermediate care units (when established) would in most hospitals encompass a diverse patient mix, including cases from cardiology, neurology, and pneumology, among others. Given the training received by ICU physicians, several respondents argued that they are ideally positioned to serve as the responsible physicians on intermediate care units. Furthermore, when intermediate care units are utilised as a step-down from the ICU, it offers the advantage of maintaining continuity in medical follow-up. In contrast, organ-specific medical specialists run the risk of concentrating excessively on the specific organ in which they are specialised.

Persoonlijk ben ik van mening dat dat het beste door een intensieve zorgen arts gebeurt of iemand met een opleiding van intensieve zorgen. ….. de stroke is neurologie, en jammer genoeg kijken die vooral naar dat ene orgaan. Dus dat moeten mensen zijn volgens mij die ofwel daarin opgeleid zijn om dat ook heel breed te kunnen bekijken, ofwel moeten dat intensivisten zijn. Dus mij lijkt dat het meeste evident dat dat intensivisten zijn, want intensivisten kijken van de teen tot het hoofd. En die complex patiënten, die long ICU-patiënten of chronische ICU-patiënten hebben niet enkel één probleem, maar meerdere problemen. (ICU physician)

OUT-OF-OFFICE HOURS: MORE DIFFICULT TO ORGANISE WHEN ORGAN-SPECIFIC MEDICAL SPECIALISTS ARE RESPONSIBLE

Moreover, when (several) organ-specific specialists are responsible for a single intermediate care unit (e.g. shared responsibility of cardiologists, neurologists, pneumologists), respondents stated that problems might occur during out-of-office hours when patients develop problems outside the expertise domain of the responsible specialist's discipline (e.g. cardiologist responsible for out-of-office service when a patient develops neurological problems). In addition, when there is shared responsibility between different medical disciplines it will have an impact on the work of and collaboration with the nursing team (e.g. medical rounds at different moments of the day, no single point of contact). The alternative (i.e. intermediate care beds in organ-specific general units such as gastro-enterology or neurology) will be faced with the same problems during out-of-office hours in addition to the fact that patients who require intermediate care also often have problems with more than one organ or body system. Moreover, the number of intermediate care beds on such units will be limited, which makes it difficult for the nursing team to acquire sufficient expertise to take care for these patients.

Puis alors il y a un gros problème dans les medium care …c'est le suivi. La journée effectivement on va peut-être avoir un médecin sur place, un encadrement infirmier à peu près correct, mais la nuit qui est-ce qui va s'occuper des alarmes ? Qui est-ce qui va s'occuper de cela ? Donc, en général dans les hôpitaux aujourd'hui, qui est-ce qui s'occupe de l'unité coronaire quand elle n'est pas intégrée dans les unités de soins intensifs, mais qu'elle est une unité un peu spécialisée en tant que telle ? Souvent ce sont les intensivistes qui vont voir s'il y a un problème particulier. Même chose dans les stroke units. Est qu'il faut des medium care ailleurs ? Un medium care habituellement considéré comme pouvant être le cas ailleurs, c'est par exemple en pneumologie. (hospital umbrella organisation)

8.7.4 Implementation of intermediate care: autonomous decision of individual hospitals or intervention of public authorities needed?

SOME ADVOCATED FOR CLEAR STAFFING STANDARDS FOR INTERMEDIATE CARE

Not all nursing staff of an intermediate care unit will require specific ICU expertise. When setting up a broader context for intermediate care in Belgium, it is necessary to reflect on which staffing norms are required. It is not as simple as setting up units with a slightly lower staffing level compared to an ICU. It is required to reflect on the goal of these units and what is needed to achieve these goals (e.g. more rehabilitation compared to the ICU). The public authorities are supposed to set some general framework to assure its quality. The payment system should, according to respondents, include a patient acuity measurement to adjust the allocated budget based on the patient profiles.

> *Op het eerste zicht lijkt het logisch om dat te beschouwen als zijnde een aparte entiteit met een aparte financiering meer gestoeld op revalidatie, kiné en daar dan… Als daarvoor zou geopteerd worden, denk ik dat er wel minimum vereisten zouden moeten zijn voor die revalidatiemogelijkheden aan te kunnen bieden. Dat daar ook wel echt op ingezet moet worden. En dat het niet zo mag zijn dat zo'n medium care, dat daar de patiënt in een ander bed gelegd wordt, er minder verpleegkundige bestaffing is en voor de rest niet veel mee gebeurt. Dan ga je uw momentum verliezen om die kwaliteit van zorg te optimaliseren. Dus in die zin denk ik wel dat het goed zal zijn dat er een bepaalde regelgeving zou zijn of een wettelijk minimum kader, van dit moet je wel kunnen aanbieden aan die patiënten. Op welke manier dat dan gefinancierd moet worden, ja, lijkt wel evident dat de zorgzwaarte qua verpleegkundige bestaffing, qua alles, minder intensief dan op de intensieve zorgen zelf. In die zin vind ik het niet onlogisch om dat iets anders te doen, maar er staat wel iets tegenover vind ik. Ik weet niet of dat een antwoord is op uw vraag. (ICU physician)*

THE CONCEPTION OF INTERMEDIATE CARE UNITS (DEDICATED, MIXED OR ORGAN-SPECIFIC) DEPENDS ON THE LOCAL CONTEXTS: AUTONOMY FOR HOSPITALS IS IMPORTANT

The way an intermediate care unit is being set up (organ specific or multipurpose) depends, according to the respondents, on the local context. Coronary care units are a specific type of organ-specific units with a care context which is closely connected to that of ICUs but generally with patients not needing ventilation. In large tertiary hospitals, it is already possible to organise such intermediate care for specific organ systems (neurology, cardiology, pneumology). Yet, in most hospitals the critical mass of patients for these specific conditions will be too low for an organ-specific intermediate care unit. Respondents acknowledged that the current hospital budget (BFM basic and supplementary points and other sources like the pharmaceutical budget and deduction of physicians fees) allows the flexibility to allocate resources at the unit level in the most efficient way. This results in some hospitals, despite the absence of a legal framework, to already the setup of intermediate care units or to increase staffing levels based on patient needs. Examples are the current coronary care units, haematology units, etc.

Respondents stated that in absence of guidance from public authorities, it is currently the chief medical officer who decides (after concertation with the respective physicians) who is the medical responsible of an intermediate care unit. Respondents questioned if it is necessary to change this. After all, the decision to set up an intermediate care unit is possible within the current legal framework and some respondents embraced this flexibility. Respondents from larger hospitals, for instance, stated that the pressure on their ICU capacity pushes them to create intermediate care units (step-down units). Several respondents were in favour of this autonomy over interventions from the public authorities. The necessity of establishing a dedicated intermediate care unit is contingent on various factors, including the level of care provided by the hospital's ICUs, the characteristics of the general wards, and the overall case-mix of the hospital. Respondents stated that installing such a level within the nationwide organisation and payment system is not clearcut. When the decision is taken at the hospital level, it might be quite evident.

> *Quel type (de patients) on met dans le medium care ? Je pense que cela dépend vraiment aussi de l'hôpital en question. Je pense qu'il y a des profils de patients qui dépendent de l'activité de*

l'hôpital. Un hôpital qui fait beaucoup de chir cardiaque extérieure ou de neuro-chir, on voit qu'il y a toute une série de patients qui, à l'heure actuelle, viennent aux soins intensifs qui pourraient peut-être être dans des unités plutôt medium care mais chirurgicales. Ou ici on est en train de terminer une étude sur la réadmission aux soins intensifs, on voit que la charge de travail le jour de la sortie influencent cela aussi. (ICU nurse)

De vraag is in hoeverre wilt je als overheid in elk ziekenhuis alles controleren? Mijn bedenking was vooral: als je het wil controleren, gaan er een hele hoop vragen komen. Tegenover nu is dat aan de hoofdarts en de directeur om aan die artsen met zijn verpleegkundigen te kijken wat een goede organisatie is voor onze setting, wat ook wat flexibiliteit toelaat. (hospital management)

SOME RESPONDENTS ADVOCATED FOR BASIC NORMS IMPOSED BY THE PUBLIC AUTHORITIES WITH SUFFICIENT DEGREES OF FREEDOM FOR THE HOSPITAL SECTOR TO ADAPT INTERMEDIATE CARE ORGANISATION TO THE LOCAL CONTEXT

Nevertheless, while some stakeholders advocated for a considerable degree of flexibility and autonomy for the hospital sector, several respondents stated that there is a need to establish a general framework for intermediate care. This is rooted in the substantial budgets required to organise these units, and it is therefore, from a societal perspective, necessary to define certain limits and prerequisites.

Ja, maar als we realistisch blijven en ook rekening houden met het standpunt van de overheid die het allemaal moet kunnen betalen, want al die flexibiliteit en van alles kunnen doen en dan verwachten dat de overheid het financiert, is waarschijnlijk een beetje… ..Ik ga ervanuit dat dat een stuk noodzakelijk blijft, want het gaat over grote budgetten, het is dure zorg. Dus je kan niet als sector verwachten dat de overheid zomaar een blanco cheque geeft: hier is uw budget en doe maar wat je wilt ermee. Er moet een minimale normering zijn waar dat ge minstens moet aan beantwoorden om recht te hebben op die bijkomende erkenning en dus ook financiering die daartegen over staat. Hoe je dat in praktijk precies invult, kan ik begrijpen dat de ziekenhuizen zeggen: we moeten iets meer flexibiliteit hebben. Het mag niet te rigide zijn. Maar dat is nog iets anders dan totale vrijheid over hoe ge dat organiseert. (hospital management)

8.7.5 The organisation of intermediate care and ICU is interconnected: impact on budget, capacity and staff

SETTING UP INTERMEDIATE CARE UNITS WILL IMPACT THE PATIENT ACUITY LEVEL OF ICUs: ADAPTATION OF STAFFING LEVELS REQUIRED

Respondents stated that presently, a substantial proportion of patients admitted to the ICU exhibit an intermediate care profile. Examples given were post-surgical patients upon ICU admission or critically ill patients in the recovery phase who necessitate extensive monitoring beyond what a general unit can provide. Respondents anticipated that the establishment of intermediate care units, either to prevent these patients' admission to the ICU or to facilitate accelerated discharge from the ICU, will result in an elevation of patient acuity levels within the ICU. Consequently, the staffing levels in ICUs, which typically maintain a basic staffing ratio of 3:1 and are considered low in an international context, would need augmentation. The instalment of intermediate care units would entail an increased demand in ICUs for a 2:1 or even 1:1 patient-to-nurse ratio. Respondents raised concerns regarding whether the introduction of intermediate care units would alleviate the need for nursing staff, contending that it is more likely to lead to a redistribution of the existing staff pool. Furthermore, the viability of staffing intermediate care units alongside existing ICUs, rather than partially replacing ICU capacity, was deemed highly improbable due to the prevailing nursing shortage.

Wij hebben nu die mix. De patiënten blijven liggen en het voordeel is dat de zorgzwaarte hanteerbaar is, want er liggen zwaar zieke patiënten tussen minder zwaar zieke patiënten. Als je die minder zwaar zieke patiënten die zo wat meer de chronische zorg nodig hebben, wegtrekt van intensieve zorgen en je brengt die onder op zo'n step down unit, dan heb je wel het probleem dat uw zorgzwaarte extreem naar omhoog gaat op intensieve zorgen. En dat je er in sommige

gevallen niet gaat komen met 1 à 2 verpleegkundigen. Wij zien dat nu ook al dikwijls: als wij ECMO patiënten hebben of heel complexe, ja, dat gaat niet met één verpleegkundige voor twee patiënten. Dan moet je naar een één op één gaan. Als je dan een andere verpleegkundige drie patiënten geeft, en daar zit één revalidatiepatiënt tussen, lukt dat allemaal wel. Maar in het geval dat al die minder zware patiënten weggetrokken worden uit intensieve zorgen is dat… Je hebt het voordeel dat op die medium care of step down, je dan minder verpleegkundigen aan bed nodig hebt, maar anderzijds ga je de zorgzwaarte op intensieve zorgen dan verhogen. Ik ben niet 100% zeker dat dat zich netto met een grote vermindering van het aantal verpleegkundigen gaat… dat dat het gevolg gaat zijn. (ICU physician)

RESPONDENTS QUESTIONED IF INTERMEDIATE CARE UNITS ARE AN ATTRACTIVE WORK SETTING

Several participants emphasised that the integration of patients exhibiting an intermediate care profile with those who are critically ill is well-received by nurses. Managing intermediate care patients provides an opportunity for nurses to release stress and apply various nursing skills, such as patient education and communication. Nevertheless, respondents doubt that intermediate care units with only patients with such a profile are sufficiently attractive for nurses with the required expertise (e.g. nurses with specific training and expertise in intensive care). ICU nurses mostly prefer high-technical care and will be reluctant to work in an intermediate care unit. As a consequence, separating care for patients with an intermediate care profile in separate units will, according to respondents, probably lead to intermediate care units predominantly staffed with nurses without ICU specific expertise while these patients might still benefit from such expertise.

In 'the war for talent' merk ik dat het heel moeilijk is om verpleegkundigen die graag intensieve zorgen willen doen om die te zeggen: we hebben voor u een mogelijkheid om op een step down of ne medium care te werken. Dit is minder aantrekkelijk met als gevolg dat het heel moeilijk is om daar ook die experten te kunnen krijgen. Dat pleit voor ne mix zorg voor dat het op beddenniveau is en niet op units. Dat is niet aantrekkelijk. …Als ge graag intensieve zorgen doet, wilt je een high level hebben, of voldoende blootstelling aan high level pathologie. Daarom is zo een mix wel goed denk ik. … We hebben er ook al met onze intensivisten over gesproken. Het echt separaat maken heeft als risico dat je daar minder goede profielen op af krijgt, terwijl je die ook wel nodig hebt die klinisch goed onderlegd zijn om te kunnen inschatten wanneer er iemand een upgrade van zorg nodig heeft. (hospital management)

CREATING INTERMEDIATE CARE UNITS WILL BE AT THE EXPENSE OF ICU CAPACITY

Given the relative high ICU capacity in Belgium, the creation of intermediate care capacity without reducing ICU capacity is considered (in budgetary terms) to be an unrealistic scenario. This is reinforced by the nursing shortage which makes it unlikely to find enough staff to turn general units into intermediate care units. Moreover, there is a fear, especially with the recent COVID-19 pandemic in mind, that a reduction of ICU capacity would be a step back for the Belgian healthcare system.

Une des idées évidemment derrière les medium care, imaginez que demain on invente des medium care en Belgique, il faut voir si le total des lits nouveaux soins intensifs et medium care, c'est plus ou moins que nos lits de soins intensifs actuels. Parce que si l'idée c'est de prendre des lits normaux et de les mettre dans les medium care en plus, c'est très bien pour les malades, ils seront mieux suivis, ce sera un petit peu plus cher. Si l'idée c'est de prendre des malades de soins intensifs et de les mettre là, c'est bien pour l'efficacité du système, cela coûtera moins cher pour les malades qui n'en ont pas vraiment besoin. Globalement je pense qu'au bout du compte les medium care, si on s'y prend bien cela ne sera pas beaucoup plus cher ou beaucoup moins cher. (ICU physician)

8.8 Data

8.8.1 Current nationwide data not ICU specific enough and insufficient for benchmarking of quality

AVAILABLE DATA ABOUT SEVERITY OF ILLNESS AND INTENSITY OF CARE ARE NOT SPECIFIC ENOUGH FOR INTENSIVE CARE SETTING

In the Belgian healthcare context, the utilisation of the Minimal Hospital Data (MZG – RHM) serves as the foundation for the hospital payment system. However, respondents pointed out that the administrative nature of these data presents limitations, particularly in capturing the severity of illness among critically-ill patients, especially in the realm of medical cases. As such, the inadequacy of these data becomes, according to respondents, pronounced in analyses focusing on ICUs, where the use of specialised instruments such as the SOFA score or APACHE score is deemed imperative (see Chapter 4). An inherent challenge of these administrative data also lies in the temporal aspect, with a considerable lag of approximately two years before the data becomes available for thorough analysis. This delay hampers real-time insights into critical care trends and impedes the timely implementation of targeted interventions. Additionally, concerns have been raised regarding coding creep, further compromising the accuracy and reliability of the dataset.

Next to the medical data in the MZG – RHM, nursing data are also collected during 60 days each year. These nursing data mirror, according to respondents, similar limitations as the medical data, including issues of upcoding and a lack of ICU-specific granularity. Despite these drawbacks, some respondents acknowledged the potential of nursing data, compared to medical records, in illustrating variations in the intensity of care across different ICUs. However, respondents also indicated that, to truly discern variations in nursing workload and facilitate informed adjustments in staffing levels, the current datasets fall short. There is a recognised need for more ICU-specific tools that can effectively capture nuances in nursing care demands, ultimately contributing to a more comprehensive understanding of the intricacies involved in ICU management. The call for reform within the existing data infrastructure is evident, aiming to bridge the gaps and enhance the precision of healthcare analyses in the critical care domain.

> *Maar je mist cruciale informatie. ..nee, ik geloof daar niet in. MZG is daar niet voor gemaakt. De SOFA score die niet de ideale score is langs geen kanten, maar het is makkelijk te bepalen en dat zou toch al een beetje een beeld geven van de zorgzwaarte. Maar als je echt wilt kijken: wat voor patiënt hebben we op intensieve zorgen, heb je een voor een stuk van de patiënten onvoldoende met de MZG gegevens, denk ik. Dat is de reden waarom we MICA nodig hebben. Anders zou het veel gemakkelijker zijn en nemen we de MZG gegevens. Ze lopen ook maanden achter. (ICU physician)*

> *Actuellement … un des problèmes des soins intensifs, c'est qu'il n'y a absolument personne qui sait ce qu'on fait dans les lits de soins intensifs. (ICU physician)*

MEASURING ICU QUALITY IS COMPLEX AND NEEDS TO BE ADAPTED TO THE UNIQUE DEMANDS OF THIS SETTING

Several respondents stated that quality of care across ICUs vary. This was already common knowledge within the sector before the COVID-19 pandemic but was definitely confirmed during the pandemic. Yet, respondents admitted that this is more a narrative than based on hard data. While several respondents referred to the publication of Taccone et al. (2021)[105] (which illustrates the variation in standardised mortality rates across ICUs during the first waves of the pandemic), most stated that quality measurement on ICUs is too limited or absent (despite the limited number of hospitals that participate in MICA on a voluntary basis, see below).

Assessing quality outcomes in an ICU is inherently complex, necessitating case-mix adjustment for accurate evaluation. Moreover, ICU admission is but one episode within a broader hospital stay, and challenges in observed quality may stem from issues in other units. Consequently, some respondents cautioned against public reporting of quality outcomes, citing difficulties in interpretation due to these

complexities. Conversely, there was a counterargument advocating for increased transparency, extending beyond outcome measurement and publication to encompass auditing practices. Notably, a respondent highlighted a perceived lack of public authorities' auditing of ICUs in the context of accreditation, emphasising the need for a more comprehensive approach to ensure accountability and quality improvement.

> *… mais les médecins on les connaît, ils savent où sont les mauvais hôpitaux et les mauvais traitements, mais ils ne veulent jamais le dire et puis vous allez récolter des données … je pense que s'il y a de mauvais hôpitaux il faut le dire … c'est dans l'intérêt des malades et je ne vois pas pourquoi on doit commencer, continuer à financer les hôpitaux qui travaillent mal. Que des médecins qui travaillent mal reçoivent de l'argent, c'est dommage, mais ça ne me dérange qu'à moitié. Mais que des malades soient maltraités, ça, je ne trouve pas ça normal. Et donc moi je pense qu'il faut que ça se dise. (ICU physician)*

8.8.2 The MICA initiative: potential – limitations – barriers for implementation

8.8.2.1 The MICA-registry is a voluntary-based ICU-specific registry which holds the potential to improve insights into the functioning and outcomes of Belgian ICUs

ICU-SPECIFIC DATA SYSTEM IS REQUIRED

The need for a nationwide valid and ICU-specific system which includes instruments that allow to measure both the severity of illness as well as the intensity of care is needed. Respondents stressed that while both concepts are related, they are not the same. A patient can be critically ill but require a relatively low degree of nursing care and vice versa. This information is needed for several purposes (e.g. quality management, organisation, staffing allocation, payment system). Valid ICU-specific instruments could, for instance, help to justify different patient-to-nurse ratios for different ICUs within and across hospitals. Before to start a big reform in levels, a better grasp on what is happening inside these ICU beds is needed. Also correct data about the available capacity (which already improved since the start of the pandemic) will be needed.

> *Ja, dat is wel echt zo. En dat is dan ook iets, wat ik dan ook vind… Je kijkt dan vaak naar de beademingen en zo, maar vaak zijn de patiënten die net niet aan de beademing zijn, die daar rondzweven van moeten we ze intuberen of niet, naar workload voor de verpleging en ook voor de aanwezigheid en checks door artsen, vaak veel zwaarder. De rustigste wachten zijn iedereen geïntubeerd, kalm, stabiel… dat is het rustigste, dat is wat draaien aan de knopkes, maar diegene waar dat ge moet gaan kijken: zou ik hem intuberen? Moet ik den tube eruit halen? Dat zijn mensen die veel meer workload creëren en veel meer aandacht nodig hebben dan diegene die… Ik vind het echt wel een hele uitdaging om dat te wegen. (hospital management)*

ICUs ARE VERY COSTLY: SETTING UP A REGISTRY WILL BE POSSIBLE AT A RELATIVELY LOW COST

Respondents pointed out that the organisation of ICU care demands a high budget. As such, they are surprised that we know so little about our ICUs and point out that setting up a high-performance data system will only demand a relatively low share of this budget. Parallels were drawn with other healthcare areas (e.g. cancer has a high burden of disease, a high-performance cancer registry exists). ICU-specific data systems will increase transparency and will allow a more data-driven oriented policy (e.g. quality, levels of care with adjusted patient-to-nurse ratio). Respondents also emphasised that, besides a budget, there is an urgent need to develop a vision on the organisation of ICU care (e.g. different levels) as well as a vision on the collection of data and its applications (e.g. financing, quality measurement and benchmarking, staffing). According to respondents, the data collection should serve to develop the landscape according to this overall vision in a data-driven manner.

> *On avait dit, à l'époque, regardez vos dépenses totales de soins de santé pour les malades en soins intensifs sont…, je simplifie maintenant, de 600 millions d'euros par an. Si on vous demande de payer 6 millions par an pour faire l'évaluation et tout cela, cela veut dire que vos dépenses, vous dépensez 99 % pour soigner les malades et vous ne savez pas s'ils sont bien soignés ou*

pas, c'est ce qui se passe maintenant et on vous propose à côté de cela 1 % de tout cela en plus pour savoir tout ce que vous faites avec les 99 autres pourcents. (ICU physician)

MICA-REGISTRY HOLDS THE POTENTIAL TO BE USED FOR MANY PURPOSES

MICA[y] has the objective to increase insights into what is happening inside Belgian ICUs and what the outcomes are. Via MICA it is possible to measure the severity of illness, workload of nurses and (case-mix adjusted) outcomes. It is, in contrast with the administrative data, ICU-specific. It includes, according to respondents, the best possible instruments (e.g. APACHE, SOFA, NAS). Respondents stated that MICA holds the potential to enhance transparency regarding the types of patients, activities, and quality metrics within Belgian ICUs. MICA's utility extends to identifying different levels of ICU care based on both activity and severity of illness, as well as quality metrics.

Est-ce qu'il est envisageable d'enregistrer au niveau de tous les hôpitaux belges un set de données qui nous permet de bien décrire les malades et donc au bout de la chaîne d'évaluer les résultats ? Une des solutions à tout cela serait évidemment, ce qu'on fait dans MICA et ce n'est pas par hasard, c'est pour cela qu'on le fait, c'est juger de la gravité des malades avec une série d'éléments qui ont été validés dans les études internationales de bonne qualité et ils ont choisi à l'époque les éléments les plus objectifs possibles. (ICU physician)

8.8.2.2 Barriers to implement MICA nationwide

POTENTIAL REGISTRATION WHEN IT SYSTEMS DO NOT ALLOW AUTOMATIC DATA EXTRACTION

While clinicians criticised the lack of clinical details in the current administrative data, some of the interviewed respondents warned for the risk that a coding system conceived by clinicians can become too detailed (e.g. for clinicians typically a lot of clinical details are important to register) and will make the registration burden unnecessary high. It is essential that most data are extracted automatically from the electronic patient records. While many hospitals already have adequate systems (e.g. allowing automatic extraction of classification systems based on lab results, vital observations, etc.) this is not the case for all (e.g. registration on paper or different IT-platforms that are not or poorly connected). Therefore, MICA entails, according to respondents, a risk to increase the registration burden for physicians and nurses in some hospitals. On the one hand a critical eye on which data are essential might be needed to limit the coding burden. On the other hand a further implementation of well-documented electronic patients records (which is part of a qualitative care process) is essential to allow automatic data extraction of ICU-specific tools.

Pour l'instant dans mon hôpital, pour demander une prise de sang, il faut le faire dans un programme et pour regarder les résultats, il faut aller dans un autre programme et puis alors pour encoder la charge de travail, moi je leur demande de faire cela dans un autre programme et alors pour encoder le patient quand il arrive dans la chambre pour dire qu'il est arrivé dans la chambre, il faut regarder dans un autre programme, il faut se recoder dans un autre programme et pour faire le DI-RHM, il faut le faire dans un autre programme. (ICU nurse)

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y MICA ('Monitoring Intensive Care Activities') includes data from 14 Belgian hospitals who participate on a voluntary basis to this initiative that was initially set up with the support of the Federal Public Service of Public Health. The main objectives are to encourage hospitals to share quality and performance indicators about their ICUs and to build a registry that allows to enhance the epidemiological insights on patient profiles admitted on Belgian ICUs. It includes laboratory, medical, diagnostic and therapeutic data that allow to derive severity of illness scales, medical outcomes, etc. It also includes a module that, when completed, allows to calculate workload measures.

IMPLEMENTATION IS HAMPERED BY LACK OF FUNDING AND TRUST

Despite the technical feasibility to further implement the MICA registry, its widespread adoption faces impediments. Challenges mentioned by respondents include a lack of funding from public authorities, hesitancy from hospital management to invest in such a registry, ambiguity surrounding data ownership, trust issues concerning public authorities and among participating hospitals, and concerns about potential repercussions. Additionally, the current reliance on a foreign commercial partner[z] raises questions regarding licensing, participation fees, data ownership, and compliance with General Data Protection Regulation (GDPR).

> *Financiële ondersteuning enerzijds, zeker in deze tijd waar alle ziekenhuizen extreme besparingsrondes aan het doen zijn en aan het beknibbelen zijn op iedere cent dat ze uitgeven, personeel afvloeiingen. Dat is zeker een issue. Het andere is dat andere ziekenhuizen mij ook al boudweg gezegd hebben: wij gaan nooit participeren tenzij we verplicht worden. Omdat ze van mening zijn, en ik begrijp dat voor een stuk, ze weten dat ze oneigenlijk intensieve zorgen gebruiken, of ze denken misschien dat ze slecht presteren, dat weet ik niet. Dat leggen ze mij ook niet uit of dat terecht is onterecht. In ieder geval hebben ze schrik voor big brother. Ze hebben schrik dat er inzage is in hun cijfers, in hun manier van werken, en ze hebben het gevoel dat als er inzage is, ze gepenaliseerd worden. Dus ja, waarom zou je gepenaliseerd worden als alles loopt zoals het moet lopen? (ICU physician)*

8.8.2.3 Benchmarking and/or public reporting

BENCHMARKING DATA IS CONSIDERED THE WAY FORWARD BUT PUBLIC REPORTING IS A BRIDGE TOO FAR FOR SOME

Respondents tended to agree that there are many benefits of benchmarking data about case-mix, activities and quality. Yet, for many of the respondents public reporting is a bridge too far. The main argument is that the interpretation of the data is difficult without an ICU background. In addition, respondents feared coding creep when data are publicly reported (i.e. change coding to improve their results). Therefore, respondents advocated to set up an independent body responsible to audit, benchmark and interpret the data. The respondents with a MICA link did not seem to trust the public authorities to take up this role. On the other hand, they demand funding from the public authorities to roll out the MICA registry across hospitals. They stated that they see a role for the colleges of intensive medicine or a similar committee to fulfil this role. From their perspective it is essential that intensivists are in charge as they are best placed to interpret the data.

> *De initiële opzet is benchmarking en de bedoeling is dat ieder ziekenhuis zichzelf vergelijkt ten opzichte van zijn peers. Maar persoonlijk vind ik het te vrijblijvend. Vind ik daarom dat de overheid dat moet doen voor ons? Nee, want de overheid… Je hebt ook een bepaalde voeling met de IZ zelf om dat op een goede manier te kunnen inschatten. Het zijn niet zomaar cijfertjes, want benchmarking kan je ook op veel verschillende manieren bekijken. En als er problemen zijn in een ziekenhuis is het dikwijls ook logistiek en dergelijke meer of wanneer patiënten ontslagen worden, of communicatie en dergelijke. (ICU physician)*

BENCHMARKING DATA REQUIRES TRUST AMONG THE PARTICIPANTS

Respondents state that the MICA hospitals that participate on a voluntary base (and pay for it) gradually shared more and more of their results. This benchmarking exercise has taken some time. While at the start hospitals were reluctant to share information, now there is a culture of trust and a willingness to learn from each other. It is essential, according to respondents, that more hospitals register MICA to get a good view on the Belgian ICU system. Currently, the benchmarking relies on a platform hosted by a commercial company. Some respondents asked financial support from the public

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[z] The MICA-registry makes use of the software from a Brazil-based company (Epimed Solutions) that hosts the platform to share data and benchmarking of performance and quality indicators.

authorities (more than is actually provided via the P4P system[aa]) to foster implementation both at the hospital level and at the macro level (e.g. to work with the data, organise peer reviews, etc.).

> *Momenteel is MICA een vrijwillig systeem waarbij ieder ziekenhuis participeert, betaalt daar ook voor, maar dat overkoepelende orgaan met audits en dergelijke meer is niet geïnstalleerd, één omdat we niemand hebben om dat te betalen, ... Ondertussen is het vertrouwen in die mate wel groter geworden tussen alle centra onderling dat dat wel zou kunnen. Door die MICA, als er één ding dat wel verbeterd heeft, is dat je echt wel een groter vertrouwen hebt en in het begin bij ons jaarlijkse congres was het zo dat de data geanonimiseerd getoond werd, maar ondertussen is dat open en breed voor de deelnemers. Dus ik zie … hoe dat hun mortaliteitscijfers zijn. Dus er is geen haan die daar nog naar kraait dat dat een issue is. Maar dat is intern en onder intensivisten, en we weten allemaal dat cijfers zijn, maar het is vooral voor introspectie om te kijken: wat kan er beter binnen mijn ziekenhuis? Maar ik denk wel dat het jammer is dat het niet meer opgelegd wordt door de overheid omdat… en dat er ook geen financieel incentive is. De P4P maar dat is peanuts. Jammer genoeg is de firma die dit aanbiedt… De benchmarking is naar mijn aanvoelen te duur, maar het is wat het is. Er was niemand anders die het toen kon. Maar doordat het zo duur is vinden ziekenhuizen dat er ook geen extra geld geïnvesteerd kan worden om die auditingtool, om die overkoepelende organisatie ook nog eens te installeren. (ICU physician)*

THE ROLE OF PUBLIC AUTHORITIES IS A MATTER OF DEBATE: ACTIVE PARTICIPANT WITH ACCESS TO THE DATA OR ONLY FUNDER?

As mentioned above, the role of public authorities is a matter of debate. ICU physicians stated that the coordination of the data (coding, audit, benchmarking) has to be dedicated to an independent body. Yet, they are looking to the public authorities to fund such an initiative. In fact, they argued that for a sector that is so resource consuming, the investment in a performant MICA registry and reporting system is only peanuts. Respondents stated that public authorities could receive aggregated data from the MICA-body. The position of the interviewed policymakers was different. They asked, in return for an investment in the MICA registry, access to the data. ICU physicians feared that public authorities will use these for other purposes than quality benchmarking (e.g. capacity planning, payment) which will negatively impact trust in the system as well as change the coding behaviour (e.g. upcoding). A stepwise approach is, according to them, advisable to build trust (e.g. make hospitals that do or do not participate public; benchmarking with all, except the own hospital, being anonymous). Such a careful approach could overcome the strong resistance (e.g. small hospitals that fear to be penalised because of less severe caseloads or potentially not meeting some quality standards) and increase the participation rate. Transparency can gradually increase when trust augments but at a certain point registration will have to be made compulsory to make the results public.

> *D'une manière ou d'une autre, il faut, à mon sens en tout cas, essayer de militer pour avoir des données qui permettent de faire du benchmarking ou des comparaisons mêmes anonymisées dans un premier temps, mais qui permettent en tout cas d'y voir un peu plus clair. (hospital umbrella organisation)*

[aa] In the Belgian hospital payment system, part of the budget is allocated, based on a point system, to hospitals in the context of 'pay-for-performance'. Hospitals can earn a maximum of 100 points based on (Structure-Process-Outcomes) indicators. One of the structure indicators is the participation to a limitative list of registries (a.o. MICA) which results in 5 points.

8.9 Payment

8.9.1 Do the current payment mechanisms sufficiently take into account the variation in case-mix and patient acuity?

BASIC PAYMENT FOR NURSING STAFF IS CASE-MIX ADJUSTED: DOES IT SUFFICIENTLY TAKE INTO ACCOUNT THE DIFFERENCES IN STAFFING NEEDS OF CRITICALLY ILL PATIENTS?

Respondents stated that the basic payment of the BFM is the main mechanism to pay for nursing staff. The case-mix based financing via the BFM compensates hospitals with a higher proportion of heavier patients financially more than hospitals with a lower proportion. These patients are proportionally also more admitted in higher intensity ICUs during (part of their) stay. Moreover, this hospital activity (i.e. admission of patients with an ICU profile) results, more specifically, in a number of beds with an ICU character. The payment per bed with an ICU character is not differentiated. Respondents questioned if this payment system sufficiently takes into account the variation of the severity of illness of the critically ill patients across hospitals. It is, according to respondents, also not intuitive that financing starts from justified C/D/E-beds rather than providing a basic payment for ICU beds. Respondents denounced the lack of transparency. They stated that hospitals with a higher number of justified than licensed ICU beds probably have a higher case-mix. Visualising this could, according to them, help as an indicator to identify ICUs with a higher level of care.

> *Dat heeft ook te maken met de activiteit in uw ziekenhuis. Dus in die zin houdt het BFM rekening met de case-mix. In welke mate compenseert dat die zwaardere activiteit waardoor je dan meer budget hebt om personeel in te zetten op de verantwoorde ICU bedden die er zijn? (hospital management)*

Besides severity of illness it is, according to respondents, also important that differences in patient acuity, rehabilitation needs etc. are taken into account. In any case it is important to look further than the purely technical acts alone.

> *Het is allemaal zeer technisch en dat is logisch omdat het zeer objectief is, maar soms is zorgzwaarte ook veel intellectuele of familieparticipatie, of familie- en donatiegesprekken. Ik heb vorige vrijdag een ganse dag bezig geweest met twee families, twee donatiegesprekken. Dat wordt niet verrekend of niet meegenomen in het ganse verhaal. Dat is een moeilijk te objectiveren gegeven. (ICU physician)*

THE PRINCIPLE TO DIFFERENTIATE BETWEEN ICUs EXISTS BUT IS CONSIDERED TO INSUFFICIENTLY COMPENSATE FOR PRACTICE VARIATIONS

According to some respondents the financing of 2 FTE per ICU bed is, in general, not bad. Yet, other respondents stressed that differences in case-mix and patient acuity are insufficiently taken into account via the current payment system. As a result, the ICUs of smaller hospitals are overrewarded (as they often only admit patients receiving post-surgical care which is comparable to PACUs of other hospitals) while the tertiary ICUs (where 1:1 patient-to-nurse ratios are often indicated, especially if it is regarded in a context of international best-practice examples) receive an insufficient portion of the hospital budget .

They acknowledged that the BFM includes these principles (i.e. basic financing via ‘basic points’ topped up with additional budget via ‘supplementary points’). Yet, according to respondents, this system insufficiently differentiates the payments between ICUs. First, the limit of 5 points per ICU bed (see Chapter 3) results in too few ‘basic points’ for tertiary care centres (and sometimes too many for smaller hospitals). In addition, respondents stated that the legislative backbone of this rule is somewhat opaque. Second, the share of the budget that is allocated via supplementary points is too small. The data used to calculate these points are based on, among other things, the nursing data (i.e. Nursing Resource Groups) which, according to some respondents, are not ICU-specific enough and might overrate the technical acts. Also the system of NPERCIZ (i.e. time spent on an ICU bed during a stay) is criticised since it is, to a certain extent, based on an ‘auto-definition’ by the hospitals of what is an ICU bed.

Ik denk wel dat de financiering zoals die nu loopt, ondanks dat de supplementaire punten worden verdeeld aan… is dit onvoldoende om de grote verschillen tussen de ernst van de pathologie en de noden die er zijn op te vangen. … ik blijf in de praktijk hier patiënten zien toekomen … waar dat een één op één noodzakelijk is. Wij kunnen dat niet vanuit de financiering dat wij momenteel krijgen. Ik heb niet de mogelijkheid om met die supplementaire punten te zorgen dat ik x-aantal bedden kan uitrusten met een één op één, terwijl als ik dat zie welke therapie dat er gebeurt. Dat is onmogelijk. Als je dat vergelijkt met internationaal, Europees, zijn wij de uitzondering. ..mijn punt is een beetje, die differentiatie momenteel zoals het in het BFM voorzien is met die punten, is onvoldoende differentiërend om die levels van ernst van patiënten te kunnen uitrusten met de juiste middelen. Dat is mijn kritiek een beetje. De basis is misschien te groot en de differentiatie, de supplementaire is te weinig, waardoor dat iedereen in staat is, … een I-bed één op twee bestaffing te garanderen. Dan kom ik weer terug met een aantal I-bedden of I-diensten in perifere ziekenhuizen PAZA zijn, … Dit is maatschappelijk een nadenker. Dat is mijn punt een beetje: wij hebben een instrument nodig die ook die differentiatie maakt, waardoor we misschien in staat zijn om te zeggen dan moeten we onze financiering een beetje aanpassen. Nu heb ik het gevoel… … dat we elke keer proberen om de basispunten te verhogen en de supplementaire te verkleinen omdat iedereen een beetje een eenheidsworst… Natuurlijk wil iedereen een groot stuk van de koek. Maar er wordt geen rekening gehouden met de ernst van de pathologie. En dat is mijn grootste opmerking. (hospital management)

8.9.2 Payment via BFM insufficient to cover operational costs of an ICU

HOSPITALS COMPENSATE LOSSES VIA OTHER SOURCES

Another point that was raised is the large gap that exists between financed (i.e. number of beds with an ICU character) and operational beds. Some respondents suggested that KCE should demonstrate this gap in the current report. Connected to the discrepancy between the operational costs and the allocated budget via the BFM, hospitals have to rely on other resources (e.g. deductions on physician fees) to be financially viable or keep loss-making ICUs open given their importance for the organisation of more financial rewarding services (e.g. spin-off effects from lab tests, cardio surgery).

Je hebt dan de BFM financiering en die is denk ik voor twee verpleegkundigen per bed, dat dat nog historisch staat ongeveer. Zo is het. Dat is totaal niet in verhouding tot de zwaarte die erin sommige ziekenhuizen ligt of de zwaartegraad die er is. Waarom willen ziekenhuizen graag een intensieve zorgen? Omdat de spin-off van een patiënt met zware pathologie, kost ook veel, maar de spin-off… de cardiochirurgische… Waarom wilt iedereen cardiochirurgie in zijn ziekenhuis? Omdat de honoraria voor een cardiologische ingreep nog altijd zeer substantieel zijn. En de spin-off naar een labo, radiologie – ook al is dat wat afgetopt de laatste jaren – is nog altijd zeer groot als je dat relatief ziet. Ziekenhuizen en artsen willen een intensieve zorgen omdat die zware pathologie nu eenmaal een deel is van sommige in hun gedachten dat ze dat graag willen doen, maar de constitutionele financiering van 2 verpleegkundigen per bed. (ICU physician)

8.9.3 Physician fees: fee-for-service risks to induce activity

The fee-for-service system stimulates, according to respondents, activity. While in general the fees for intensivists are not very technically oriented, technical acts on an ICU can be induced as a cause of the payment system. Moreover, respondents stated that the medical fees (implicitly) compensate for the higher case-mix by the higher tariffs for technical acts (e.g. dialysis, mechanical ventilation) and related deductions on physician fees. It can also limit the interest of intensivists to work on intermediate care units as less technical acts can be charged on these units.

…wat je nu ziet is dat de intellectuele act van het onregelmatig aanwezig zijn, relatief minder scoort t.o.v. individuele technische actie. Ik leg mij uit: hoe haal je de inkomsten als ziekenhuis of als dienst uit de hoeveel beademde patiënten, hoeveel aan de dialyse en zo meer? Dat is een heel moeilijk begrip met een heel gemengde zwaartegraad. … .als je zwaardere pathologie hebt en meer type 3 en 4 patiënten t.o.v. 1 en 2 die misschien op de medium care liggen. We hebben

relatief veel van type 4 en 3. En we zijn nog altijd niet failliet, dat klopt. Dat is nog altijd zo en vertaalt zich ook een beetje in honoraria. Honoraria zijn opgebouwd, hoe zwaarder ziek uw patiënt, hoe substantieel hoger het honorarium. Je hebt een toezichtshonorarium, maar ligt uw patiënt aan de dialyse, de beademing, de ECMO? Heeft uw patiënt een ventrikeldrain, brengt die in de honorariumsector substantieel meer op dan het toezichtshonorarium. (ICU physician)

8.9.4 Design elements future payment systems

MIXED PAYMENT SYSTEM TO SERVE THE ENVISAGED ORGANISATIONAL MODEL

Respondents stated that a payment system is only a means, not an end. First, it is necessary that there is a clear vision on the organisational model. The payment system that is implemented should serve this overall objective. Several respondents referred to the organisation of ICUs in levels of care (e.g. concentration of highly complex ICU care). Respondents stated that the introduction of ICU levels implies that there will be winners and losers. They estimated that probably the tertiary hospitals would be among the winners and the smaller general hospitals among the losers. After all, the introduction of levels of care would result in less budget for smaller hospitals as the concentration of high-complex care, and the financially more attractive pathologies, would probably go to tertiary hospitals.

If the introduction of levels of care is the objective of policymakers, it is important that they also provide sufficient financial incentives to collaborate and ensure that transfers are facilitated and outcomes improve (e.g. P4P payment elements). Respondents stated that, in any case, ICU payments will have to be a mix of fixed and variable components together with outcome-based payment elements.

Je hebt dan het hele debat over hoe financieren we dat? Maar dat hangt wel wat samen. Ik denk dat de financiering van de ICU anders en beter zou kunnen, maar dan moet je weten hoe dat uw organisatiemodel eruit ziet. … de zogenaamde zorgmodellen en financiering zijn er een aantal onzekerheden of discussies mogelijk, maar over de resultaten dat we willen bereiken, kan ik geen discussie over zijn. Over de kwaliteit… Wat produceren we daar en wat is de kwaliteit van wat we daar produceren. Dat zouden we moeten transparanter kunnen maken. (policymaker)

THE HIGHLY VARIABLE CHARACTER OF CRITICALLY ILL PATIENTS MAKES IT NOT SUITABLE FOR PATHOLOGY-BASED LUMP SUM PAYMENT

Respondents referred to the ongoing reform of the hospital payment system: i.e. prospective all-in cost-based lump sum payments per pathology. Several respondents doubted that this payment system is suitable to finance intensive care. After all, intensive care can be highly variable. Therefore, it was suggested by some to keep the budget for intensive care out of the pathology-based lump sum payment. Others were more nuanced. They stated that some pathology groups on ICU follow a standardised pathway (e.g. post-surgical care after cardiac surgery). It is an option to include the ICU care that is more or less standardised into the fixed lump sum (e.g. professional organisations can define for which care programmes or pathways this is possible). Other ICU care can be kept outside the lump sum payment. Since 24/7 availability is important on an ICU, it can be considered to provide a fixed budget (the size of this fixed budget can be hospital dependent based on other parameters: e.g. type of ICU function, etc.) in combination with a variable payment component.

Vous savez cela probablement mieux que moi, mais les financements qui sont des financements de type all-in même si le all-in, on met les honoraires à part, mais peu importe. Un financement all-in, cela va dépendre entre autres choses en tout cas, de la dispersion des malades par rapport à la moyenne. Les malades en soins intensifs, ils sont très personnalisables. Il y a des malades qui vont pouvoir avoir la même pathologie et rester peu de temps et des malades qui vont avoir la même pathologie et rester beaucoup de temps pour des raisons multiples et diverses. Quand il y a une grande diversité ou une grande dispersion ou une plus grande variance en tout cas de cette population-là en soins intensifs, c'est forcément un peu plus compliqué, je dirais, à faire un financement all-in. (hospital umbrella organisation)

8.10 Nursing teams and physicians

8.10.1 Currently staffing levels are mainly based on generic standards instead of on acuity

The current licensing standards are, according to some respondents, simple and clear. Also in the payment system there are staffing standards which are more or less the same for all hospitals. Although case-mix differences and differences in intensity of nursing care have an impact on the budget hospitals receive to staff their ICUs, in practice hospitals have flexibility to decide how to use the budget as long as they respect the licensing standards. Respondents stated that many hospitals staff on or close to these standards. As a consequence, the variation in staffing levels across ICUs is, according to respondents, limited while variation in care intensity and case-mix might be high. Staffing levels might be too high in some (e.g. smaller ICUs) and too low (e.g. tertiary care) in other hospitals given their patient mix. Respondents addressed the lack of transparency between the allocated budget and the staffing levels in practice.

> *Mais pour revenir là-dessus et je pense qu'il a raison, c'est bien théoriquement mais effectivement dans les faits, pour avoir travaillé dans plusieurs unités de soins intensifs, je n'ai jamais vu un staffing adapté à l'activité. On se base toujours sur ces normes de plus ou moins un infirmier pour trois patients. Ces normes, elles sont fixes quelle que soit l'activité. Je pense qu'il faut quelque chose peut-être qui accompagne le financement ou qu'il soit plus transparent pour qu'on sache effectivement là on a droit à un peu plus de personnel ou là un peu moins parce qu'on est dans des normes qui sont très statiques et c'est comme cela que sont organisés les soins intensifs en Belgique avec des normes en personnel très statiques. (ICU nurse)*

8.10.2 Staffing models for non-ICU nursing staff

Respondents stressed that ICUs in Belgium have a highly educated workforce that provides high quality care. Yet, in the aftermath of the COVID-19 pandemic, many hospitals have to close ICU beds due to staff shortages. Respondents stated that the reform of the specialised nursing education programmes contributed to ICU workforce problems. Some respondents referred that a certain stability of the ICU nursing workforce was experienced in the pre-COVID era, but that this feeling is gone. There is a serious problem to attract and retain nurses with the required ICU skills. Working on an ICU is stressful (moral distress). The tight labour market forces hospitals to increase the efficiency in the manpower allocation. Since nurses currently also have non-nursing tasks within their duties, respondents think it is a good idea to also increase the employment of non-nursing staff (e.g. administrative and logistic support staff) within the context of ICUs. When this revision of duties would also involve care (e.g. healthcare assistants taking up care tasks or nursing staff without specific ICU expertise) alternative models for primary nursing (team nursing)[bb] will need to be evaluated. Respondents specified that ICU nurses perform activities that can and possibly should only be done by nurses with specific ICU expertise. In case of differentiated nursing practice it means that one ICU nurse will have to be substituted by more than one non-ICU nurse. The advantage for patients could be that they do not have to move from one unit to another (when their profile evolves from ICU to intermediate care) but that staffing levels within the unit are made flexible based on care load.

> *Het team zelf: hoe is dat opgebouwd? De skill mix en het aantal ratio dat daarbij gehanteerd worden ten aanzien van patiëntenzorg. ..Waarschijnlijk heeft COVID daar ook nog mee te maken dat die emotionele veerkracht bij veel verpleegkundigen onder enorme druk heeft gestaan en nog wel wat restletsel of naweeën veroorzaakt. Dat betekent dat het aanwerven van volwaardige of doorgedreven verpleegkundigen – in kennis – loopt achteruit en dat heel wat verpleegkundigen die setting verlaten omwille van talrijke redenen. Dat maakt dat die gewaarborgde kwaliteit waar*

[bb] Since the 1980s primary nursing is the preferred model in most Belgian hospitals. This implies that a single registered nurse is responsible for and carries out the patient care for specific patients. In contrast with the primary nursing model, the assigned nurse in the team model delegates tasks to nurses (with other competencies) and other care personnel.

we tien jaar geleden voor stonden… die groep die toen aanwezig was, was heel stabiel. Die kennis was… je had daar een anciënniteit die veel hoger was dan nu het geval is. Dat brengt wel wat risico's met zich mee. … op het vlak van functiedifferentiatie en ik denk dat dat een uitdaging is die op ons pad ligt. Daarmee bedoel ik: als we kunnen - en momenteel is dat niet het geval – gaan we idealiter voor de verpleegkundige die gespecialiseerd is die die competentie heeft en die opleiding heeft gevolgd. Maar we weten – omwille van de hele context – dat we daar niet komen, dus dat zet ook wel de deur open voor de beginnende bachelor verpleegkundige. (ICU nurse)

8.10.3 Physicians in intensive care

Belgium has, according to respondents, the advantage that there is a medical specialty in intensive care. Yet, it is a bit particular that these physicians first have to specialise in another discipline (e.g. internal medicine, paediatrics, pneumology, anaesthesia). The level of expertise of Belgian ICU physicians is regarded as high by the interviewed respondents. A respondent was, nevertheless, critical about intensive care physicians with a specialisation in anaesthesia both in terms of expertise (e.g. diagnostic expertise and knowledge about infectious diseases) and availability (i.e. spend much time in operation theatre). Several respondents (see above) also pointed out that ICU physicians have the best profile to be in charge of intermediate care units. Yet, since in Belgium there is no formal system that differentiates ICUs in levels, some respondents stated that in some ICUs, physicians are in charge of patient profiles for which, in fact, they have insufficient experience.

Et l'autre auquel je pensais… Deuxième élément particulier en Belgique, c'est que pour devenir intensiviste, il faut déjà être un spécialiste dans une autre discipline qui est en gros médecine interne ou chirurgie ou pédiatrie ou anesthésie aussi. Cela a des avantages, mais des inconvénients aussi. (ICU physician)

De sterke punten … er is een vorm van kader. Dat is denk ik niet slecht. Maar ik denk dat met de toenemende complexiteit, wat er kan op intensieve zorgen, de nodige kennis, denk ik dat er nood is aan fine tuning in een aantal dingen. Twintig jaar geleden en nu, dat is totaal verschillend. En daar zijn al wel een aantal aanpassingen gebeurd, maar nog onvoldoende denk ik, om te zorgen dat ge alles kunt opvangen wat er opgevangen moet worden. (ICU physician)

8.11 Transport

THE ORGANISATION OF ICUs IN LEVELS OF CARE WOULD HAVE AN IMPACT ON THE TRANSPORT OF PATIENTS, WHICH IS CURRENTLY A BARRIER TO CONCENTRATE CARE

Respondents stated that the between-hospital transport of patients in Belgium is poorly organised and financed. If you want to reorganise the hospital landscape, there will be transport implications: emergency transport bypassing hospitals to arrive at the most adequate hospital and increased inter-hospital transfers. Yet, respondents stated that it is currently insufficiently clear who has the responsibility to organise the transport and who has to bear the costs, which is a serious barrier to reform. Moreover, some hospitals are very reluctant to use their staff (ICU nurses and physicians) for inter-hospital transport for several reasons (e.g. cost, shortage of staff, etc.). In general, it is, according to respondents the accepting hospital that performs the transfer. This has the disadvantage that the staff does not know the patient yet. But respondents stated that this has the advantage that these transport teams might have more experience to care for the very severe critically ill patients compared to the staff from the ICU from which the patient is discharged (i.e. because accepting hospitals are mostly tertiary care level hospitals).

Dat is een beetje het probleem. Ge moet daar echt mensen op inzetten. Ge moet daar intensivisten, intensieve verpleegkundigen op inzetten. En ge zijt die voor een paar uur kwijt. En daar staat niks tegenover. Plus dan nog een keer de kost dat dat naar de patiënt toe geeft. Ik weet niet of je die facturen kent, maar dat is ongelooflijk. (hospital umbrella organisation)

A CENTRALLY ORGANISED TRANSPORT SYSTEM HAS ADVANTAGES AS WELL AS DISADVANTAGES COMPARED TO THE CURRENT SYSTEM

Some respondents were in favour of a centrally organised and guided transport system (that exists in other countries) as it would not cause disruptions of the teams in case of transfers. After all, the accepting hospitals nowadays have to send ICU physicians and nurses to other hospitals for a considerable part of their shift. This has an impact on the workload of the staff in the units. Yet, they also acknowledged that there are several potential disadvantages. First, it can cause bottlenecks when several transfers have to be organised simultaneously. In addition, it has limitations in terms of continuity of care (i.e. yet another team that takes care of the patient between the sending and accepting hospital, some more advanced interventions that are currently done on site of the sending hospital by the transport team will maybe no longer be done by the transport team and will be delayed until arrival in the accepting hospital).

> *Persoonlijk denk ik niet dat het slecht zou zijn om een onafhankelijk transportsysteem te hebben met gespecialiseerde teams, gespecialiseerde materiaal. Ik vind dat toch een mooi systeem wat de ziekenhuizen ook ontlast, want als dat complexe IZ patiënten zijn, gaat er soms personeel van ons van IZ… Artsen mee naar een ander ziekenhuis. Soms doen wij daar therapeutische acties vooraleer wij de patiënt meepakken. Dan steken wij drains, doen wij echo's, van alles en nog wat, zitten wij daar gans een beleid te veranderen vooraleer wij de patiënt meenemen. Hoe dat dan gebeurt met zo'n onafhankelijk transportsysteem, weet ik dus ook niet. Gaan ze dat doen? Het is misschien zoals altijd al, als je iets minder frequent doet, ben je het ook minder gewoon en verlies je voor een stuk die competentie. Daar is dan potentieel het nadeel aan. (ICU physician)*

8.12 Reflections for policymakers when a reform is envisaged

REFORMING THE ICU LANDSCAPE HAS TO BE EMBEDDED IN A LARGER HOSPITAL REFORM

As already indicated above, respondents stressed the interconnection of ICUs with other services. A reform of the ICU landscape will have a lot of impact on the general functioning of hospitals. Therefore, it is essential, according to respondents, that a potential reform is part of a clear strategy and vision of the public authorities on the ICU and hospital landscape. It will certainly require time and transitional measures to implement. Some respondents stated that a first step is to get a better grasp on what is happening in Belgian ICUs and what the results are (cf. data). And if the conclusion of such analysis is that it is better not to reform, this should be considered as a valid conclusion. Others are, even when ICU-specific data collection is lacking, more convinced that reform efforts (e.g. concentration of more complex care) are inevitable. Respondents stated that a reform needs to be affordable from a societal perspective. While some suggested that it cannot be achieved without extra budget it is obvious for respondents that a budget increase (or increase of staffing standards) for all units or hospitals is not possible. Other respondents stated that a reform should be realised within the current budget which will imply that there will be budgets shifts. Some hospitals will need to have a budget increase (e.g. to accommodate specialised ICU care) while others will see their budget for ICU care decrease. Respondents also warned that (cf. COVID-19) it is best not to reduce the overall ICU capacity or at least make sure that (intermediate care) capacity can be upscaled swiftly to ICU capacity in case of a crisis. An ICU reform can go hand in hand with a general hospital reform if it entails a reduction of the number of hospitals and hospital sites in general. In any case, respondents stated that the reform and organisation of ICU needs to balance quality, affordability and accessibility.

> *Maar ik vind dat het wel een beetje aan de overheid is om samen met de sector een plan uit te tekenen waar dat we naartoe gaan, om te zorgen dat we de mensen geënthousiasmeerd, gemotiveerd houden, aantrekkelijk blijven en vooral goede zorg voor die bevolking blijven leveren. Nu is het soms zo'n beetje… Nog een keer, en ik… Alle complexiteit dat er is… Wordt er iets gelanceerd en dat heeft dan een hele hoop collaterals, waar dat ge van denkt dat had misschien… En ik denk die intensieve… Dat gaat echt heel diep. Het wordt altijd weggeschoven als zijnde een ondersteunende dienst, maar als je er begint aan te tornen schiet iedereen in paniek. Ik kan alleen maar zeggen, de paar die toegegaan zijn, heeft echt een heel vergaande impact. (hospital management)*

POLICY BASED ON QUALITY MEASUREMENT AND TRANSPARENCY OR STANDARDS AND REGULATION?

Some respondents suggested that public authorities should intervene by imposing standards and regulation to make a reform happen. But the importance to preserve sufficient autonomy for hospitals to organise ICUs based on the needs of the local context was also stressed. Other respondents stated that all options need to be considered. Since the evidence to impose specific standards might be insufficiently clear, it can also be an option to engage in a policy that focuses on quality measurement and transparency. This might work slower but can have the desirable system outcome in the long run.

> *Maar we kunnen ook sturen via de kwaliteit en sturen door het feit dat ziekenhuizen hun data moeten publiek maken. Dat vind ik misschien… En let op, dat is een bepaald sturingsmodel, op vele vlakken, mochten we echt over goede en betrouwbare data kunnen beschikken, denk ik vaak dat dat de beste benadering zou zijn. Kijk eens naar de slokdarmkankerchirurgie, op basis van de data heeft er een ziekenhuis na een vriendelijk telefoontje van ons een centrum gesloten. Dus dat werkt wel. Dus dat is ook goed voor mij. Dus ik denk niet dat we… Het KCE is niet verplicht om absoluut een grote reform voor te stellen. … daaronder zeggen van er moet wel een soort van minimale capaciteit zijn om voldoende levensvatbare en flexibele ICU te hebben. Dat zouden we ook kunnen doen. En dat moet ook niet allemaal in 1, 2, 3 gebeuren, maar in het kader van de netwerken zou men wel kunnen een beetje kunnen herschikken, denk ik. Ik weet het niet. (policymaker)*

UNCLEAR WHAT THE ROLE OF HOSPITAL NETWORKS WILL HAVE TO BE IN A REFORM OF THE ICU LANDSCAPE

It is unclear what the role of hospital networks will be in the reform of the hospital landscape. As indicated above, acute hospitals require an ICU on site to perform acute services. Reducing the number of ICUs can therefore, according to respondents, be achieved when the number of acute hospital sites is reduced (which can be part of a hospital network strategy where some hospital sites get another function). The discussion of ‘levels of ICU care’ is mainly focused on creating intermediate care units next to ICU units and the concentration of complex care in high level ICUs. The former is seen by respondents as a decision at the hospital level, the latter as a supra-regional care assignment.

> *Niet elk netwerk zal, denk ik een level 1(hoogste level) hebben Je moet niet in elk netwerk een ECMO centrum zetten. Ik geef maar een voorbeeld. Dus je gaat niet overal voor elk netwerk dat hebben, denk ik. Voor de meeste wel, globaal gezien. Maar je weet dat de discussies binnen netwerken een hele moeilijke zijn. (hospital management)*

9 INTERNATIONAL COMPARISON OF THE ORGANISATION AND FINANCING OF INTENSIVE CARE

KEY POINTS

Approach

- A horizon scanning exercise was carried out to identify a long list of European countries with peculiarities in the organisation and remuneration of intensive care medicine. The final selection of countries was based on criteria including a specific remuneration system of intensive care, the presence of levels of intensive care, the organisation of intermediate care units, the existence of an intensive care registry, etc.
- The following countries were selected: Denmark, England, France, Germany, Italy, Sweden and the Netherlands.
- For each selected country, relevant grey and scientific literature was analysed. In addition, an expert survey was completed by selected key informants in each country about the organisation and reimbursement of intensive care.

Legal definition and organisation of intensive care

- All studied countries have a formal or operational definition for intensive care. In four out of seven countries, the definition of intensive care has a legal character. Commonly, ICUs are identified as specialised units within hospitals dedicated to monitoring, diagnosing, and providing critical care for patients with severe, life-threatening conditions.
- In five out of seven countries, intensive care is formally organised in two or three levels of care. While categorisation into these levels is typically done at the unit level, in England, it is defined at the patient level. In most countries, the number of organ failures is one of the criteria used to define levels of care, with patients having single organ failure being treated in a lower level of care than patients with multiple organ failures. In France, the use of a supportive method (during a relatively long period), independently of the number of organ failures, determines the transfer to a higher level of care. In Sweden, all ICUs can provide care to patients with failure in all organ systems, but the availability of other resources in the hospital determines the level of care of the unit. The German system aligns with the broader hospital care framework (where three hospital levels are defined for emergency care) and focuses on specified minimum requirements.
    - In Denmark, Germany and Sweden, the highest level of ICU care takes place only in university hospitals or hospitals with highly specialised functions.
    - In some countries (England, Germany), the lowest level of ICU care consists in the enhanced observation and monitoring of patients that cannot be provided on a general unit. This level is similar to what is elsewhere labelled as intermediate care and is intended for instance for patients stepping down from a higher level of care. In case of deterioration, patients should be transferred to a higher level of ICU care. In other countries (Denmark, France, Sweden) the lowest level of ICU care corresponds to more complex care and cannot be assimilated with intermediate care.
    - Alongside multidisciplinary ICUs, in Denmark and France, specialised or monodisciplinary ICUs are separately defined.
- In most countries, the medical head of the ICU is a physician with advanced training in intensive care and/or anaesthesia. Similar qualifications are required for physicians working in ICUs, although physicians from other medical fields are also involved in ICUs.

- Minimal presence of medical staff during daytime is defined in terms of number of physicians per patient (Denmark and England), per bed (Germany, Lazio region in Italy, Sweden and the Netherlands) or per unit (e.g. in France). Specific out-of-hours requirements are available in some countries (e.g. France, the Netherlands). Except in France, Sweden and the Netherlands, requirements in terms of number of physicians are not differentiated by level.
- For the nursing staff, further training in intensive care is also often necessary. In some countries, a minimum share of the ICU nursing team should hold such diploma (e.g. 30% in Germany, 50% in England). The head nurse is also often required to have further training in intensive care. The head nurse can be supernumerary (e.g. England) or be part of the team that provides patients care (e.g. Germany).
- Nurse staffing requirements are usually differentiated by level of care, except in Denmark (0.5 to 2 nurses per patient) and the Netherlands (1 nurse per 1.5 operational beds during daytime). At the highest level of care, recommended patient-to-nurse ratios range from 1:1 (England, Germany) to 2.5:1 (France). At the lowest level they vary between 3:1 (Germany, Lazio region in Italy) and 4:1 (France). The differentiation can occur at the unit level (France and Sweden), but in England, Germany and the Lazio region in Italy, recommended patient-to-nurse ratios are set at the patient level.
- ICU equipment must be adequate to provide diagnosis, monitoring and treatment. While some countries broadly define required equipment for all ICUs, England, France and Germany specify equipment based on ICU levels. ECMO is generally only offered in high-level ICUs.
- In most countries, ICUs require the presence of other hospital services to ensure comprehensive care: hospitals with ICUs are mandated to have adequate medical specialties and support functions (e.g. cardiology, surgery, emergency). Many formal interdependencies do not need to be satisfied on site, but can be fulfilled through collaboration with other hospitals (e.g. in France) or through the development of networks (e.g. in England or the Netherlands) so that patients can be transferred to another unit when the required specialisation is not available. Critical interdependencies can also be differentiated per ICU level (e.g. in Germany or Sweden) or be defined only for specific services such as stroke care or ECMO (e.g. Italy).
- The provision of intensive care can also be a prerequisite for the provision of other hospital services. In Germany, the provision of intensive care on site is required for the provision of 52 of the 65 newly defined care delivery groups.

Intermediate care

- A formal definition of intermediate care exists in five studied countries. It corresponds to a level between an ICU and a general care unit and is intended for patients requiring enhanced or continuous monitoring, but no organ replacement therapy. In general, IMCUs are multidisciplinary units, but specialised monodisciplinary IMCUs exist in Italy, Sweden and the Netherlands.
- In England and the Netherlands, intermediate care is integrated into the intensive care system. In other countries, intermediate care is organised separately from intensive care.
- Various models of IMCUs exist: they can be stand-alone units (Denmark, France, Germany, Italy, Sweden, the Netherlands), co-located with an ICU (England, Germany, Italy, the Netherlands) or attached to a general care unit or emergency department (England, France, Italy, Sweden). When co-located with an ICU, a distinction is made between the integrated model, where intermediate care beds are situated within an ICU, and the parallel model, where the IMCU is adjacent to the ICU.
- IMCUs are led by intensivists (England, Germany, the Netherlands), anaesthesiologists (Denmark), internal medicine practitioners (Sweden), or emergency medicine physicians (Italy).

- In practice, staffing ratios in IMCUs are higher than in a general care unit, but lower than in an ICU, but in general, there are no official regulations regarding the number and qualification of nurses working in IMCUs. However, in Germany, it is recommended that at least 20% of the nurses have training in intensive care and that the nurse-to-patient ratio is at least 1:4. Similarly, one nurse for every four beds is recommended in Italy. In Sweden, recommended patient-to-nurse ratios are 2:1 to 3:1. A national training programme for IMCU nurses exists in the Netherlands and there is a willingness to develop such a programme in Denmark.

Reimbursement of intensive care

- In four of the seven countries (Denmark, France, Germany and the Netherlands), intensive care is, at least partially, reimbursed within the DRG-system. In Denmark (for stays shorter than 12 days) and France, regular DRGs apply even though the patient stays in an ICU. In Germany, Denmark (for stays that last at least 12 days) and the Netherlands, specific DRGs for intensive care apply, which are differentiated according to care complexity.
- In five countries, supplementary reimbursement is provided when a patient stays in an ICU (add-on to the DRG-payment in France and the Netherlands; to other systems in England, Italy and Sweden). These add-on payments take the form of per diems (France), specific DRG-payments (the Netherlands), activity-based contracts (England), and global budgets (Italy and Sweden).
- In general, reimbursement of intensive care is independent of the ICU level. However, in Germany, the most expensive DRG-code for intensive care cannot be billed in the lowest ICU level and in France, the highest per diem add-on cannot be billed in the lower ICU levels.

Measuring, reporting and improving quality of intensive care

- In five countries, a national intensive care registry allows the systematic collection of data related to patients admitted to an ICU. Participation is not mandatory everywhere but participation rates are high. Alongside demographic variables and data related to the hospital stay (length of stay, admission type, etc.) other indicators of the severity of critical illness are calculated such as the Simplified Acute Physiology Score SAPS-2 or SAPS-3 (Denmark, Italy, Sweden, the Netherlands), the Acute Physiology and Chronic Health Evaluation APACHE-2 score (England, the Netherlands) and the Sequential Organ Failure Assessment (SOFA) Score (Italy, Sweden, the Netherlands).
- Quality indicators are measured in all seven countries. They include structural indicators (e.g. patient-to-nurse ratio), process indicators (e.g. out-of-hours discharges) and outcome indicators (e.g. standardised mortality).
- Supply (capacity and availability) is measured in Germany, France and the Netherlands. In Germany, available and occupied bed capacity was made publicly available in real time during the COVID-19 pandemic. In France, these data were also updated almost in real time but only available for authorised professionals. In the Netherlands, the capacity module also contains Nursing Activity Score (NAS) data.

9.1 Introduction

INTENSIVE CARE IS A HIGHLY SCIENTIFIC BRANCH OF MEDICINE OF WHICH THE OPERATIONAL IMPLEMENTATION VARIES ACROSS EUROPE

Since the introduction of intensive care in the twentieth century, intensive care systems have evolved towards a multidisciplinary, and highly scientific branch of medicine.[106, 107] Intensive care will continue to evolve due to numerous challenges, such as ageing populations, social disparities, new infections, new complex surgeries and therapies, and healthcare workforce challenges such as shortages on the labour market.[106] Specific developments such as artificial intelligence (AI)-based technologies are likely to play an increasingly significant role and have the potential to drastically transform healthcare (e.g. clinical examinations carried out with AI-driven models).[108, 109]

The operational implementation as well as the available intensive care capacity varies across countries.[106] During the COVID-19 pandemic, the importance of sufficient ICU capacity became evident. In response, many European countries have increased their intensive care capacities and have also created intensive care registers. An analysis of hospital-standardised mortality revealed that besides patient, treatment and hospital characteristics, also ICU organisational features were independently associated with increased in-hospital mortality. These include, for example a high proportion of additionally created ICU beds.[105, 110]

SCOPE AND RESEARCH QUESTIONS

In this chapter, an international comparison of the organisation and financing of intensive care in a selection of countries is described to provide Belgian policymakers a context for a potential reform of the Belgian intensive care landscape. Therefore, the following research questions were formulated:

- How is intensive care legally defined and organised in a selection of countries?
- What is the role of intermediate care units?
- How is intensive care reimbursed in a selection of countries?
- Are there internationally defined and available indicators to measure outcome quality of ICUs?

9.2 Methods

A LONGLIST AND SHORTLIST OF COUNTRIES TO BE STUDIED

Based on a scan of the literature (web-search, contacts within the HSPM network[cc]), a longlist of countries was compiled as a first step. This longlist included eleven European countries with peculiarities in the organisation and remuneration of intensive care medicine: Austria, Czechia, Denmark, England, Estonia, France, Germany, Italy, the Netherlands, Spain, Sweden.

As a second step, a set of criteria was defined to select about 5-7 countries for the shortlist. The criteria included: a specific remuneration system of intensive care, the presence of levels of intensive care, the organisation of intermediate care units, access to key contact persons, the existence of an intensive care registry, the number of intensive care beds per 100 000 population, and availability of information in languages in which the research team is competent (English/Dutch/French/German).

Table 42 illustrates whether or not an inclusion criterion was met (with green indicating yes and red indicating no). Countries were excluded if two or more inclusion criteria were not fulfilled. Furthermore, the selection aimed to ensure a heterogeneous sample in terms of capacity as well as organisational, financial and regional aspects. Finally, the following seven countries were included in the shortlist: Denmark, England, France, Germany, Italy, the Netherlands, Sweden.

[cc] Health Systems and Policy Monitor (HSPM) is an international group of high profile institutions with academic standing in health systems and policy.

Germany was retained in the sample as Belgium's neighbouring country, while Austria was excluded despite meeting all inclusion criteria, due to its strong similarities with Germany. Denmark was included due to its recent large-scale changes in the hospital infrastructure which centralised the system and due to its comparable ICU bed density per population with Belgium. England, Germany and the Netherlands fulfilled every inclusion criterion and are also neighbouring Belgium. For the same reason, France was chosen even though it does not have an intensive care registry. This also applies for Italy which has been chosen due to its decentralised healthcare system and to represent Southern Europe. Even though we already included Denmark as a Nordic country, we decided to also include Sweden because it has one of the lowest densities of ICU beds per 100 000 population and might thus be an interesting example to look at. It is important to note that differences between Table 42 and the subsequent descriptions of the countries may be observed. These discrepancies can be attributed to changes that occurred in the selected countries between their selection and the redaction of the report, as well as to the fact that selection was based on a preliminary analysis, while the rest of the text provides nuanced insights from a more in-depth analysis.

Table 42 – Longlist of countries with reasons for inclusion/exclusion

Country	Different levels of intensive care	Specific remuneration of intensive care	Intermediate care units	Existence of an intensive care registry	Number of ICU beds per 100 000 population[a]	Access to key contact persons	Availability of information in known language	Reason for inclusion / exclusion
Austria	yes[b]	yes[b]	yes[b,c]	yes[d]	21.8	yes	yes	all inclusion criteria fulfilled, but similar to Germany
Czechia	yes[e]	yes[f]	yes[e]	yes[g]	43.2	yes	no	≥ 2 inclusion criteria not fulfilled
Denmark	yes[h]	yes[h]	yes[i]	yes[j]	18.5	yes	yes	all inclusion criteria fulfilled
England	yes[k]	yes[h, l]	yes[m]	yes[n]	7.3	yes	yes	all inclusion criteria fulfilled
Estonia	yes[o]	yes[p, q]	no	no	38.1	yes	no	> 2 inclusion criteria not fulfilled
France	yes[r]	yes[h]	yes	no	16.4	yes	yes	most inclusion criteria fulfilled
Germany	yes[s]	yes[t]	yes[u]	yes[v]	28.2	yes	yes	all inclusion criteria fulfilled
Italy	yes[w]	yes[x]	no	yes	8.7	yes	yes	most inclusion criteria fulfilled
Spain	yes[y]	yes[h]	yes[y]	no	10.1	yes	no	≥ 2 inclusion criteria not fulfilled
Sweden	yes[z]	yes[aa]	yes	yes[ab]	5.1	yes	yes	all inclusion criteria fulfilled
The Netherlands	yes[ac]	yes[ad]	yes[ae]	yes[af]	7.0	yes	yes	all inclusion criteria fulfilled

Sources: [a] OECD (2021)[111], [b] Joannidis et al. (2018)[112], [c] Österreichische Gesellschaft für Anästhesiologie, Reanimation und Intensivmedizin (2022)[113], [d] Österr. Zentrum für Dokumentation und Qualitätssicherung in der Intensivmedizin (2023)[114], [e] Hovorková (2016)[115], [f] Kotherová et al. (2021)[116], [g] Institute of Health Information and Statistics of the Czech Republic (2023)[117] , [h] Bittner et al. (2013)[118], [i] Martinsen et al. (2015)[119], [j] Christiansen et al. (2016)[120], [k] Anandaciva (2020)[121], [l] North West London Critical Care Network (2010)[122], [m] The Faculty of Intensive Care Medicine (2020)[123], [n] Intensive care national audit & research centre (2023)[124], [o] Lakson (2015)[125], [p] Riigi Teataja (2020)[126], [q] Habicht (2019)[127], [r] Bollaert et al. (2005)[128], [s] Robert Koch-Institut and Deutsche Interdisziplinäre Vereinigung für Intensiv- und Notfallmedizin (2022)[129], [t] Franz et al. (2010)[130], [u] Deutsche Interdisziplinäre Vereinigung für Intensiv- und Notfallmedizin (2017)[131], [v] Robert Koch-Institut and Deutsche Interdisziplinäre Vereinigung für Intensiv- und Notfallmedizin (2022)[132], [w] Berger et al. (2021)[110], [x] van Kemenade (2018)[133], [y] Spanish Ministry of Health and Social Policy (2009)[134], [z] Walther and Wickerts (2004)[135], [aa] Ettelt and Nolte (2010)[136], [ab] Swedish Association of Local Authorities and Regions (2008)[137], [ac] Kluge et al. (2015)[138], [ad] Kroneman et al. (2016)[139], [ae] Zorginstituut Nederland (2017)[140], [af] Nationale Intensive Care Evaluatie (2022)[141]

EXPERT SURVEY

For each country on the shortlist, the research questions were answered by means of a search for relevant literature (grey literature: research reports, legal documents, papers from professional organisations). In addition, an expert survey was conducted for the selected European countries about the organisation and reimbursement of intensive care. Information was obtained via a questionnaire (available upon request) to be completed by selected key informants in each country. The questionnaire was partly completed by the research team (i.e. part on general information about the organisation of intensive care). The experts were asked at this point to verify and correct/complete where necessary. Although an evaluation of policy choices was beyond the scope of the questionnaire, some insights from selected experts were gathered. All participants who completed the questionnaire are experts in the field of intensive care and/or health services research, partly from the Health System and Policy Monitor network. Completed questionnaires were reviewed and the experts were asked about points that remained unclear in their original responses. Additional sources (like reports and studies) that were mentioned by national experts were reviewed and integrated into the results. In addition, where relevant, experts in intermediate care were contacted to complete or revise these specific sections.

Table 43 shows the methodological approach, which consists of a literature review, international expert interviews and a synthesis of the results.

Table 43 – Methods approach

What	How
Literature review	• Collection of information on the organisation and reimbursement of ICU in European countries (review of the literature) • Identification of a longlist of countries • Selection of seven countries for full inclusion on the basis of the following criteria: different levels of intensive care, specific remuneration of intensive care, intermediate care units, existence of an intensive care registry, number of ICU beds per 100 000 population, access to key contact persons, availability of information in known language
International expert survey	• Development of a questionnaire asking about legal definition, general information, reimbursement, quality indicators • Completion of the questionnaire by experts and review of completed questionnaires by research team; experts answered questions about points that had remained unclear in their original responses • Review of literature (sources mentioned by national experts)
Synthesis of the results	• Summary of results from literature review and results of questionnaires

A transversal analysis of the country reports was conducted (sections 9.4 to 9.7 hereafter). We refer to the Appendix to Chapter 9 in the Supplement for the country reports and for references relating to the country information in the following sections.

CONCEPTUAL FRAMEWORK FOR INTENSIVE CARE SYSTEMS

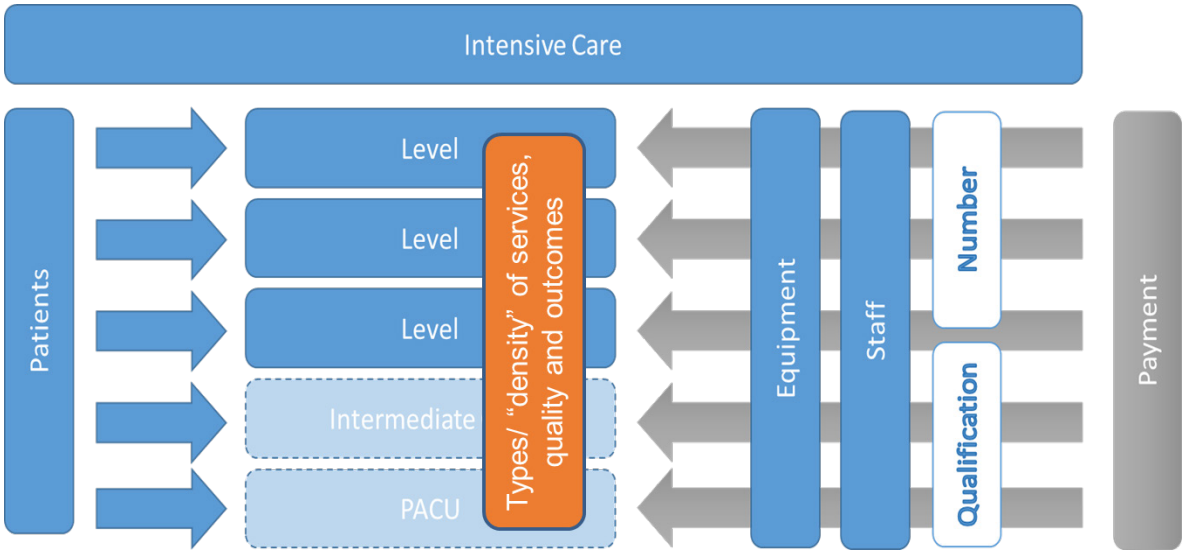
To analyse the system of intensive care and its organisation and reimbursement, it is important to see the interaction between different components. A conceptual framework was developed and applied to each of the selected countries (see Figure 130). The ICU characteristics can be described by five main components: 1) patients; 2) different levels and (sub)categories of ICUs; 3) equipment of an ICU; 4) qualifications and number of the staff; 5) reimbursement system.

In the studied countries, intensive care is differentiated into levels for which either different intensity of care is provided (patient-driven distinction, framework's left side) or different requirements exist (workforce-driven distinction, framework's right side). A further distinction can be made between 'intermediate care unit' and 'Post Anaesthesia Care Unit' (PACU). Intermediate care comprises units that offer highly specialised therapy and close monitoring and are positioned between the general

care and intensive care unit.[142] PACUs are defined as interface between operating room, ICU and the normal units, partly also 24-hours recovery rooms.[143]

Patient-driven factors for the assignment to a specific level might depend on the severity of critical illness or dependency on life-supportive devices. On the other hand, workforce-driven factors include the equipment and staffing of an ICU while staffing can be differentiated according to qualification and the number. The payment is a dimension that refers to all components and can vary in different levels or differ depending on the type of ICU. Payment can depend on how an ICU is equipped or staffed.

Figure 130 – Framework for analysing different ICU systems



Source: Framework created by the authors of the international comparison based on a quick scan of the literature

9.3 General information on the hospital and ICU capacity

Table 44 provides an overview of hospital care capacity across the selected countries, focusing on bed availability, hospitalisation rates, and staffing levels.

The hospital and ICU capacity as well as utilisation rates differ across the studied countries. Germany has a very large acute inpatient hospital sector, with 4.82 acute hospital beds per 1 000 population. The acute care hospital capacity[dd] is the lowest in Sweden (1.34 beds per 1 000 population). Similarly, the number of ICU beds is the lowest in Sweden (4.92 per 100 000 population) and the highest in Germany (28.1 per 100 000 population).

The number of hospital nurses is the highest in the United Kingdom (803 per 100 000 population) and Denmark (712 per 100 000 population) and the lowest in the Netherlands (448 per 100 000 population) and Italy (476 per 100 000 population). The number of hospital physicians is the highest in Denmark (345 per 100 000 population) and 2.5 times higher than in the Netherlands (137 per 100 000 population).

The number of hospitalisations per 100 000 population is the highest in Germany (21 264) and France (15 459), and more than twice the number in the Netherlands (7 731). Large differences in ICU utilisation are also observed across countries. As the definition and scope of an ICU differ across countries, comparing patient numbers is difficult. It may be estimated that the number of **ICU patients per 100 000 population** are the highest in Germany (1876)[144] and France (940)[145]. They are more

dd The OECD definition for 'somatic curative care beds' is used: 'Somatic care beds in hospitals are hospital beds that are available for care relating to the body, as distinguished from psychiatric/mental care; curative care (acute care) beds in hospitals are hospital beds that are available for curative care.'

similar (around 400 ICU patients per 100 000 population) in Denmark, England, Sweden and the Netherlands.[146-149] From that, it may be estimated that the number of **ICU patients per 1 000 patients** is around 88 (or 1 in 11 patients) in Germany, 61 (1 in 16 patients) in France, and ranges between 25 and 50 in Denmark, England, Sweden and the Netherlands. ICU utilisation rates seem smaller in Italy, but no data were available. Differences in capacity and utilisation rates might reveal differences in definitions, staffing patterns on the ICU, admission criteria, availability of alternatives (such as IMCU), etc.

The consulted experts provided an assessment of the availability of personnel, equipment, and infrastructure for intensive care in their country. For this critical appraisal, we refer to the Appendix to Chapter 9 in the Supplement.

Table 44 – Healthcare resources (latest available year)

	Denmark	England	France	Germany	Italy	Sweden	The Netherlands
Curative somatic care capacity – beds per 1 000 population [a]	1.85 (2022)	2.10 (2022) (UK)**	4.73 (2022)***	4.82 (2022)	2.49 (2022)	1.34 (2022)	1.54 (2022)
Adult ICU beds per 100 000 population [a]	18.50 (2019) [c]	7.01 (2024)[d] +	21.17 (2022)	28.10 (2022)	10.25 (2022)×	4.92 (2021)	5.74 (2022)
Hospitalisations per 100 000 population [a]	14 132 (2017)	12 725 (2019) (UK)	15 459 (2022)	21 264 (2022)	9 749 (2022)	12 743 (2022)	7 731 (2022)
Hospital nurses per 100 000 population [b]	712 (2022)	803 (2021) (UK)[e]	563 (2022)	653 (2022)	476 (2022)	n.a.	448 (2022)
Hospital physicians per 100 000 population [b]	345 (2022)	235 (2021) (UK)[e]	277 (2022)	258 (2022)	238 (2022)	n.a.	137 (2022)

Sources: [a] OECD (2025)[150]; [b] Eurostat (2025)[151]; [c] OECD and EU (2022)[152]; [d] NHS England (2025)[153]; [e] OECD (2023)[154]

*Notes: + = own estimation based on absolute numbers; * = own calculation based on the number of hospitalisations and the number of ICU admissions/discharges; ** Data were available without a distinction between curative and non-curative beds; *** Palliative care beds are included; × Although the classification of ICUs in different levels is not used in Italy, the data correspond to level 3 only.*

9.4 Legal definition and organisation of intensive care

9.4.1 Overview of the definition of intensive care in the selected countries

FOUR OUT OF SEVEN COUNTRIES HAVE AN OFFICIAL DEFINITION FOR ICUs

All studied countries have a formal or operational definition of intensive care (see Table 45). In four out of seven countries, the definition of intensive care has an official character. In France and Italy, intensive care is formally defined in national laws. In Denmark, the definition is given in the specialty plan for anaesthesiology, that is integrated in the Danish national planning of specialised hospital services. In the Netherlands, the definition was established by Zorginstituut Nederland. In England, the definition is functional, only applicable to NHS providers. In Sweden, a guideline defines what constitutes intensive care, similar to the situation in Germany, where the definition also has a financial component.

Table 45 – Overview of definition and levels of intensive care

Country	Type of definition	Existence of levels	Number of levels
Denmark	Official	Yes	3
England	Recommendation	Yes	3
France	Official	Yes	2
Germany	Recommendation	(Yes)	2/3
Italy	Official	No	None
Sweden	Recommendation	Yes	3
The Netherlands	Official	No	None

DEDICATED UNITS TO MONITOR AND TREAT PATIENTS WITH SEVERE, LIFE-THREATENING CONDITIONS

Across the examined countries, ICU definitions share several common elements. As illustrated in Table 46, ICUs are commonly identified as specialised units within hospitals dedicated to monitoring, diagnosing, and providing critical care for patients with severe, life-threatening conditions. The emphasis is on the potential reversibility of organ failures, necessitating continuous observation and organ-supporting treatment.

Table 46 – Examples of definitions of intensive care

Country	Definition
Denmark	Intensive care is the monitoring, observation, diagnosis, care and treatment of critically ill patients with potentially life-threatening conditions. Intensive therapy often includes organ-supporting treatment of threatened or failing vital functions.[155]
France	Critical care is the management of patients who have or are likely to have one or more acute organ failure(s) that can be directly life-threatening or alter their functional outcome and that may require the use of one or more supportive methods.[156]
Italy	Resuscitation and intensive care activities are dedicated to the intensive treatment of people suffering from one or more acute, potentially reversible, organ failure, that can be life-threatening and cause major complications.[157]

Sweden	Intensive care is the care of patients with acute or worsening organ failure, either with organ support, organ replacement or organ preservation treatment. Intensive care may also include advanced monitoring of patients with imminent organ failure.[158]
The Netherlands	An intensive care patient has one or more acutely endangered or disturbed vital functions, where continuous monitoring is necessary and treatment of a potentially reversible condition can lead to recovery of vital functions.[159]

LEVEL OF DETAIL AND SPECIFIC ELEMENTS DIFFER BETWEEN COUNTRIES

Despite these shared characteristics, different accents or distinct elements can be identified.

France adopts a legal framework: bed requirement, staffing, equipment and interdependencies are legally specified.

Denmark outlines criteria for ICU admission (i.e. failure or threatened failure of one or more organs, potentially reversible condition, treatment and/or monitoring not possible in IMCU or general hospital bed). A distinction is made between various types of ICUs: multidisciplinary (treating patients from several specialties), monodisciplinary (i.e. ICUs designed for specific patient categories such as neurosurgery ICUs), post-operative ICUs for patients who have undergone major surgical interventions.

In **Sweden,** the most recent guideline clarifies the distinction between organ replacement treatments, which must take place in an ICU, and organ support treatment, which, depending on local conditions, can also be provided outside an ICU.

In **Italy,** the national legal definition can be adapted at the regional level. The Lazio region, for instance, makes a distinction between patients requiring targeted intensive care (i.e. who suffer from one or more potentially reversible acute organ failures, which are life-threatening or the onset of major complications) and patients who require monitoring and maintenance of vital functions in order to prevent major complications.

In **the Netherlands**, the definition is supplemented by a flowchart allowing to determine whether a patient meets the criteria for the ICU or for another type of unit such as Coronary Care Unit (CCU), Post Anaesthesia Care Unit (PACU) or Medium Care Unit (MCU – see section 9.5).

England's definition is functional, emphasising critical care periods and staffing prerequisites (e.g. number of medical, nursing and allied healthcare staff). The classification goes beyond simply identifying the presence or absence of organ failure.

Germany lacks a legal definition but provides recommendations in terms of staff, equipment and interdependencies, structured in three levels of intensive care.

9.4.2 Physicians and nurses must have specific ICU expertise

ICU SPECIFIC TRAINING REQUIREMENTS

In most countries, physicians working in ICUs are specialists in intensive care requiring specific training in critical care medicine (see Table 47). The required qualifications in countries like **Denmark, France, Italy and Sweden** are in areas like intensive care medicine or anaesthesiology. But this does not necessarily mean that physicians from other disciplines do not work in an ICU. In **Sweden**, for instance, physicians with other specialties also work in intensive care: cardiologists, emergency physicians, infectious diseases specialists, or internists. They have extra training in anaesthesia, but rarely hold a full specialist qualification in intensive care medicine. In **Denmark**, the permanent medical staff (with required special training in intensive care) can be assisted during out-of-hours services by other anaesthesiologists from the hospital, always with at least one specialist in attendance. In **France**, the medical team is composed of specialists in intensive care medicine and resuscitation or in resuscitation and anaesthesiology, but it can be supplemented by other physicians with a training or

experience in intensive care. In **Italy**, however, only physicians with a post-graduate specialisation in anaesthesia, resuscitation, intensive care, and pain management can work in ICUs.

In **Germany**, there are minimum requirements regarding the presence of specialists in intensive care medicine (defined by level, see section 9.4.3): for instance, at least one unit round should be performed daily by a specialist with additional further training in intensive care medicine. However, no specific qualifications are required for additional physicians, except that they should be specialists in a domain with direct patient care (including general medicine, anaesthesiology, surgery, etc.). Similarly, in **England**, a unit round must be undertaken twice a day by a consultant in intensive care medicine, and patients' care must be led by such consultant in intensive care medicine. This does not hamper other physicians to be involved in patient care. In **the Netherlands**, the presence of an intensivist is required during day-time. ICU patients are primarily treated by an intensivist, with co-management provided by the relevant primary specialty. A daily formalised multidisciplinary consultation with active participation by intensivists, ICU physicians[ee], ICU nurses and other relevant medical specialists and healthcare professionals should be held.

For the nursing staff, further training in intensive care is also often necessary: for all nurses working in an ICU in **Sweden** and **the Netherlands**, or for part of the nursing team: e.g. at least 30% in **Germany**, 50% in **England**, or a non-binding target of 50% in **Denmark**. In **Italy**, only a bachelor's degree in nursing is required, while a master's degree in critical care is desirable but not mandatory. Similarly, in **France** there are no specific requirements for further training in intensive care.

Table 47 – Overview of qualification required for medical and nursing staff

Country	Medical staff	Nursing staff
Denmark	**Specialists in anaesthesiology** with special practical and theoretical training in **intensive care**	The aim is for the majority of nurses to have **specialised training in intensive care nursing**
England	**Consultants in intensive care medicine** (fellow/associate fellow or eligible to become a fellow/associate fellow of the Faculty of Intensive Care Medicine)	Fifty percent of registered nursing staff must be in possession of a **post-registration award in critical care nursing**
France	Physicians **specialised in intensive care medicine and resuscitation** or specialised in resuscitation and **anaesthesiology**	**Degree in nursing**
Germany	Specialists from an area of direct patient care At least one unit round daily by a specialist with **training in intensive care medicine**	At least 30% of the nursing team should be **specially qualified nurses (intensive care nurses)**
Italy	Physicians in intensive care: **medical and surgical degree**; **specialisation** in **anaesthesia**, **resuscitation, intensive care, and pain management**; registration with the medical association	**Obligatory bachelor's degree in nursing**, optional master's degree in critical care
Sweden	Physicians with **specialist competence in anaesthesia and intensive care**, recommended two-year advanced training in intensive care	Nurses with **further training in intensive care**

[ee] In the Netherlands, most hospitals differentiate between intensivists (i.e. consultants who completed their education) and ICU physicians who are in training to become an intensivist.

The Netherlands	**Trained intensivists**: certified as such by the Joint Intensivists Commission; need to be registered in the register of their professional association	CZO (College of education of healthcare professionals) **recognised diploma** is required as well as a registration in the V&VN (Professional organisation of nurses and care assistants) quality register

Source: Own compilation.

HEAD OF ICU REQUIREMENTS

In the studied countries, there are similar qualification requirements for the medical head of the ICU (see Table 48). The head of ICU should be a physician with advanced training in intensive care, but additional requirements, such as employment rate in the ICU, may also apply. In **Denmark**, the medical head of the ICU should be a staff member and work primarily in the ICU; in **England**, an ICU consultant needs to work in the ICU and cannot oversee another specialty; in **Sweden** the medical head should be clinically active at least 50% in the ICU; in **France** the coordinator-physician is part of the ICU medical team. In **Denmark** and in **Italy**, also a formal training in management is required.

For nursing staff, the head nurse is not everywhere explicitly required to have a specialised training/experience in intensive care nursing, although it is likely the case in practice. In **England**, head nurses are supernumerary (i.e. not rostered to deliver direct patient care to a specific patient) to provide the supervisory clinical coordinator role on duty 24/7 in intensive care units. In **Sweden** however, it is explicitly stated that the role does not exclude simultaneous patient responsibility.

Additional management staff might be required when the scale of the ICU exceeds a certain threshold. In **Germany**, it is recommended that each ICU has a nursing head and a back-up (1.3 FTEs), as well as an additional 0.13 FTE for every bed exceeding 10 beds. In the **Netherlands**, it is stated that the amount of management time allocated to the task by the designated medical head should be based on the size, function, and complexity of the ICU to ensure effective leadership.

Table 48 – Overview of qualification required for the head of ICU

Country	Medical head	Head nurse
Denmark	The medical director (medical and administrative responsibility) is a specialist in **anaesthesiology** with specific practical and theoretical training in **intensive care** and relevant **management** training. The head of the ICU must be a full-time staff member and work primarily in the ICU	The head nurse (overall responsibility for nursing care in the unit) is a nurse with specialist training in **intensive care** nursing
England	Care of patients is led by **a consultant in intensive care medicine**	Supernumerary **senior registered nurse** (supervisory clinical coordinator role)
France	Coordination is ensured by a member of the medical team (i.e. physician specialised in **intensive care medicine and resuscitation** or specialised in **resuscitation and anaesthesiology**)	Nurse manager (responsible for nursing and caring staff); no extra qualification required
Germany	Head is a physician who has additional training in **intensive care medicine** and who works full-time in the ICU	The head nurse (responsible for organisational and professional management) holds, if possible, a degree in the field of **nursing** combined with further training
Italy	Chief physician is an experienced physician, specialised in **anaesthesia, resuscitation and intensive care,** registered in the professional register, with seven years'	Head nurse: no information regarding qualification requirements

	seniority, and a certificate of **management** training	
Sweden	Medical management responsibility by a physician specialist in **anaesthesiology and intensive care** and advanced training in **intensive care,** who is clinically active at least 50% in the ICU. Care responsibility is carried out in consultation with physicians responsible for the patients outside of ICU	Operational management responsibility: experienced nurse specialist in **intensive care.** The function does not exclude simultaneous patient responsibility
The Netherlands	Medical head (responsible for the medical quality and coordination) is an **accredited intensivist**	Nursing head or unit manager: no information regarding qualification requirements

Source: Own compilation

9.4.3 Differentiation in levels of ICU care

FORMAL CATEGORISATION OF ICUs IN LEVELS IS A COMMON PRACTICE

As summarised in Table 49, five out of seven examined countries work with formal levels (two to three levels). The comparison reveals both shared features and country-specific distinctions in categorisation and functioning. In the description that follows, level 1 refers to the least specialised level of intensive care, with higher levels indicating increasingly complex and resource-intensive care provision.

Denmark structures its ICUs into three levels, each addressing specific patient needs and services. The lowest level admits patients with moderate organ failure (maximum one organ failure) and excludes children younger than ten years old. Level 2 ICUs are located in hospitals performing major surgical procedures or other treatment of critically ill patients and medical emergency departments. They target patients with multi-organ failure. Level 3 ICUs are restricted to highly specialised hospitals and can treat patients with all types of organ failure and can perform particularly advanced and rare intensive therapy.

In contrast, **England** employs a tiered approach with levels 1 to 3, distinguishing patients rather than hospitals based on organ system support and nursing requirements. Level 1 patients require enhanced care (e.g. enhanced post-operative care, basic support for a single organ system including patients stepping-down from a higher level). Level 2 patients are labelled as 'critical care' patients requiring increased levels of observations and interventions beyond level 1 (e.g. basic support for two or more organ systems; one organ system monitored and supported at an advanced level; long-term advanced respiratory support; level 1 patients that require extra nursing care, for instance because of severe agitation). Level 3 patients include patients requiring critical care such as monitoring and support at an advanced level for two or more organ systems, patients requiring level 2 care with delirium or agitation in addition, complex patients requiring support for multiple organ failures not necessarily including advanced respiratory support. Level 1, and to some extent level 2, can be considered as patients requiring intermediate care (see section 9.5), so that only level 3 patients are considered as ICU patients.

Although these levels are defined at the patient level, hospitals report to the NHS the configuration (in terms of beds) of their critical care units, according to two levels. Level 2 refers to beds for patients requiring enhanced observation or intervention including support for a single failing organ system or post-operative care and those stepping down from higher levels of care. Units with level 2 beds are also known as 'high dependency units' (HDU), corresponding to intermediate care (see section 9.5). Level 3 beds are intended for complex patients requiring support for multi-organ failure patients. In 2022-2023, the vast majority (79.6%) of critical care episodes took place in flexible units where there is a mix of level 2 and level 3 beds.

France, following a recent reform, recognises two levels: resuscitation units and general ICUs.[ff] The latter should be adjacent to the former although derogations from this rule exist. The distinction between both is that general ICUs are used to treat a single failure for a limited time, while resuscitation units are used for the management of multiple organ failure during a longer period. When a patient in a general ICU has one or more acute failure(s) that can be directly life-threatening or alter their functional outcome which requires the use of a supportive method, they are transferred to the resuscitation unit.

Germany's system, which is evolving from two payment-driven levels (i.e. basic and complex intensive care) to a three-level structure, aligns with the broader hospital care framework. The recommended division into levels is based on specified minimum requirements (type and number of specialist departments, staff number and qualifications, scope of provision of emergency services). Level 1 ICUs are able to stabilise vital functions of patients at short notice in such a way that they can be transferred to an ICU of a higher level within the framework of hospital cooperation. Level 2 ICUs are equipped in such a way that they can fully care for most medical and surgical intensive care patients. Patients for whom the corresponding specialties are not available at the site (e.g. neurosurgery, cardiac surgery, transplant medicine) or who need special organ replacement procedures (e.g. ECMO, extracorporeal life support (ECLS)), are treated within the scope of cooperation or are transferred to level 3 ICUs. Level 3 ICUs are adequately staffed and equipped for the care of highly complex patients and are located in university hospitals and large academic teaching hospitals. In the future, hospitals will only be eligible for payments for care delivery groups that were assigned to them by state planning authorities. Each care delivery group has minimum quality requirements that must be met by hospitals. For intensive care, these requirements are structured in three levels, largely following the above recommendations.

Sweden classifies ICUs into three levels, emphasising organisational structure, staffing, expertise, and equipment. The distinction between levels is not only based on the type of intensive care that can be delivered but also on the broader resources available within the hospital. Safe transfer plans are established between levels. Level 1 ICUs can provide intensive care for patients with failure in any organ system, but they lack most peripheral resources (i.e. 24/7 access to specialised services, such as paediatrics, vascular surgery, ENT surgery, or a blood centre). Level 2 ICUs can provide intensive care for patients with failure in all organ systems, but they do not have 24/7 access to most specialties, particularly emergency surgery, radiology, laboratory services, and blood centres. Level 3 ICUs provide the most qualified monitoring and treatment methods that can be offered for various types of organ failure. These are preferably located in university hospitals. Regional/university hospitals also often have special ICUs for e.g. thoracic and neurosurgery, paediatrics and burn care

Table 49 – Overview of levels per country

Country	Number of levels	Level 1 (lowest)	Level 2	Level 3 (highest)
Denmark	3 ICU levels	Moderate organ failure (max. 1 organ failure); children <10 years old excluded	Target patients with multi-organ failure; located in hospitals with major surgical procedures or other treatment of critically ill patients	Patients with all types of organ failure; an advanced and rare intensive therapy (e.g. ECMO); located in hospitals with highly specialised functions

[ff] In France, resuscitation units (‘*unités de reanimation’*) are equivalent to what is internationally known as ICUs. General ICUs (‘*unités de soins intensifs polyvalents’*) do not correspond to ICUs in an international context. Throughout the text, the official French terms will be used to describe the French system. We invite the reader to pay particular attention to avoid any misinterpretation.

England	3 levels of ICU patients	Patients requiring enhanced care (e.g. enhanced post-operative care, basic support for a 1 organ system, patients stepping-down from a higher level)	Critical care patients requiring increased levels of observations and interventions (e.g. ≥2 organ systems; 1 organ system monitored and supported at an advanced level; level 1 patients requiring extra nursing care for instance in case of severe agitation)	Monitoring and support at an advanced level for ≥2 organ systems, level 2 patients with delirium/ agitation, etc.
France	2 adjacent ICU levels (previously 3 levels)		General ICU: ≥1 organ failure(s) requiring temporary use of a supportive method, pending transfer to a resuscitation unit if necessary	Resuscitation unit: ≥1 organ failure(s) requiring ≥1 supportive method
Germany	In evolution: from 2 towards 3	Basic ICUs are able to stabilise vital patients at short notice before a transfer to higher-level ICU	Extended ICUs can fully care for most conservative and surgical intensive care patients	Comprehensive ICUs: highly complex patients located in university and large academic teaching hospitals
Italy	No formal levels for intensive care (but levels for hospitals); proposal to formalise 4 levels			
Sweden	3 ICU levels	Intensive care for acute impairment in several organ systems, but lack most peripheral resources	Intensive care for acute functional impairment in most organ systems, but lack many peripheral resources	General ICUs at regional/university hospitals providing the most qualified monitoring and treatment for various types of organ failure
The Netherlands	No formal levels; in clinical practice, larger ICUs treat more complex patients; previous guidelines recommended three levels based on annual patient volume, number of ICU beds, number of ventilation days, and physician and nurse staffing.			

Source: Own compilation

Italy employs a 'hub and spoke' model, categorising hospitals into hubs offering the full range of services and spokes which are secondary facilities with fewer specialties. Specific criteria are specified to ensure levels of hospital care (including intensive care) throughout the entire national territory, in terms of adequacy of facilities, human resources employed in relation to the number of patients treated, the level of clinical care complexity of the facility and its synergistic interaction within the territorial care network. Hospitals are categorised into three types: basic hospital facilities, first-level hospitals, second-level hospitals. Basic hospital facilities should be equipped, among others, with beds for 'Short Intensive Observation'. In first-level hospitals, the specialty 'Anaesthesia and Resuscitation' should be available, along with beds for 'Short Intensive Observation' and beds for 'Sub-intensive Therapy'. In addition to that, second-level hospitals should also offer, among others, cardiac resuscitation, paediatric ICU and neonatal ICU. Except from that, there are no regulations for differentiation in levels of intensive care, although such differentiation in levels is advocated by the scientific intensive care societies. Some regions like Emilia Romagna or Lazio have implemented accreditation criteria with the requirements for intensive care medicine (structural, technological, organisational) so that it is possible to differentiate intensive care from semi-intensive care.

A proposal held by two Italian scientific societies recommends to formalise a differentiation of intensive care levels. Accordingly, level 1 ICU would concern patients who require continuous monitoring (patients are at risk of developing one or more acute organ failures but who do not require organ support immediately or are not expected to deteriorate such that they will need it in the next 12 hours). This also includes patients who are recovering from one or several acute vital organ failures but whose condition is too unstable or when the nursing workload is too high/complex to be managed in a regular unit, therefore level 1 corresponds to intermediate care (see section 9.5). Level 2 (resp. 3) would concern patients who require continuous monitoring and pharmacological or mechanical support of a single organ (resp. multiple organs) with acute phase failure that is life-threatening. Level 4 would concern patients with moderate to severe dysfunction of two or more organs, patients on invasive mechanical ventilation, patients with multiple acute organ failure (two or more), or life-threatening acute single organ failure. These patients receive organ support through drug infusion or mechanical organ support (haemodynamic, respiratory, or renal replacement therapy).

The organisation of ICUs in **The Netherlands** was addressed in a guideline (*Kwaliteitsstandaard Organisatie van Intensive Care)*. The Dutch guideline on the organisation of intensive care defined three levels based on annual patient volume (level 2: > 2500 treatment days per year; level 3: >3000 treatment days per year), number of ICU beds (optimal size for level 1: 6 beds; for levels 2 and 3: 12 beds), number of ventilation days (e.g. level 2: >1250 ventilation days per year; level 3: >1500 ventilation days per year), number of physicians (e.g. intensivist staffing level 1: 0.1 – 0.15 FTE per bed; level 2: 0.35 – 0.42 FTE per bed; level 3: 0.45 – 0.55 FTE per bed) and nurse staffing (level 1: 2.7 FTE per ventilation bed, level 2: 3.5 FTE per ventilation bed; level 3: 4.2 FTE per ventilation bed). After its introduction the guidelines were reviewed but no consensus could be reached. Therefore, the system of formal levels was abandoned and quality standards were introduced. According to the Quality Standard (which is currently being updated by a working group), there are no differences between ICUs in terms of levels. In clinical practice, however, larger ICUs treat more complex patients.

REFERRAL SYSTEM BETWEEN LEVELS

Alongside the classification of ICUs into several levels, a system of transfers between levels is often organised. Sufficient capacity should be foreseen in higher level ICUs to allow these transfers. In **Denmark** for instance, where a national referral system ensures regional collaboration to maintain adequate ICU resources, ICUs must have the capacity to admit acute patients without delay, meaning the average hourly occupancy rate should not exceed 75%. Critical care services in **England** need to ensure that services can respond to changes in demand. This may require the transfer of the patient to another unit where the required specialisation is available. In **Sweden**, there is a national system for ICU bed capacity reporting. Collaborations with other hospitals exist and patients are referred to a university hospital in cases of special treatment, i.e. thoracic surgery, neurosurgery, paediatric and neonatal care according to national and local routines.

In **the Netherlands**, although there is no formal classification into levels, intensivists in smaller ICUs (fewer than 12 beds) must discuss all patients with a Sequential Organ Failure Assessment (SOFA) score of 10 or higher within 24 hours with another intensivist. Additionally, hospitals without ICU, but where patients requiring intensive care may be present, must establish regional partnerships to ensure proper care for ICU patients. If an ICU patient needs to be transferred to another facility, this should be done using a mobile intensive care unit, and this must be possible at least 16 hours a day. Also, each hospital has an emergency ICU transport protocol in which local agreements are recorded.

MONODISCIPLINARY ICUs ALONGSIDE MULTIDISCIPLINARY ICUs

The classification of ICUs into different levels generally concerns multidisciplinary ICUs. However, specialised or monodisciplinary units also exist.

In **Denmark** and **France**, these units are separately defined and regulated. In **Denmark**, only multidisciplinary units are organised in three levels, while monodisciplinary ICUs (e.g. thoracic surgery or neurosurgery ICU) are defined as an intensive care unit which is designed for a special patient

category, but which can also treat failure of several organ systems. In **France**, there are legal specifications for specialised ICUs in the following areas: cardiology, vascular neurology, haematology, nephrology, respiratory and hepato-gastro-enterology. They ensure the care of patients who present or are likely to present an acute failure of the considered organ (without any other organ failure) that can be directly life threatening or alter their functional outcome and require domain-specific treatment.

In **Sweden**, university hospitals often have special level 3 ICUs for e.g. thoracic and neurosurgery, paediatrics and burn care.

In **England**, highly specialised services (including neurosciences, cardiothoracic surgery, specialised cardiology, transplant surgery, specialist cancers, major spinal injuries, specialist burns services, etc.) are commissioned at national and regional level and often incorporate a component of critical care.

In **Italy**, sub-intensive or ultra-specialty therapies (i.e. specialised ICUs in cardiology, respiratory, neurology, etc.) exist but are not actually formally defined nor regulated.

ECMO IS RESTRICTED TO LEVEL 3 ICUs

In countries with formal levels for intensive care, extracorporeal membrane oxygenation (ECMO) can only be performed in (some) level 3 centres. It is performed in four centres in **Denmark**, among which two only perform veno-arterial ECMO (only one for paediatric patients). In **England**, respiratory ECMO is restricted to six centres. In **Sweden**, ECMO is provided by all thoracic ICUs. In addition, there is a national highly specialised centre in Stockholm for ECMO where only patients with a need for ECMO are treated. This centre also provides ECMO to neonates and children. In **France**, reference centres for ECMO also exist but are not formalised.

INTERDEPENDENCIES OF ICUs WITH OTHER SPECIALTIES AND COLLABORATION ACROSS HOSPITALS

In most countries some form of interdependencies of ICUs with other services is formalised.

In **Denmark,** hospitals with ICUs are required to ensure adequate qualitative and quantitative coverage of medical specialties and support services, including cardiology, surgery, clinical microbiology, and blood banking.

In **Sweden,** all ICU levels require an emergency service, blood supply, and a 24/7 lab within the hospital. While some services are only required for level 3 ICUs, they are also recommended for levels 1 and 2 (e.g. 24/7 pharmacy, clinical physiology unit, microbiology). An operating room and X-ray department are recommended at level 1 and required at levels 2 and 3.

The recommendations of the **German** Interdisciplinary Society of Intensive and Emergency Care set requirements for each level of ICU care in terms of availability of other services. For level 1 ICUs, (trauma) surgery, internal medicine and anaesthesiology should be available. Level 2 and 3 require a larger range of services including at least two (for level 2) or five (for level 3) of the following: neurosurgery; orthopaedics/trauma surgery; neurology; cardiology; gastroenterology; gynaecology; and at least two of the following: pneumology; vascular surgery; thoracic surgery; urology; ENT medicine; ophthalmology; maxillofacial surgery; haematology/oncology. However, in the ongoing hospital reform, interdependencies are formulated differently. Interdependencies between care delivery groups are listed so that related care delivery groups are provided at the same location, or through cooperations. But for intensive care medicine, no related care delivery groups are formally required. However, the provision of intensive care medicine at the same location is a prerequisite for delivering 52 of the 65 care delivery groups (e.g. general internal medicine, interventional cardiology, etc.).

Also in **England** formal interdependencies with other hospital services/medical specialties exist. ICUs participate in development networks that were set up to coordinate pathways and share expertise.

In **France**, a hospital with an ICU must also have, on site, available 24/7 a surgery unit and an operating theatre offering the possibility for post-operative monitoring. Other interdependencies can be satisfied via agreements: medical unit, medical imagery (conventional radiology, angiography by scanner and ultrasound, MRI (Magnetic Resonance Imaging) and interventional radiology), bacteriology, haematology, biochemistry, haemostasis, and blood gas tests.

In **the Netherlands**, a system of regional collaboration exists. Fifteen intensive care networks were created among which eight are centred around an academic hospital. A network consists of at least three physical ICU locations and at least one larger ICU location (i.e. ≥ 12 beds and ≥ 70% bed occupancy). The care policy plan for the ICU lists all medical treatments that are possible in one region (a region consists of different networks), including cardiac surgery, neurosurgery and traumatology. For very specialised treatments such as burn care, agreements can be made with another region.

In **Italy,** formal hospital and emergency services interdependencies for life-threatening medical conditions such as trauma, stroke, acute myocardial infarction and ECMO are defined at the national level. These interdependencies are detailed in two national decrees on territorial networks and in the implementing decrees issued by each region, which specifically regulate these interdependencies.

9.4.4 Staffing for allied healthcare, nursing and medical staff

NURSE STAFFING LEVELS ARE DEFINED IN SEVERAL WAYS: PER ICU LEVEL, PATIENT, UNIT AND SHIFT TYPE

In all seven countries, there are requirements or recommendations regarding the patient-to-nurse or bed-to-nurse ratio which are depicted in Table 50. Yet, the way staffing requirements are set differs across countries.

In **Denmark**, the allowed range to staff may vary from 0.5 to 2 patients per nurse with higher staffing levels during daytime compared to out-of-hours periods. There is no explicit link with ICU levels. In fact, it is stated that nurse staffing has to be adapted to the patient case mix and the complexity of the patients. The planned number of nurses should be sufficient to ensure optimal patient care. Also in **the Netherlands**, there is a distinction in staffing requirements according to shift types. A span of control of 1.5 operational ICU beds per nurse is recommended during daytime. In the evening and at night, the maximum span of control is 1.75 operational ICU beds and 2.0 operational ICU beds, respectively.

In **England**, staffing ratios depend on the patient level. However, it is emphasised that the goal should be to maintain flexibility in staffing to address all patient care needs. Therefore, while the level of care assigned to a patient should influence staffing requirements, it should not dictate them. Nevertheless, level 3 patients must have at least a 1:1 patient-to-nurse ratio, while it is 2:1 for level 2 patients. For level 1 patients, no recommendation is provided. In the Lazio Region in **Italy**, staffing levels depend on the level of ICU a patient requires. For patients requiring monitoring and instrumental therapies to support vital functions, a 2:1 patient-to-nurse ratio has to be guaranteed over 24 hours while for patients in need of monitoring and non-instrumental therapies the patient-to-nurse ratio should be equal to 3:1 over 24 hours.

In **Germany,** there is a hybrid approach aligning recommended staffing levels both to shift and patient care needs. A validated assessment tool (i.e. INPULS®) is used to assess the patients' severity on a daily basis. Staffing requirements for shifts should be calculated using 'Level of Care (LOC)' and averaged over one year or one quarter of normal operation and re-evaluated annually/quarterly. The recommended patient-to-nurse ratios are: 3:1 for LOC I patients; 2:1 for LOC II patients and 1:1 for LOC III patients. Furthermore, to prevent understaffing a staffing limit of 2 patients per nurse on day shifts and 3 patients per nurse on night shifts is applied in intensive care.

In **France**, there is a link between the staffing requirements and ICU levels. For resuscitation units (highest level), there must be at least 2 nurses per 5 open beds (2.5:1 bed-to-nurse ratio), and one care assistant per 4 beds. For the general ICUs, this is one nurse per 4 open beds (4:1 bed-to-nurse

ratio) and 1 care assistant per 4 or 8 beds during day and night, respectively. Defining staffing levels per bed has as a consequence that when the occupancy rate is not maximal, the pressure on nursing staff decreases. Although this was not implemented in the revised 2022 decrees, a 2:1 bed-to-nurse ratio was part of policy discussions. Similarly, in **Sweden**, different staffing ratio apply according to the ICU level. In level 1 ICUs, the bed-to-nurse ratio for specialist nurses should be between 4:1 and 2:1. In level 2 ICUs, it should be between 3:1 and 1.5:1 and in level 3 between 2:1 and 1:1.2. It should be noted that the median number of specialist nurses per bed (in 2023) were not very different in different levels. In the proposal made to implement ICU levels in **Italy**, also staffing requirements are defined by ICU level: 6 to 8 patients per nurse in level 1 ICUs, 3 to 4 patients per nurse in level 2 and 3 ICUs, and 1 nurse for every 2 beds and 1 on-duty nurse for every 8 beds in level 4 ICUs.

Table 50 – Staffing of nursing staff (patient-to-nurse or bed-to-nurse ratio)

	4:1	3:1	2.5:1	2:1	1.5:1	1:1	1:1.2	1:1.5	1:2
All levels / no levels									
Italy (Lazio region)		x		x					
Denmark				x	x	x	x	x	x
The Netherlands				x	x				
Level 1									
Sweden	x	x	x	x					
Germany		x							
Level 2									
Sweden		x	x	x	x				
Germany				x					
France	x								
England				x					
Level 3									
Sweden				x	x	x	x		
Germany						x			
France			x						
England						x			

Notes: blue: patient-to-nurse; orange: bed-per-nurse. Source: Own compilation.

MEDICAL STAFF

Table 51 shows the staffing ratios for medical staff, expressed in patients or beds per physician. The highest staffing ratios can be found in **Germany** (0.7 FTE physicians per bed) and the smallest in **England** (daytime patient-to-consultant ratio must not normally exceed 8:1 to 12:1). However, in England, the patient-to-consultant ratio is accompanied by a patient-to-resident ratio that should also not normally exceed 8:1.

The ratios in **Denmark** (2-3 patients per physician during daytime) and **Sweden** (2-4 beds per physician with specialist expertise in anaesthesia and intensive care in level 2 and 3 ICUs) are comparable in magnitude with the ratios in **the Netherlands**. The Dutch ratios depend on the scale of the ICU. In ICUs with less than 12 beds, 0.35-0.45 intensivists (FTE) per operational bed are required. For ICUs with at least 12 beds, the number of required intensivists increases to 0.45 to 0.55 FTE. It is, however, important to note that the distinction of size does not refer to different levels.

The above requirements are not binding in all countries. In **Denmark**, for instance, it is recommended to adjust staffing levels (recommended 2-3 patients per physician) to the case-mix. In other countries, it is specified that medical staffing levels should be increased under certain conditions. In **Germany**, for instance, in case of special requirements (e.g. a large number of isolation patients, patients with extensive high-grade burns, polytrauma and extracorporeal organ replacement procedures) and when taking on special tasks (e.g. participation in the resuscitation team, shock room cover, intensive care transport, complex organisational requirements such as high patient throughput, etc.), a larger number of physicians is required. The **English** consultant ratio is related to the seniority and competency of junior staff, the reason for admission (e.g. standard post-operative care pathway) and the number and complexity of emergency admissions. The English resident ratio may also need to be adapted if local arrangements dictate that the intensive care resident is expected to provide emergency care outside of the critical care unit (e.g. wards and emergency department).

In some cases, medical staff ratios are simply not defined and/or requirements are set at the unit level. In **France**, requirements are set for the resuscitation unit together with the general ICU. Two physicians should be present during daytime and one physician for out-of-hours services. If the general ICU is not adjacent to the resuscitation unit, then specific requirements are defined. In **England**, no consultant ratio is defined for night times. In **Italy**, no requirement is set at the national level, but the Lazio region notably requires the presence of an anaesthetist for every 4 beds. In **Sweden**, for level 1 ICUs, the presence of at least one physician with specialist competence in anaesthesia and intensive care is required per unit.

Table 51 – Medical staff requirements (patient-to-physician or bed-to-physician ratio)

	1:0.7	1:0.55	2:1	1:0.45	1:0.35	3:1	4:1	8:1	12:1
Denmark			x	x	x	x			
England								x	x
Germany	x								
Italy (Lazio region)							x		
Sweden (levels 2-3)			x	x	x	x	x		
The Netherlands (<12 beds)				x	x				
The Netherlands (≥12 beds)		x	x	x					

Notes: blue: patient-to-physician; orange: bed-per-physician. Source: Own compilation.

ALLIED HEALTHCARE STAFF

The specifications for allied healthcare staff are less pronounced compared to nursing and medical staff. In most countries, physiotherapy requirements are specified. In **Germany**, for instance, physiotherapy has to be available daily. In **France**, a physiotherapist with experience in critical care should be part of the team. In **Sweden**, 0.25 FTE physiotherapist should be available in level 1 ICUs, 0.2-0.5 FTE in level 2 ICUs and 0.5-1 FTE in level 3 ICUs.

But also for other allied healthcare staff, specifications are made: for example availability of psychological counselling, ethical consultation and palliative care in **Germany**; clinical pharmacy requirements depending on the level of care in **England**; counsellors, occupational therapists, pharmacists, speech therapists, dieticians, etc. in **Sweden**.

9.4.5 Unit size and equipment

MINIMUM NUMBER OF BEDS FOR AN ICU

In most countries, a minimum size is defined for an ICU. In **Denmark**, there should be a minimum of six treatment places in an ICU. In **France**, a resuscitation unit must have at least eight beds (ten for

new units) and a general ICU must have at least six beds (eight for new units). In **Sweden**, an ICU should be designed to regularly accommodate care for at least four intensive care patients simultaneously. In **Germany**, it is recommended that an ICU has between 8 and 12 beds, but minimum requirements for the intensive care service are set per level (minimum 6 beds for level 1, 10 beds for level 2 and 20 beds for level 3).

REQUIRED MONITORING, DIAGNOSTIC AND TREATMENT EQUIPMENT

In many countries, specific required equipment is listed, sometimes differentiated by ICU level. Commonly listed equipment includes devices for radiology, ultrasound, endoscopy, ventilation and monitoring.

In **England,** a long list of required equipment is defined for level 2 and 3 ICUs (mobile X-ray machine, haemodialysis machine, hemofiltration machine, peritoneal dialysis machine, EEG machines, electrocardiography machines, echocardiography machines, transoesophageal echocardiography machines, invasive cardiac output monitoring devices, ultrasound machines, gamma cameras, endoscopes).

In **Sweden**, the list includes: Continuous Renal Replacement Therapy (CRRT) equipment, defibrillator, fibre bronchoscope, equipment for applying spinal anaesthesia, equipment for thoracocentesis/thoracic drainage, etc.

In **Germany**, the required equipment is differentiated by level. In level 1 ICUs, the required equipment consists of mechanical ventilation, resuscitation and computer tomography. In addition, level 2 ICUs should have continuous access to the following: renal replacement, endoscopy, percutaneous coronary intervention, MRI, stroke therapy, and bronchoscopy. For level 3 ICUs, the following are added: plasmapheresis, ECMO, ECLS, interventional neuroradiology, and interventional radiology.

In **France**, a distinction is made between resuscitation and general ICUs. For instance, the equipment of resuscitation units should allow to perform organ support therapy, while invasive and non-invasive mechanical ventilation should be possible in both types of units.

9.5 Legal definition and organisation of intermediate care

9.5.1 Overview of the definition of intermediate care in the selected countries

INTERMEDIATE CARE IS FORMALLY DEFINED IN MOST SELECTED COUNTRIES

In five out of seven countries, a formal definition of intermediate care exists (see Table 52).

Table 52 – Overview of definition of intermediate care

Country	Existence of IMCUs	Definition of IMCU	Source of definition	IMCU within ICU system
Denmark	Yes	No		No
England	Yes	Yes	Guidelines	Yes
France	Yes	Yes	Transitional rules	No
Germany	Yes	Yes	Guideline	No
Italy	Yes	No		No
Sweden	Yes	Yes	National working group	No
The Netherlands	Yes	Yes	Quality standard	Yes

Source: Own compilation. ICU = intensive care unit, IMCU = intermediate care unit

As illustrated in Table 53, intermediate care units (IMCU) correspond to a level of care between an ICU and a regular unit and are intended for patients requiring enhanced or continuous monitoring, but no organ replacement therapy (in **Sweden**, vasopressors may be used in IMCU). Even in the absence of an official definition (in **Denmark** and **Italy**), in practice an IMCU is a unit that is positioned in between an ICU and a general care unit.

In **England** and the **Netherlands**, IMCUs are regarded as part of the intensive care continuum (in **England** they are considered as level 1 and 2 of the continuum), while in other countries they fall outside the scope of intensive care. In several countries (**Denmark, Germany, France** and **Sweden**), guidelines and/or legal guidance for intensive care explicitly exclude intermediate care.

In **France**, continuous monitoring units were previously considered as the lowest level (level 1) of intensive care. In a recent reform, however, continuous monitoring units that were adjacent to a resuscitation unit (level 3) were transformed into general ICUs (level 2). Stand-alone continuous monitoring units that cannot be transformed into an ICU are deemed to disappear. They will be replaced by reinforced care units for which no legal text has been published so far. In the meantime, transitional rules have been defined for these intermediate care units, called 'continuous monitoring units outside the scope of critical care'.

Table 53 – Definitions of intermediate care

Country	Definition
England	**Enhanced care** is an intermediate level of care where a higher level of observation, monitoring and interventions can be provided than on a general unit but not requiring high dependency care/organ support.[123] [see level 1 in Table 49] **High dependency units**: patients requiring increased levels of observations or interventions, including basic support for two or more organ systems and those 'stepping down' from higher levels of care (…).[160] [see level 2 in Table 49]
France	**Continuous monitoring units** are organised to care for patients who, due to the seriousness of their condition or the treatment they are receiving, require repeated and methodical clinical and biological observations.[161]
Germany	**Intermediate care units** are suitable for the monitoring and treatment of patients with moderate or potentially serious instability of physiological parameters requiring instrumental monitoring and organ support, but not requiring organ replacement.[131]
Sweden	**Intermediate care** is the level of care for patients with threatened or already developed organ dysfunction where organ support treatment may be needed or is needed. It offers organ-supportive treatment and advanced nursing and rehabilitation, which, due to their complexity, cannot be provided on a general unit.[162]
The Netherlands	**Medium care units** are units with a level of care between the general care unit and the ICU, where patients can receive extra care, monitoring and treatment that they would not be able to get in a general care unit. This may concern patients who come from the emergency department, nursing unit or operating room (step up) or from the ICU (step down).[163]

IMCUs ARE MULTIDISCIPLINARY UNITS, BUT MONODISCIPLINARY IMCUs ALSO EXIST

In general, IMCUs are multidisciplinary units, admitting patients from a range of specialities, but monodisciplinary IMCUs also exist. The latter are dedicated to patients with a single-specialty health issue (e.g. stroke units, respiratory intermediate care units, coronary and cardiovascular care units). In **Italy**, the concept of 'sub-intensive therapy' is used in legal documents but not defined. It refers to general IMCUs on the one hand and to specific IMCUs (or ICUs) on the other hand. In **Sweden** also an intermediate care unit may be broad in its scope or more specialised. In the **Netherlands**, the Dutch Quality Standard groups under the term 'medium care' all kinds of different names and

functions, including central medium care units (treating patients from several sending specialties) but also coronary care units, stroke units, etc.

ADMISSION CRITERIA: PATIENTS WHO DO NOT MEET THE CRITERIA FOR AN ICU

In all countries, criteria are defined to decide whether a patient should be admitted in an IMCU. In general, however, criteria developed for all units (legally or in a guideline) are either broad, or aimed to serve as a basis for the development of local criteria. More precise criteria are defined locally for each IMCU.

In **France**, criteria are set legally. The list of admissible patient groups is broadly defined (in three groups according to the patient's origin: medical, surgical or critical care unit) but admitted patients should be stable, with no foreseeable short term risk of organ failure. In **the Netherlands**, the Dutch Quality Standard also stated that it should be avoided that patients who meet or are likely to meet the criteria of an ICU patient in the near future are admitted to an IMCU instead of an ICU.

In **Germany**, recommended inclusion and exclusion criteria have been developed nationally (guideline), detailed by health issue (general, cardiac, respiratory, etc.). They are aimed to serve as a basis for the development of the criteria in each IMCU. Similarly, in **Italy**, the Society of Emergency Medicine developed criteria for critical patients coming from the emergency department, that can be suitable for patients coming from other units. IMCUs should admit patients at high developmental risk or clinically unstable, but with no indication for admission to the ICU. These patients may present a single life-threatening acute organ failure (possibly associated with less severe dysfunction of other systems), require monitoring (usually non-invasive) and may require instrumental or pharmacological support of one or more functions (usually not by invasive mechanical ventilation). Similarly, the Italian Thoracic Society developed recommended criteria for admission in respiratory IMCUs.

In **England**, where levels of care are defined at the patient level and not at the unit level, clinical judgement should be used to determine which level of care is most appropriate for a patient. The classification (particularly for level 2) is wider than only the presence or absence of organ failure.

In **Sweden**, local clinical judgement is deemed appropriate as the decision about who should be admitted should be made on a case-by-case basis by the attending physician in consultation with the patient and/or their relatives and other staff. In practice, even patients receiving norepinephrine can be treated in IMCUs. However, if more than one vasopressor is required, the patient should preferably be cared for in the ICU. Also, to be admitted in the IMCU, patients must have a clear airway and be able to breathe independently. In **Denmark** also, admission criteria are developed locally. For instance, Nordsjællands Hospital developed precise inclusion and exclusion criteria as well as prioritisation criteria. Patients requiring non-invasive ventilation, intubated patients, infusion of high-dose inotropes and vasopressors and patients with Sengstaken – Blakemore sonde or continuous dialysis should normally not be admitted in the IMCU, but transferred to the ICU. A list of predefined patients groups for whom intermediate care is considered particularly beneficial is also provided.

9.5.2 A wide variety of organisational models

Various models of IMCUs exist: they can be stand-alone units, co-located with an ICU or attached to a general care unit or emergency department. When co-located with an ICU, a distinction is made between the integrated model, where intermediate care beds are situated within an ICU, and the parallel model, where the IMCU is adjacent to the ICU. Table 54 provides an overview of the models observed in the selected countries.

Table 54 – Organisational models for IMCUs

Country	Stand-alone unit	Co-located with an ICU (integrated model)	Co-located with an ICU (parallel model)	Attached to a general unit or emergency department
Denmark	x			
England		x		x
France	x			x
Germany	x	x	x	
Italy	x	x	x	x
Sweden	x			x
The Netherlands	x	x	x	

Source: Own compilation.

In **England**, intermediate care is considered as the lowest levels of intensive care. Level 2 mainly takes place in flexible beds, within ICUs (see section 9.4.3). Enhanced care services (level 1), however, are usually situated together and collaborate closely with specific services, units, or interventional areas. They report to a surgery or medicine department distinct from critical care. The Faculty of Intensive Care Medicine supports their co-location with emergency care services.

In **Germany**, the type of IMCU varies according to local conditions: it can be incorporated within an ICU, positioned next to an ICU (with shared management), or function as an independent unit. It is advised that stand-alone IMCUs have at least 10 to 12 beds. For smaller units, an integrated or parallel model is recommended. The **Italian** Society of Emergency Medicine advises that general IMCUs should be situated alongside the emergency department. For respiratory IMCUs, the Italian Thoracic Society recognises several possible models: stand-alone units, co-location with ICU (integrated or parallel model), or integration within a pulmonology unit. The **Dutch** Quality Standard also acknowledges that hybrid departments could be established, accommodating together ICU, PACU, and IMCU patients.

In other countries, IMCUs is generally separate from ICUs. In **Sweden**, intermediate care can be provided in a stand-alone unit or be integrated in another non-ICU unit, for instance, in the emergency department. In **Denmark**, IMCUs are part of the anaesthesiology department and therefore not situated alongside specific departments. In **France**, the transitional legislation about continuous monitoring units only applies to units that are not co-located with an ICU. They can be stand-alone units, or units adjacent to a specific service (e.g. cancer treatment, etc.).

9.5.3 Staff numbers and qualifications

IMCUs ARE LED BY INTENSIVISTS OR OTHER PHYSICIANS

In three countries, IMCUs are led by intensivists. In **Germany**, the IMCU director should be certified in intensive care and the deputy director should be a specialist with at least one year experience in intensive care. In **the Netherlands**, central (i.e. multidisciplinary) medium care is generally under the responsibility of an intensivist. In **England**, level 2 and 3 patients' care should be led by a consultant in intensive care medicine. However, care for level 1 patients (enhanced care) should normally not be delivered by the critical care team. A clinical decisionmaker should be identified within the IMCU team and it should be avoided to contact an intensivist, in order not to jeopardise care for higher level patients.

In **Denmark**, the objective is for IMCUs to be organised in a similar way as ICUs, although the units are separate. The head of the IMCU is an anaesthesiologist (similarly to ICUs), who holds sole responsibility for the unit (i.e. management is not shared with another unit).

The large majority of IMCUs in **Sweden** were developed by internal medicine practitioners. However, some are also led by other specialists such as intensivists or specialists in infectious diseases.

In **Italy**, the Society of Emergency Medicine recommends that physicians working in general sub-intensive units are qualified as specialists in emergency medicine.

In **France**, a physician in charge must be identified for each IMCU, but there are no legal requirements for additional qualifications, nor are there restrictions on the physician in charge being shared with an adjacent unit.

CONTINUOUS MEDICAL PRESENCE, OR WITHIN A FEW MINUTES

In addition to guidance regarding the medical management of the IMCUs, minimum medical presence is often described. In **Germany**, at any time, a specialist with knowledge of intensive care must be present in the IMCU within five minutes (and a physician must be continuously present in the IMCU during daytime). In **the Netherlands** also, each IMCU should have a physician present 24/7, or reachable within five minutes. For enhanced care in **England**, a senior clinical decisionmaker must be clearly identified at all times to provide oversight including admission and triage decisions. No further requirements are made regarding the qualifications, except that it should not be an intensivist from the ICU. In general sub-intensive units in **Italy**, the Society of Emergency Medicine recommends that a medical coverage should also be ensured 24/7, but physicians can also have activities elsewhere (e.g. in the emergency department).

In IMCUs in **Denmark**, the responsibility of a patient is shared between an anaesthesiologist (responsible for the acute management of the patient, or ABC – airway, breathing, and circulation) and a physician from the relevant general unit (referred to as the 'receiving physician'). An anaesthesiologist must be present 24/7.

In **Sweden**, a specialist physician or experienced resident with adequate expertise in intermediate care (defined in each hospital depending on the type of patients) should be available in the hospital 24/7. Specialist physicians (usually one for four to six patients) ensure continuity in the IMCU but work in close collaboration with other specialties including ICU and anaesthesia.

NURSE QUALIFICATIONS

Some countries recommend specialised training for nurses. In **the Netherlands**, a national training programme for medium care nurses exists. In **Denmark**, there is no official training programme at the national level, but hospitals have developed programmes to train intermediate care nurses at the same time they developed IMCUs. Currently, collaborations exist to train nurses in newly established IMCUs. In Nordsjællands Hospital nurses working at the IMCU are not intensive care nurses, but nurses with an extra education in acute management. In **Germany**, a minimum of 20% of the nursing staff should be trained in intensive care, and at least one nurse having specialist intensive care training should be present during each shift.

HEAD OF NURSING

In **Germany** and **England**, specific recommendations are given regarding the head of nursing. In **Germany**, a head nurse and a deputy should be appointed. The head nurse must have a designated time slot each day, reserved for administrative and organisational management duties, during which (s)he is not involved in any patient care activities. Also, the head nurse should have specialist training in intensive care and at least three years of working experience in an ICU, while the deputy nurse should have at least specialist training in intensive care or intermediate care. In level 2 units in

England, the head nurse is not rostered to deliver direct patient care. For enhanced care (level 1) it is not specified if the head nurse should be supernumerary.

NURSE STAFFING RATIOS

In most countries, there are generally no official regulations regarding the number of nurses in IMCUs, although in practice, staffing ratios in IMCUs are higher than those in general care units but lower than those in ICUs.

In Nordsjællands Hospital in **Denmark**, for instance, bed-to-nurse ratios in the IMCU correspond to roughly twice the ratios for ICUs beds. In **Germany**, a maximum patient-to-nurse ratio of 4:1 is recommended. In **Sweden**, the recommended patient-to-nurse ratios range from 2:1 to 3:1. In **England**, a recommendation is made for level 2 patients only (maximum 2 patients per registered nurse who delivers direct care). For level 1 patients, no clear patient-to-nurse ratio could be set, but it is 'highly unlikely that enhanced care can be consistently delivered' where the patient-to-nurse ratio is above 4:1. In **Italy**, the Society of Emergency Medicine recommends a 4:1 bed-to-nurse ratio in general sub-intensive units.

Table 55 – Recommended staffing levels (patient-to-nurse or bed-to-nurse ratio)

	4:1	3:1	2:1
England (level 2)			x
England (level 1)	x		
Germany	x		
Italy	x		
Sweden		x	x

Notes: blue: patient-to-nurse; orange: bed-per-nurse. Source: Own compilation.

ALLIED HEALTHCARE STAFF

As for ICUs, the specifications for allied healthcare staff are less pronounced compared to nursing and medical staff. The daily availability of physiotherapy is recommended in **Germany** and **Sweden**. In **Sweden**, the physiotherapist should have experience and/or specialisation in respiratory or intensive care. The availability (not necessarily daily) of other allied healthcare staff is also mentioned: hygiene officer (Germany), pharmacist (Germany, Sweden), psychologist (Germany), occupational therapist (Germany, Sweden), speech therapist (Germany, Sweden), dietician (Sweden), healthcare assistant (France), assistant nurse (Sweden), etc.

9.5.4 Equipment

Equipment requirements for IMCUs are generally less stringent than for ICUs. Various equipment for non-invasive monitoring (electrocardiographic/heart rhythm, non-invasive blood pressure measurement, etc.), non-invasive ventilation, infusion pumps are often cited. In **England**, units treating level 2 patients have similar requirement as those treating level 3 patients. For level 1 (enhanced care), the requirements are lower. In **Germany**, **Sweden** and **the Netherlands**, detailed lists are provided of monitoring, diagnostic and therapeutic equipment that are required for IMCUs.

9.6 Reimbursement of intensive care

Although a shift away from diagnosis related groups (DRGs) is observed, all studied countries still have some kind of DRG system for the reimbursement of general hospital care. However, there are some differences when it comes to the reimbursement of intensive care. Irrespective of the inclusion into the general payment system, the majority of countries apply add-on payments to reimburse intensive care. Payment differences based on different levels (mainly activity-based) are only made by three countries. Table 56 shows an overview of reimbursement of intensive care.

Table 56 – Overview of reimbursement of intensive care

Country	Payment within DRG system	Add-on	Differences between levels
Denmark	Yes	No	Partly
England	No	Yes	No
France	Yes	Yes	Partly
Germany	Yes	No	Partly
Italy	No	Yes	n/a
Sweden	No	Yes	No
The Netherlands	Yes	Yes	n/a

Note: n/a = in this country there are no formal ICU levels. Source: Own compilation.

SOME COUNTRIES INCLUDE INTENSIVE CARE WITHIN THE DRG SYSTEM…

In four out of the seven studied countries, intensive care is integrated into the DRG system. In **France**, the payment mechanism for intensive care services is a mixed-mechanism based mainly on an activity-based payment (DRG payment) that varies according to the intensity of care provided and on a per diem payment that depends on the type of unit, the severity level and the performed medical acts. The DRG payment is based on patient's medical information and is the same whether the patient's stayed in an ICU or not. DRG tariffs are based on mean costs and can be modulated by the length of stay or the patient's severity of illness. The per diem payment is added to the reimbursement if the patient stays in a critical care unit (with a higher per diem for resuscitation units than for general ICUs). When a patient on the highest level (resuscitation unit) does not meet all requirements for the per diem payment (e.g. severity score (SAPS-2) not high enough) then only a per diem payment for a general ICU is received.

In **Denmark**, the case is classified and reimbursed under the normal DRG when the hospital length of stay is less than 12 days, even though the patient stayed in an ICU. Otherwise, specific DRGs apply which are differentiated in four intensive care groups based on the severity of illness and the number of organs with failure: 1) simple failure in one or more organs; 2) increasingly severe failure in single organ; 3) increasingly severe failure in multiple organs; 4) severe multiorgan failure.

Also in **Germany**, intensive care is included in the DRG system. It includes two procedural codes for the remuneration of intensive care medicine, depending on the complexity: 1) intensive care complex treatment; and 2) extensive intensive care complex treatment. In addition, special intensive care procedures, such as plasmapheresis and immunoadsorption, installation and operation of an ECMO/ECLS, measures in the context of resuscitation, etc., are coded and reimbursed separately.

In **the Netherlands**, intensive care is considered as disproportionately increasing the cost of care, and therefore subject to supplementary reimbursement in addition to the DRG payment. There is, for instance, an add-on payment for care processes with admission to the ICU with associated treatment by another treating medical specialism (add-on is made to the DRG of this medical specialism) and for care pathways with admission to the ICU without associated treatment by another specialism. The payment depends on the ICU type: type 1 refers to the smaller locations that collaborate with the larger (type 2) locations. This differentiation does not refer to different levels of patient care.

… BUT ACTIVITY-BASED ICU-PAYMENTS ARE BEING REFORMED

In **France**, the DRG and per diem payment together represent 75% to 85% of total revenues of critical care services. As such, ICU-payment is largely dependent on the volume of activity. This has been criticised. In particular, the per diem system incentivises to increase lengths of stay in the resuscitation unit (once a patient is eligible for a per diem payment for resuscitation, (s)he is eligible for each day of

the stay in the unit) and to evict from the resuscitation units patients requiring heavy and complex nursing care but whose life is not threatened (because they are not likely to undergo medical acts that justify the per diem payment). To minimise these impacts, a new financing system will be implemented in 2027. It will combine activity-based payments and global budgets, calculated on the basis of the number of beds, aiming at covering the fixed costs of the ICU.

In **Denmark**, the activity-based funding model was recently replaced with a payment system that uses broader performance measures. DRG rates are still calculated (based on average cost) every year and used for interregional payments for patients treated outside their home region and for benchmarking.

In **Germany**, while the DRG system is kept to incentivise hospitals to generate sufficient activity in an efficient way, its importance decreases. Germany adds a pillar to the payment systems in which remuneration for the services provided (i.e. remuneration for the availability of the respective services at all times in the sense of the state's provision of services of general interest) is foreseen. The aim of this reform is to reduce the economic pressure on hospitals, as they no longer receive their payment exclusively from treated cases. Hospitals will be allocated a global budget associated with intensive care, only if one of the three levels of intensive care has been assigned to them in the planning process (planned to be finalised at the end of 2026).

SOME COUNTRIES DO NOT INCLUDE INTENSIVE CARE IN THE DRG PAYMENT SYSTEM

In **England**, there is currently no national tariff for critical care and payments are arranged at the local level. Payments are typically activity-based and are determined by, for instance, the number of critical care days and corresponding reference costs (local or national). Providers and purchasers agree a value (which may be based on activity or bed days x price) that is fixed for the year. For some specialised pathways (e.g. specialist cardiac surgery) that are only available in some hospitals, NHS England is the responsible funder and pays the provider (in accordance with the national payment scheme guidance).

Also in **Sweden** intensive care is funded outside the DRG payment. Instead, it is generally financed through a budget allocated to the hospital, which is primarily based on historical cost data from previous years. Yet, different calculation methods exist. An example is the VTS2014 (*Vårdtyngdsmätning VTS 2014*) classification methods. It includes indicators that are based on the types of treatment given in the unit, and are assessed three times a day (every 8-hour shift). Examples are ventilator requirement, number of infusions for pharmaceutical drugs, renal replacement therapy, or need for taking care of relatives. VTS2014 consists of eleven indicators and each indicator can generate 0-3 points, depending on the intensity of the activity. Another important factor measured by VTS is the time spent by different caregivers. Various hospitals use VTS and length of stay to convert it to a cost.

In **Italy**, the payment mechanism for intensive care differs across regions. While it can be part of a DRG payment system, in most regions ICUs are financed through 'function-based funding' (*finanziamento per funzione*). The function-based financing was introduced because DRG based payment was deemed not suitable to adequately account for costs of hospital activities with unpredictable timing, or those with a high degree of technical (as well as organisational, managerial, etc.) complexity. Under this function-based payment mechanism, services are paid based on a global amount determined according to the care functions and activities performed. In the Lazio region, for instance, the budget for intensive care is allocated to individual providers on the basis of the number of occupied days of the accredited beds.

DIFFERENTIATION BETWEEN LEVELS

In general, reimbursement for intensive care does not depend on the level of the ICU. However, in practice, as some procedures only take place in higher level ICUs, the reimbursement differs between levels of ICU. In **Denmark** for instance, level 1 ICUs can only treat patients with single organ failures, they are therefore not eligible for DRG payments related to multi-organ failures. In **Germany**, the

procedural code for extensive intensive care complex treatment can only be billed in level 2 and level 3 ICUs.

In **France**, the per diem payment is higher in resuscitation units than in general ICUs. However, it largely depends on the severity level and on the type of medical acts provided, so that no real difference in reimbursement exists between levels of critical care.

9.7 Measuring, reporting and improving quality of intensive care

ICU-SPECIFIC DATA ARE COLLECTED IN NATIONAL REGISTRIES

In most countries, a national intensive care registry allows the systematic collection of detailed ICU-specific patient data..

The **Danish** Intensive Care Database was established in 2007 using data already routinely reported by the ICUs. Although not mandatory (anymore), participation is widespread. It contains data related to the hospital stay (date of admission, admission type, etc.) but also mortality up to 90 days after ICU admission, Charlson comorbidity index, and the Simplified Acute Physiology Score (SAPS) 3. The data are updated daily and an aggregated public report is published annually.

In the **Swedish** Intensive Care Registry however, data are not registered in real time but when ICUs have the ability to report. All ICUs in Sweden participate. The registry includes SAPS 3, the Sequential Organ Failure Assessment (SOFA) Score and standardised mortality ratios.

In **England**, the national clinical audit for critical care units is called Case Mix Programme and is open to both NHS (publicly funded) and independent ICUs. Currently, all adult general ICUs participate. Alongside demographic variables and data related to the hospital stay, it includes the Acute Physiology and Chronic Health Evaluation APACHE-2 score. An annual report is also published and is publicly available. In addition, quarterly benchmark reports are produced at the unit level, showing how the unit compares to others.

In **the Netherlands**, all ICUs provide data to the National Intensive Care Evaluation registry, that was established in 1996. It contains variables that define demographics, admission and discharge data, physiology, reasons for admission and severity of illness (APACHE-2 and SAPS-2) as well as outcome measures like hospital mortality, duration of treatment as well as ventilation and readmissions. Optionally, participants can also register SOFA scores for their patients. Also, a capacity module aims to provide insight into the nursing workload, with the objective to deploy nurses more efficiently. This module contains Nursing Activity Score (NAS) data.

In other countries, national registries focus on capacity management. Since the COVID-19 crisis, the **German** DIVI Intensive Care Register has recorded daily data on available and occupied treatment capacities (operational beds, ECMO) in ICUs. These daily data are publicly available.

In **France**, the development of a national registry of the healthcare supply is in progress. It will be the national reference for bed capacity in healthcare facilities, with dynamic data. For critical care, an update is expected at least daily. During the COVID-19 pandemic, a national online health emergency registry was used to collect data on intensive care capacity and patients. It was updated almost in real time but only available for authorised professionals.

In **Italy**, there are no specific requirements for monitoring intensive care, but several initiatives are taken to collect ICU-specific data. In particular, the Margherita-PROSAFE project is a volunteer, peer network, designed as an observational project for the continuous electronic collection of data on patients admitted to ICUs. Among others, the SAPS-2 and SOFA scores are collected.

QUALITY INDICATORS

Quality indicators are measured in all seven countries. They include process indicators, outcome indicators and structural indicators covering, among others, the following topics:

- Readmissions (Denmark, England, Sweden)
- Out-of-hours discharges (Denmark, England)
- Transfers (Denmark, England, Sweden)
- (Standardised) mortality (Denmark, England, Sweden, the Netherlands)
- Infections (England, Germany)
- Team practices / staffing (France, Germany, the Netherlands)
- Sedation (Germany, Sweden)
- Communication / satisfaction (Germany, the Netherlands)

In **Italy**, no specific quality indicators are measured for intensive care units, but there is a monitoring systems that analyses the overall performance of time-dependent pathways (stroke, acute myocardial infarction, trauma) in which ICUs play a central role.

Except in **England**, where the NHS has a scheme for encouraging quality improvement through reimbursement (only one indicator related to critical care), quality indicators are not directly tied to reimbursement. Also, the registration of quality indicators is generally not mandatory.

10 INTERMEDIATE CARE UNITS: A LITERATURE REVIEW OF THE EVIDENCE

KEY POINTS

- The objective of the present systematic literature review is to provide a comprehensive overview of the impact of intermediate care units (IMCUs) on several patient and hospital utilisation outcomes.
- The selected studies demonstrate heterogeneity in terms of the targeted patient populations, nomenclature, IMCU organisation, study design, and setting.
- The results of the impact of IMCUs on mortality and length of stay are conflicting. The majority included studies found no statistically significant effect of the introduction of an IMCU on hospital readmission rates and adverse events. Nevertheless, it appears that IMCU care might not be inferior to ICU care and may be beneficial for certain specific patient populations, health conditions or therapies, but may not be suitable for others.
- These conflicting and nonsignificant results may be due to differences in patient characteristics, intervention types, and the settings in which the studies were conducted. More research is needed to better understand the effectiveness of IMCUs and identify the factors that contribute to their success or failure.
- The results with respect to costs are more straightforward. Most of the publications that collected cost data found a cost savings effect following the introduction of IMCU. However, these cost savings may be associated with certain unfavourable effects (such as increase in in-hospital mortality or LOS for IMCU patients). This suggest that IMCU care may not be suitable for all groups of patients.

10.1 Introduction

In recent years, there has been a growing interest and debate about the added value of intermediate care units (IMCUs) as an alternative to intensive care units (ICUs). IMCUs provide a level of care that is more intensive (e.g. in terms of medical and nursing staff, monitoring and therapeutic possibilities) than that provided on general hospital wards, but less intensive than the level of care provided in ICUs. IMCUs are designed to provide specialised care to patients who are not critically ill but who require close monitoring, frequent interventions, and complex treatments. The goal of IMCUs is to provide a more cost-effective and less resource-intensive alternative to ICUs while still ensuring that patients receive the appropriate level of care for their medical needs. In practice, IMCUs may allow for earlier discharge of some ICU patients who no longer require full ICU facilities but are not ready for discharge to the general unit (i.e. step-down unit), (ii) or for early admission of patients who require more intensive care than is available on the general unit (i.e. step-up unit).[164]

The existing body-of-knowledge reports inconclusive results of the impact of IMCUs on efficiency, costs, or patient outcomes.[3, 4, 165-169] The variability of these results may be attributed to differences in the characteristics of the patients included in the studies, the types of interventions provided in IMCUs, and the settings in which the studies were conducted. However, there has not been a recent general systematic review of the literature on the effectiveness of IMCUs that is not specifically limited to certain patient populations or types of units. Therefore, the present chapter aims to provide an updated review of the published evidence on the effectiveness of IMCUs.

10.2 Methods

The methodology used in this chapter was based on a systematic review of the medical literature and follows standard KCE procedures.[170]

10.2.1 Research question

The purpose of this systematic literature review is to examine the effects of IMCUs on various outcomes, including mortality, length of stay (LOS), hospital readmission in 30 days, ICU readmission during stay in IMCU, costs and adverse events. Additionally, the review aims to identify common features of different IMCU formats and provide an overview of the IMCU landscape. The research question is formulated using the PICOTS (Participants-Interventions-Comparator-Outcomes-Timing-Study design) framework (Table 57).

The intervention of interest is the implementation of an IMCU as a potential alternative to standard intensive or standard hospital care. Primary outcomes of interest are mainly hospital utilisation metrics and patient outcomes, with mortality, LOS, hospital readmission within 30 days, ICU (re)admission during IMCU stay, costs being the outcomes of primary interest. Data on adverse events are also extracted and discussed when available.

Table 57 – Inclusion and exclusion criteria

	Inclusion criteria	Exclusion criteria
P	Adult patients requiring intermediate, step-down or step-up care	
I	Intermediate care units	
C	Standard ICU care or standard hospital care	
O	*Primary:* mortality, length of stay, hospital readmission, ICU (re)admission during IMCU stay, costs *Secondary:* adverse events	
T	Studies published between 2013 – 16 January 2025[gg]	
S	Studies with comparative design: e.g. pre-post observational studies, randomised clinical trials (RCTs)	Studies without control group Systematic literature reviews (used to select additional primary studies)

10.2.2 Literature search and selection

The following bibliographic databases were searched for relevant publications: (i) Ovid-Medline, (ii) Embase, and (iii) Cochrane Database of Systematic Reviews. To ensure sensitive search strategies, a KCE information specialist collaborated on the initial search strategy, which was developed for the Ovid-Medline interface and then adapted for Embase and the Cochrane Database of Systematic Reviews. These databases were searched on 16 January 2025. The search strategies used are documented in Appendix to Chapter 10 in the Supplement.

Eligible studies were required to have a comparative design, be published in English, Dutch, French, or Spanish, and be conducted in OECD countries.[hh] Letters, editorials, commentaries, studies without

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[gg] The initial literature search was conducted on 18 September 2023, to identify scientific evidence published in the past 10 years. Since the report was finalised in 2025, the search was updated in January 2025 to include the latest publications.

[hh] Austria, Australia, Belgium, Canada, Chile, Colombia, Costa Rica, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, South Korea, Latvia,

comparative design or systematic reviews of the literature were excluded. Although this latter group was used to check for additional primary studies. For a summary of the inclusion and exclusion criteria, we refer the reader to Table 57.

Following bibliographic record export and deduplication in the Rayyan QCRI tool, two independent reviewers (KVH and JD) screened all titles and abstracts of references. The full text of potentially relevant publications was obtained and screened against the inclusion and exclusion criteria by the same reviewers, with unclear publications being discussed between the two reviewers. The reviewers then extracted data from the included publications using a specially developed Excel data extraction file, with cross-checking by the second reviewer.

10.2.3 Quality assessment

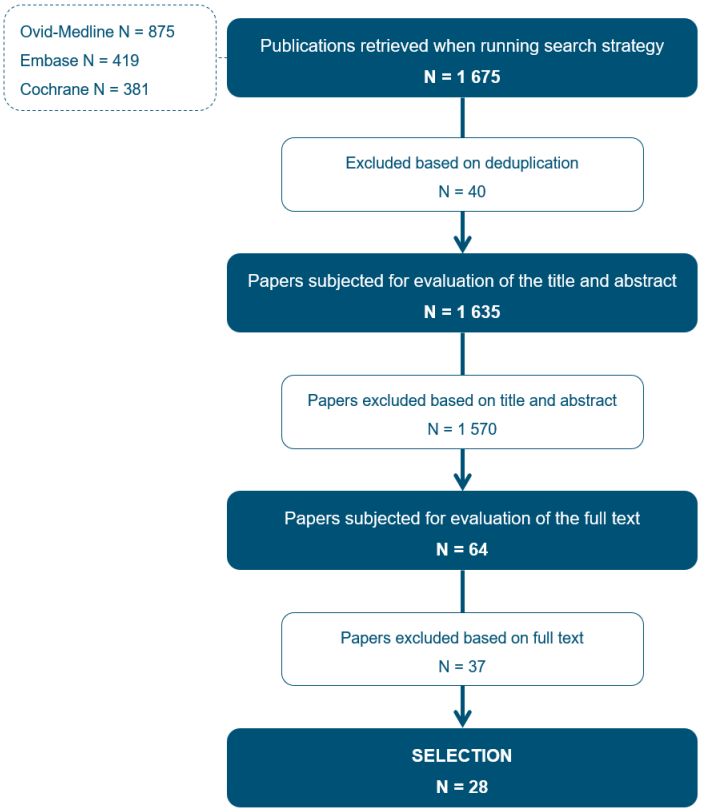
To evaluate the methodological quality of the selected publications, four tools developed by the National Institutes of Health (NIH) were used: (i) a tool for observational cohort and cross-sectional studies, (ii) a tool for before-after (pre-post) studies without a control group, (iii) a tool for case-control studies, and (iv) a tool for controlled intervention studies.[171-174] The risk of bias in included publications was evaluated by two reviewers (KVH and JD).

10.3 Results

A total of 1 675 publications were found from the search in the three bibliographic databases. After merging and removing duplicates, the titles and abstracts of the remaining 1 635 publications were screened for eligibility. Of these, 1 570 publications were excluded. In the second screening round, the full texts of the remaining 64 publications were evaluated, leading to the selection of 28 publications. The flow chart in Figure 131 summarises the screening process.

Lithuania, Luxemburg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States of America (OECD countries on 23 September 2022).

Figure 131 – Flow chart of the study selection process



10.3.1 Overview of the included publications

The identified studies are characterised by a variety of:

- **Countries:** USA (n=9), Japan (n=6), Canada (n=2), Denmark (n=2), Spain (n=2), Netherlands (n=2), France (n=1), Italy (n=1), Scotland (n=1), Australia (n=1) and one multicountry study that included 17 countries.
- **Study designs:** retrospective cohort design (n=12), pre-post retrospective design (n=4), RCT (n=3), observational cohort design (n=5), comparative study with matched case-control subgroup design (n=1), prospective observational cohort design (n=1), retrospective controlled design (n=1) and a pre-post prospective design (n=1).
- **Nomenclature:** the included studies use the term intermediate care unit (IMCU, n=13), step-down unit (SDU, n=6), high-dependency unit (HDU, n=6), high-acuity unit (HAU, n=1), high-acuity post-operative unit (n=1), and high care unit (n=1). Of the studies that use the term IMCU, most originate from EU countries and also in three studies conducted in the USA. The term SDU is used mainly in the USA (n=5) and Canada (n=1). HDU is used in articles from Scotland (n=1) and Japan (n=5), and HAU is from Canada. Six articles specify the focus of the unit: two studies specify respiratory and surgical units, one study specifies medical units, and one specifies neurological units.
- **Population:** medical and/or surgical patients (n=2), low-risk patients with aneurysmal subarachnoid haemorrhage or primary intracerebral haemorrhage (both n=1), patients with acute respiratory failure, acute exacerbation of chronic obstructive pulmonary disease (COPD) or community-acquired pneumonia (n=1), mechanically ventilated patients with pneumonia (n=1) or mechanically ventilated Medicare beneficiaries (n=1), patients with septic shock (n=3), patients with diabetic ketoacidosis (n=1), patients with COVID-19 (n=2), patients undergoing emergency

abdominal surgery (n=2), patients undergoing transsphenoidal microsurgical resection of sellar lesions (n=1), patients undergoing cardiac surgery (n=1), patients with acute myocardial infarction (AMI, n=1), patients undergoing elective or unplanned noncardiac surgery (n=1), trauma patients (n=1), low-risk patients with peritoneal cancer undergoing cytoreductive surgery with hyperthermic intraperitoneal chemotherapy (n=1) and adult patients (not further defined, n=5). One study did not specify its study population.

Full details of each study (including inclusion and exclusion criteria, time frame, sample size, and outcomes studied) are provided in Table 58 and Table 59.

The quality of the design of ten of the included studies was considered ‘good’, eight were rated ‘fair’ and nine ‘low’. Details of the quality assessment of all publications can be consulted in Appendix to Chapter 10 in the Supplement.

PATIENT-TO-NURSE RATIO

The patient-to-nurse ratio in the IMCU is reported in 22 of the included studies and ranges from 1.5:1 (n=1) to 5:1 (n=4). Most IMCUs have a patient-to-nurse ratio of 4:1 (n=10) or 2:1 (n=7). The ICU patient-to-nurse ratios were reported in 9 studies and ranged from 1:1 (n=3) to 2:1 (n=9). More information on the setting of the IMCU and the comparator unit is provided in Appendix to Chapter 10 in the Supplement.

Table 58 – Overview of the included studies (part 1)

Author (year)	Country	Design	Intervention	Population
Amiruddin et al. (2018)[168]	UK (Scotland)	Pre-post retrospective study	Introduction of a medical high-dependency unit (HDU)	Medical and surgical patients
Capuzzo et al. (2014)[175]	Austria, Belgium, Czech Republic, Denmark, France, Germany, Greece, Ireland, Italy, Norway, Poland, Portugal, Romania, Spain, Switzerland, Turkey, UK	Observational multinational cohort study	Introduction of IMCUs to ICUs	Adult patients
Chartrain et al. (2017)[176]	USA	Pre-post retrospective study	Introduction of a step-down unit (SDU) transfer protocol	Low-risk patients with aneurysmal subarachnoid haemorrhage
Confalonieri et al. (2015)[177]	Italy	Comparative study with matched case-control subgroup design	Introduction of a respiratory IMCU	Patients with acute respiratory failure, acute exacerbation of chronic obstructive pulmonary disease (COPD), or community-acquired pneumonia
Endo et al. (2022)[178]	Japan	Retrospective cohort study	Introduction of HDU	Adult patients with septic shock
Fernando et al. (2019)[179]	Canada	Retrospective cohort study	Introduction of SDU	Adult patients with diabetic ketoacidosis
Galdeano Lozano et al. (2022)[180]	Spain	Prospective observational cohort study	Introduction of a respiratory IMCU	COVID-19 patients during the first wave of the pandemic
Gershengorn et al. (2020)[181]	USA	Retrospective cohort study	Introduction of a medical IMCU	Medical patients
Hansted et al. (2020)[182]	Denmark	Randomised clinical trial	Introduction of intermediate care for at least 48 hours after emergency abdominal surgery	Patients undergoing emergency abdominal surgery (major laparoscopy or laparotomy)
Harlan et al. (2024)[183]	USA	Retrospective cohort study	Introduction of IMCU in rural areas versus urban areas	Medicare beneficiaries aged 65 years and old who received mechanical ventilation

Hunsaker et al. (2021)[184]	USA	Observational cohort study	Introduction of an ICU-based surgical SDU	Patients undergoing transsphenoidal microsurgical resection of postoperatively managed sellar lesions (surgically resected pituitary adenomas)
Labata et al. (2018)[185]	Spain	Pre-post retrospective study	Introduction of an IMCU	Postoperative cardiac surgery patients
Laws et al. (2020)[186]	USA	Retrospective controlled cohort study	Introduction of a neurologic SDU	Low-risk patients suffering primary intracerebral haemorrhage
Lekwijit et al. (2020)[187]	USA	Retrospective cohort study	Discharge to SDU after discharge from ICU instead of discharge to general unit	Adult patients
Ludbrook et al. (2023)[188]	Australia	Observational cohort study	Introduction of a high-acuity postoperative unit (advanced recovery room care)	Patients undergoing elective or unplanned noncardiac surgery and scheduled for postoperative care in a standard surgical ward for at least 2 postoperative nights
Mitra et al. (2020)[189]	Canada	Pre-post retrospective study	Introduction of high-acuity unit (HAU)	Patients with more acute care and closer monitoring than a general hospital unit
Ohbe et al. (2021)[190]	Japan	Retrospective cohort study	Introduction of HDU	Mechanically ventilated patients with pneumonia
Ohbe et al. (2022 a)[191]				COVID-19 patients with invasive mechanical ventilation
Ohbe et al. (2022 b)[192]				Patients hospitalised for AMI
Ohbe et al. (2023)[193]				Patients hospitalised for sepsis
Plate et al. (2018)[194]	The Netherlands	Observational cohort study	Introduction of surgical IMCU	Trauma patients
Schwartz. et al. (2022)[195]	USA	Retrospective cohort study	Introduction of IMCU	Low-risk patients with peritoneal cancer who underwent

				cytoreductive surgery with hyperthermic intraperitoneal chemotherapy
Solberg et al. (2014)[196]	The Netherlands	Pre-post prospective study	Introduction of IMCU	Not reported (NR)
Sykora et al. (2020)[197]	USA	Retrospective cohort study	Introduction of IMCU	Adult patients
Thietart et al. (2022)[198]	France	Randomised prospective multicentre (N=24) clinical trail	Evaluation of the 6-month outcome after admission to the ICU, IMCU or acute medical ward	Adult patients aged 75 years or older
Umegaki et al. (2024)[199]	Japan	Multicentre (N=900) cross-sectional study	Impact of high care units on patients with sepsis	Adult patients with sepsis
Vester-Andersen et al. (2015)[200]	Denmark	Multicentre (N=7 university-affiliated secondary referral hospitals) randomised clinical trail	IMCU after high-risk emergency abdominal surgery	High-risk patients who had emergency abdominal surgery
Yang et al. (2020)[201]	USA	Retrospective cohort study	Specialty SDU for the management of complex head and neck patients	Head and neck free flap reconstruction patients

Table 59 – Overview of included studies (part 2)

Author (year)	In- and exclusion criteria	Sample size		Time frame	Reported outcomes
		Intervention group	Control group		
Amiruddin et al. (2018)[202]	**Inclusion:** adult patients (16 years or older) admitted to ICU	Pre- and post-group not separately reported: 3 209 medical patients and 3 980 surgical patients		Pre-period: January 1, 2005 to December 31, 2005 Post-period: December 2012 to February 2013	In-hospital mortality
Capuzzo et al. (2014)[175]	**Inclusion:** adult patients (16 years or older) admitted to level III ICUs	5 031 patients admitted to 140 ICUs with IMCU	803 patients admitted to 27 ICUs without IMCU	November 7, 2011 to December 4, 2011 or	In-hospital mortality Hospital LOS

Author (year)	In- and exclusion criteria	Sample size		Time frame	Reported outcomes
		Intervention group	Control group		
	Exclusion: patients admitted to ICU with only level I or level II care			January 16, 2012 to February 12, 2012	ICU LOS
Chartrain et al. (2017)[176]	**Inclusion:** Hunt and Hess Grade III or better, completed diagnostic angiography since admission, secured or protected if found, stable neurological examination for longer than 24 h, no concern for impending symptomatic vasospasm (i.e., elevated or upward-trending transcranial Doppler ultrasound velocities) and no elevation in intracranial pressure for >24 h	72 patients	65 patients	January 2011 to September 2016	In-hospital mortality Hospital LOS ICU LOS 90-day hospital readmission ICU readmission Adverse events: requiring vasospasm intra-arterial therapy, hydrocephalus with external ventricular drain, hydrocephalus with ventriculoperitoneal shunt, acute respiratory failure, tracheostomy, pulmonary oedema, pulmonary embolism, deep venous thrombosis, stress-induced cardiomyopathy
Confalonieri et al. (2015)[177]	**Inclusion:** first episode of acute respiratory failure **Exclusion:** multiple acute respiratory episodes; patients with end-stage disease (e.g. stroke with severe functional limitations,	647 patients	1 725 patients	January 2004 to March 31, 2005	In-hospital mortality ICU readmission

Author (year)	In- and exclusion criteria	Sample size		Time frame	Reported outcomes
		Intervention group	Control group		
	metastatic cancer, etc.) and/or palliative treatment				
Endo et al. (2022)[178]	**Inclusion:** patients with septic shock who were ≥ 18 years and admitted to ICUs or high-dependency units having septic shock. Patients with the diagnosis of infection[ii] and organ dysfunction[jj] and patients in whom both intravenous antibiotics and noradrenaline were used on the day of hospitalisation **Exclusion:** patients with severe burns, patients who died within 24h after hospitalisation, patients complicated with congestive heart failure (International Classification of Diseases and Related Health Problems [ICD]-10 code I509), complicated with severe acute pancreatitis (ICD-10 code K859), and patients who underwent the following procedures: percutaneous coronary intervention, coronary artery bypass grafting, valve replacement, valvuloplasty, transcatheter aortic valve implantation, operation for aortic aneurysm or dissection, or endovascular aortic repair	4 234 patients	6 584 patients	April 2008 to February 2021	In-hospital mortality 30-day mortality Hospital LOS ICU or high-dependency LOS
Fernando et al. (2019)[179]	**Inclusion:** adult patients (≥ 18 years of age) that had a primary hospital admission or discharge diagnosis of diabetic ketoacidosis.	801 patients	71 patients	2011 to 2016	In-hospital mortality Hospital LOS

[ii] ICD-10 codes: A039, A021, A047, A207, A217, A227, A239, A241, A267, A280, A282, A327, A392, A393, A394, A400, A401, A402, A403, A408, A409, A410, A411, A412, A413, A414, A415, A418, A419, A427, B007, B377, J189, J440, N390

[jj] ICD-10 codes: J960, J969, J80, R092, R570, R571, R578, R579, I951, I959, N170, N171, N172, N178, N179, K720, K729, K763, F050, F059, G931, G934, G938, D695, D696, D65

Author (year)	In- and exclusion criteria	Sample size		Time frame	Reported outcomes
		Intervention group	Control group		
	The criteria for the diagnosis of diabetic ketoacidosis were adapted from the ADA (and based on initial laboratory values), which defines diabetic ketoacidosis by the presence of all the following: serum glucose >13.9mmol/L; presence of ketonuria or ketonemia; arterial pH <7.30; serum bicarbonate <18 mmol/L If arterial pH was not available, venous pH was used. The resolution of diabetic ketoacidosis was also defined using the existing ADA criteria, which includes all of the following: serum glucose <11.1 mmol/L; venous pH >7.30; and serum bicarbonate >18mmol/L				
Galdeano Lozano et al. (2022)[180]	**Inclusion:** a ratio of arterial oxygen pressure and fraction inspired oxygen (PaFiO2) <50% and oxygen saturation < 95%, or respiratory frequency >25 rpm and PaFiO2 <250.	32 patients	25 patients	February 25, 2020 to April 28, 2020	In-hospital mortality Hospital LOS
Gershengorn et al. (2020)[181]	**Inclusion:** patients were included if all covariate and discharge data were available. **Exclusion:** patients were excluded if admission to the ICU could not be confirmed, if they were transferred to the ICU in a third hospital within the system, if they were admitted to a non-medical ICU, if the ICU admission resulting from the consultation was not the first hospitalisation of the patient, or if time to transfer to ICU was >72 hours (out of concern for erroneous time stamps)	355 patients	323 patients	Pre-IMCU period: October 2013 to March 2014 Post-IMCU period: October 2014 to March 2015	In-hospital mortality Hospital LOS

Author (year)	In- and exclusion criteria	Sample size		Time frame	Reported outcomes
		Intervention group	Control group		
Hansted et al. (2020)[182]	**Inclusion:** patients who had undergone emergency laparoscopy or laparotomy procedures, were ready to be discharged from the post-anaesthesia care unit to the ward within 24 h and had a perioperative Acute Physiology and Chronic Health Evaluation (APACHE) II score of 10 or more. **Exclusion:** minor surgery (appendectomies, laparoscopic cholecystectomies and negative diagnostic laparoscopies), do not resuscitate or no intensive care orders, no consent available, and required prolonged postoperative intensive or intermediate care for more than 24 hours	144 patients	142 patients (regular ward care)	October 4, 2010 to November 30, 2012	6-year mortality
Harlan et al. (2024)[183]	**Inclusion:** all fee-for-service Medicare beneficiaries (aged 65 years and older) who were hospitalised between 2010 and 2019 and received invasive mechanical ventilation. Patients receiving invasive mechanical ventilation were identified using International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) and International Classification of Diseases, 10th Revision, Clinical Modification (ICD-10-CM) procedure codes **Exclusion:** psychiatric ICU admissions and patients from US territories	10 436 patients in rural IMCU 263 780 patients in urban IMCU	173 400 patients in rural ICU 2 166 980 patients in urban ICU	January 2010 to December 2019	30-day mortality LOS (not further specified)
Hunsaker et al. (2021)[184]	**Inclusion:** patients aged >17 years, extubated intraoperatively or within 1 hour after arrival at PACU, cognitive status and language skills allowing clear communication and cooperation, stable or improving neurologic status over 4 hours of observation of PACU, mild focal deficit consistent with presurgical examination	27 patients	27 patients (also compared with 634 historical control patients)	August 2018 to March 2020	Hospital LOS ICU/IMCU LOS Costs Adverse events: intraoperative cerebrospinal fluid

Author (year)	In- and exclusion criteria	Sample size		Time frame	Reported outcomes
		Intervention group	Control group		
	findings, stable or improving pulmonary status on nasal cannula oxygen, systolic blood pressure <150 mm Hg for >1 hour without intravenous antihypertensive medication ASA grade 3 **Exclusion:** pituitary lesion-specific characteristics (mass size≥2 cm in greatest diameter, cavernous sinus invasion, history of prior pituitary surgery, craniotomy, or radiation lumbar drain or external ventricular drain use unexpected intraoperative complications, Cushing disease, pituitary apoplexy				leak, intraoperative fat harvest, intraoperative fascia harvest, intraoperative lumbar puncture, intraoperative alcohol, postoperative visual deficits, postoperative endocrine abnormalities, transient diabetes insipidus, postoperative complications
Labata et al. (2018)[185]	**Inclusion:** patients who underwent cardiac surgery in a university hospital	650 patients	674 patients	Pre-IMCU period: November 2012 to April Post-IMCU period: May 2014 to April 2015	In-hospital mortality Hospital LOS ICU LOS 30-day readmission ICU readmission during IMCU stay Adverse events: bleeding, dehiscence, per-intervention acute myocardial infarction (AMI), tamponade, atrioventricular block, atrial fibrillation, renal failure, intestinal ischaemia, stroke

Author (year)	In- and exclusion criteria	Sample size		Time frame	Reported outcomes
		Intervention group	Control group		
Laws et al. (2020)[186]	**Inclusion:** intracerebral haemorrhage is supratentorial and volume is ≤5 ml (by ABC/2 method) Symptom onset less than 24h from presentation (or ≤ 30 ml if over 24h from onset) Glasgow coma scale ≥ 13 National Institutes of Health Stroke Scale ≤ 10 No intraventricular haemorrhage or hydrocephalus No evidence of active bleeding on noncontrast head computed tomography and/or computed tomography angiography Absence of coagulopathy: international normalised ratio ≤ 1.4, partial thromboplastin time ≤ 40, platelets ≥ 100 No significant respiratory distress, seizures on presentation, or other medical problems requiring intensive care. **Exclusion:** patients with haemorrhaging conversion of an ischemic stroke, primary SAH, primary intraventricular haemorrhage and haemorrhage due to an underlying mass or vascular lesion	75 patients	58 patients	2014 to 2016	Hospital LOS ICU LOS (Re)admission to neurologic ICU
Lekwijit et al. (2020)[187]	**Inclusion:** admitted through the ED to a medical service, admitted to the ICU during hospitalisation, and admitted to an SDU or a general ward following first ICU stay	3 839 low-severity patients and 3 892 high-severity patients		January 2010 to November 2011	In-hospital mortality Remaining hospital LOS (after ICU stay) Hospital readmission (2 weeks and 30 days) ICU readmission (2 days and 5 days)

Author (year)	In- and exclusion criteria	Sample size		Time frame	Reported outcomes
		Intervention group	Control group		
Ludbrook et al. (2023)[188]	**Inclusion:** patients undergoing elective or unplanned noncardiac surgery and scheduled for postoperative care in a standard surgical ward for at least 2 postoperative nights. Patients were identified from operating schedules, then screened prior to the start of operating lists to identify those considered medium risk, defined as predicted 30-day mortality of 0.7% to 5% by the American College of Surgeons National Safety and Quality Improvement Program risk calculator.	452 patients	419 patients	March 1, 2021 to March 1, 2022	Mortality (30 days and 90 days) Hospital LOS Hospital readmission (30 days and 90 days) ICU admission Medical emergency response complications
Mitra et al. (2020)[189]	**Inclusion:** patients (16 years) were admitted to the HAU at the discretion of the attending critical care physician if they required non-invasive positive pressure ventilation, vasopressors/inotropes, or cardiac or other close clinical monitoring for >24 hr.	3 396 patients	984 patients	Pre-HAU period: January 1, 2013 to December 31, 2017 Post-HAU period: June 16, 2014 to December 31, 2017	In-hospital mortality Hospital LOS ICU LOS
Ohbe et al. (2021)[190]	**Inclusion:** patients hospitalised for pneumonia as those with a diagnosis of pneumonia (ICD-10 codes: A48.1, B01.2, B05.2, B37.1, B59, J10.0, J11.0, or J12–J18) **Exclusion:** patients aged < 15 years, those in hospitals for which Survey of Medical Institutions 2017 data could not be combined, and patients with missing data on the severity of pneumonia	7 528 patients	7 331 patients	April 2014 to March 2019	In-hospital mortality ICU/HDU mortality Hospital LOS Costs Adverse events: acute respiratory distress syndrome, catheter-related bloodstream infection
Ohbe et al. (2022 a)[191]	**Inclusion:** COVID-19 patients with ICD-10 code U071 **Exclusion:** COVID-19 patients with a suspected diagnosis	682 patients	1 303 patients	February 10, 2020 to November 30, 2021	In-hospital mortality Hospital LOS ICU/HDU LOS ICU admission

Author (year)	In- and exclusion criteria	Sample size		Time frame	Reported outcomes
		Intervention group	Control group		
	No invasive mechanical ventilation during hospitalisation Patients aged < 15 years Patients were discharged to another hospital on the first day of invasive mechanical ventilation Patients who were not admitted to the HDU or ICU on the first day of invasive mechanical ventilation				Costs
Ohbe et al. (2022 b)[192]	**Inclusion:** patients with ICD-10 code I21, I22, or I23 **Exclusion:** patients aged < 15 years Patients who were not admitted to HDU or ICU on the day of hospital admission Patients who did not undergo percutaneous coronary intervention on the day of admission Patients admitted to hospitals that could not be combined with data from the Survey of Medical Institutions (2017)	45 760 patients	89 382 patients	April 1, 2014 to March 31, 2021	In-hospital mortality Hospital LOS ICU/HDU LOS Costs
Ohbe et al. (2023)[193]	**Inclusion:** patients hospitalised for sepsis and with Sequential Organ Failure Assessment (SOFA) scores greater than or equal to 2 on their day of admission **Exclusion:** patients aged < 15 years Patients whose clinical information could not be combined with data from the Survey of Medical Institutions 2018–2020 Patients whose total SOFA scores were less than two on the day of admission according to the Sepsis-3 definition	12 717 patients	12 717 patients	April 1, 2018 to March 31, 2021	In-hospital mortality Hospital LOS Total hospitalisation costs

Author (year)	In- and exclusion criteria	Sample size		Time frame	Reported outcomes
		Intervention group	Control group		
	Patients who had at least one incomplete score for each of the six organ systems to calculate the total SOFA score on the day of admission				
Plate et al. (2018)[194]	**Inclusion:** trauma patients in need of critical care	675 patients: 324 admitted to neuro(surgical) IMCU and 351 to mixed-surgical IMCU	645 patients	January 1, 2011 to January 7, 2015	In-hospital mortality ICU readmission Costs
Schwartz. et al. (2022)[195]	**Inclusion: low-risk** adult patients with peritoneal cancer who underwent cytoreductive surgery with hyperthermic intraperitoneal chemotherapy Low risk was left to the discretion of the operative surgeon, factors influencing this decision: short operation time (<8h), lower peritoneal cancer index, minimal estimated blood loss, and minimal anticipated resuscitation needs **Exclusion:** patients not undergoing curative-intent surgery (e.g. prophylactic or palliative cytoreductive surgery with hyperthermic intraperitoneal chemotherapy)	16 patients	71 patients	Pre-IMCU period: March 2014 to February 2020 Post-IMCU period: February 2020 to June 2021	30-day mortality Hospital LOS ICU LOS 30-day hospital readmission rate Costs
Solberg et al. (2014)[196]	**Exclusion:** cardiac patients: were admitted to specialised cardiac ICU	479 patients	548 patients	Pre-IMCU period: 9 months Post-IMCU period: 8 months	In-hospital mortality LOS ICU readmission ICU readmission <48h
Sykora et al. (2020)[197]	**Inclusion:** adult patients admitted to the hospital internal medicine service	4 917 patients in the IMCU (no transfer to higher levels of care)	18 578 medical-surgical patients	January 1, 2013 to December 31, 2016	LOS

Author (year)	In- and exclusion criteria	Sample size		Time frame	Reported outcomes
		Intervention group	Control group		
		199 patients with IMCU (transfer to higher levels of care, TX)			
Thietart et al. (2022)[198]	**Inclusion:** patients aged 75 years or older, with a preserved functional status (defined by Katz Index of Independence in Activity of daily living of at least 4), a preserved nutritional status (defined as the absence of cachexia, subjectively evaluated by a physician), with no active cancer, who arrived in an emergency department with pre-established conditions (as listed in ICU-CUB2) and hospitalised in ICU, IMCU or medical ward	504 patients in IMCU	1 448 patients in the ICU 1 084 patients in medical ward	January 2012 to November 2015	In-hospital mortality
Umegaki et al. (2024)[199]	**Inclusion:** patients with sepsis were identified as those with the relevant International Classification of Diseases, 10th Revision codes on admission **Exclusion:** patients who were admitted before the study period or who were not yet discharged from hospital during the study period, patients aged below 18 years and patients with missing age data	4 904 patients in high care unit	6 604 patients in ICU	April 1, 2018 to March 31, 2019	In-hospital mortality ICU LOS Hospital LOS
Vester-Andersen et al. (2015)[200]	**Inclusion:** high-risk patients who had undergone emergency abdominal laparotomy or laparoscopy High-risk defined as perioperative Acute Physiology And Chronic Health Evaluation (APACHE) II score of 10 or above Emergency surgery was defined as surgery to be performed in 24h	144 patients in intermediate care unit	142 patients in surgical ward	October 4, 2010 to November 30, 2012	30-day mortality ICU (re)admission Adverse events: postoperative complications

Author (year)	In- and exclusion criteria	Sample size		Time frame	Reported outcomes
		Intervention group	Control group		
	Exclusion: patients who had undergone appendectomy, laparoscopic cholecystectomy, negative diagnostic laparoscopy, not indicated intensive care (patients receiving palliative care or with irreversible organ failure), previous participation in the trial, age below 18 years, trauma, and no intermediate care bed available				
Yang et al. (2020)[201]	**Inclusion:** adult patients (>18 years of age) who underwent free flap surgery for reconstruction of head and neck defects.	100 patients in speciality SDU	205 patients in non-speciality ICU	August 1, 2014 to August 30, 2017	LOS Hospital readmission within 30 days Adverse events: postoperative complications (wound infection, fistula, cellulitis, haematoma, pneumonia, abscess, deep venous thrombosis, pulmonary embolism, chyle leak)

10.3.2 Mortality

The present systematic literature identified 24 publications that examined the impact of the introduction of an IMCU in the ICU setting on mortality.[175-183, 185, 187-196, 198, 200, 202] Of these, four studies reported a decrease in the mortality rate after the implementation of an IMCU.[175, 177, 189, 198] In their multinational study (in 17 European countries), Capuzzo et al.[175] found that ICUs with an IMCU had a higher crude hospital mortality rate (24.5%) compared to those without (20.5%, p = 0.017). However, after adjusting for patient characteristics at admission, such as illness severity and ICU and hospital characteristics, the odds ratio (OR) of mortality was 0.63 (95%CI 0.45 to 0.88, p = 0.007), indicating that the presence of an IMCU is associated with lower mortality. Furthermore, Confalonieri et al.[177] found that patients with acute respiratory failure, acute exacerbation of COPD, or community-acquired pneumonia admitted to a respiratory IMCU had a significantly lower in-hospital mortality rate (5.4% vs 19.1%, p = 0.0001) compared to those admitted to internal medicine units, and this result remained significant even after controlling for potential confounders. The risk of mortality in patients with acute respiratory failure, acute exacerbation of COPD, or community-acquired pneumonia was significantly higher in the internal medicine unit than in the respiratory intermediate care unit (OR 6.90, 3.19, and 6.7, respectively, p < 0.04). In another historical cohort study conducted by Mitra et al.[189], the in-hospital mortality rate in the ICU was 37.0% before the creation of the HAU, which decreases to 32.0% after its establishment. The introduction of a HAU was associated with a lower adjusted risk ratio (RR) of in-hospital mortality (0.80, 95%CI 0.72 to 0.89, p < 0.001). Thietart et al.[198] observed a significantly higher 6-month mortality rate for geriatric patients (≥75 years of age) admitted to a medical ward compared to IMCU patients (hazard ratio [HR] 1.31, 95%CI 1.04 to 1.63). However, this 6-month survival rate did not differ significantly between ICU patients and IMCU patients (HR 1.17, 95%CI 0.95–1.46).

Furthermore, Ohbe et al.[193] observed no significant difference in in-hospital mortality between ICU and HDU groups among the overall cohort of septic shock patients (30.9% vs 31.8%; risk difference,-0.8%; 95% CI,-2.0% to 0.3%). Patients in the ICU group had significantly lower in-hospital mortality than those in the HDU group among cohorts with Sequential Organ Failure Assessment (SOFA) scores of greater than or equal to 12. There were no significant differences in in-hospital mortality among cohorts with SOFA scores of 5-11. This may indicate that HDU care may not be inferior to those in the ICU for patients with SOFA scores of 6-11. Patients in the ICU group had significantly higher in-hospital mortality than those in the HDU group among the cohorts with SOFA scores of less than or equal to 4. However, it is important to note that among the same patient group (i.e. septic shock patients), Endo et al.[178] noted a lower overall risk-adjusted 30-day mortality rate for patients with septic shock admitted to the ICU relative to those admitted to the HDU (adjusted HR: 0.89; 95%CI 0.83 to 0.96; p = 0.005). This trend is also observed by Umegaki et al.[199] in in-hospital mortality among sepsis patients (adjusted HR 1.12; 95% CI 1.04 to 1.21; p < 0.001 for the type 2 ICU group and 1.17; 95% CI 1.08 to 1.26; p < 0.01 for the HCU group compared to type 1 ICU group). Additionally, five other publications observed a negative impact on mortality following the introduction of an IMCU.[178, 183, 190, 191, 196] For instance, a study conducted in Japan found that COVID-19 patients requiring invasive mechanical ventilation showed lower in-hospital mortality rates within 30 days when admitted to the ICU than those treated in the HDU (18.3% vs. 24.2%, p = 0.018, risk difference, -5.8%, 95%CI -10.9% to -0.8%).[191] Furthermore, Solberg et al.[196] observed a significant increase in in-hospital mortality at the ICU following the implementation of an IMCU (22.5% in the intervention period vs. 16.6% in the control period, p = 0.02). However, the authors rationalised that this could be due to the fact that the IMCUs they studied were not deemed applicable for terminal patients or palliative care, causing these patients to remain in the ICU or be transferred to the general ward.

Lastly, 12 of the included publications reported results with a statistically not significant effect of the creation of IMCU on mortality rates.[176, 179, 181, 182, 185, 187, 188, 192, 195, 196, 198, 200, 202] It is noteworthy, however, that these studies explored various types of mortality, including all-cause 6-year mortality and 30-day mortality, as well as mortality rates among specific patient populations in different clinical settings, such as medical or surgical patients within the intensive care unit. In addition, two of the reviewed publications presented mortality rates but did not conduct any statistical comparisons.[3, 180, 198] Detailed results for these publications can be consulted in Table 60.

Table 60 – Impact of IMCU on mortality

Author (year)	Impact	Detailed results
Amiruddin et al. (2018)[202]	🔵	*Crude in-hospital mortality medical patients in the ICU:* from 40% to 30% in pre-period (2005-2012), decreasing with -0.1% per month (p = 0.007); from 30% to 38% (2013-2015), increasing by 0.3% (p = 0.054) *Crude in-hospital mortality surgical patients on ICU:* from 31% to 22% in pre-period (2005-2012), decreasing with -0.1% per month (p = 0.012), from 22% to 28% in post-period (2013-2015), increasing by 0.3% (p = 0.14)
Capuzzo et al. (2014)[175]	🟢	*In-hospital mortality:* 24.5% in the intervention group (ICUs with IMCU), 20.5% in the control group (ICUs without IMCU) (p = 0.017) *Odds ratio (OR) of in-hospital mortality:* 0.63 (95%CI 0.45 to 0.88, p = 0.007) in favour of the presence of IMCU
Chartrain et al. (2017)[176]	🔵	*In-hospital mortality:* 5.6% in the intervention group (after introduction of SDU transfer protocol), 12.3% in the control group (before introduction of SDU transfer protocol) *Adjusted in-hospital mortality:* OR 0.49, 95%CI 0.11-2.19 (p = 0.351)
Confalonieri et al. (2015)[177]	🟢	*In-hospital mortality:* 5.4 in the intervention group (respiratory IMCU), 19.1% in the control group (internal medicine unit) (p = 0.0001) *Adjusted risk of mortality for patients with community-acquired pneumonia, acute exacerbation of COPD, and acute respiratory failure in internal medicine ICU:* OR 6.90, 3.19, and 6.7 respectively (p < 0.04)
Endo et al. (2022)[178]	🔴	*In-hospital mortality:* 31.0% in the intervention group (HDU), 29.9% in the control group (ICU) (adjusted OR 0.82, 95%CI 0.75-0.90, p < 0.001) *30-day mortality:* 24.2% in the intervention group (HDU), 23.9% in the control group (ICU) (adjusted OR 0.89, 95%CI 0.83-0.96, p = 0.005)
Fernando et al. (2019)[179]	🔵	*In-hospital mortality:* 7.7% in the intervention group (SDU), 8.4% in the control group (ICU) (adjusted OR 1.14, 95%CI 0.87-2.64)
Galdeano Lozano et al. (2022)[180]	⚫	*In-hospital mortality:* 25% across critical care admissions (no statistical comparison)
Gershengorn et al. (2020)[181]	🔵	*In-hospital mortality:* 21.2% in the intervention period, 20.4% in the control period (p = 0.91)
Hansted et al. (2020)[182]	🔵	*All-cause 6-year mortality:* 52.8% in the intervention group (IMCU), 47.9% in the control group (standard surgical unit) (HR 1.06, 95%CI 0.76-1.47, p = 0.73)
Harlan et al. (2024)[183]	🔴🔵	*Adjusted 30 day mortality:* 36.9% in the intervention group (rural IMCU group), 31.3% in the intervention group (urban IMCU group) (adjusted absolute risk difference 5.6%, 95% CI 3.7%-7.6% (p < 0.001); 46.7% in the control groups (rural and urban ICU group), adjusted absolute risk difference -0.1%, 95% CI 20.7%-0.6% (p = 0.884)
Labata et al. (2018)[185]	🔵	*In-hospital mortality:* 3.5% in the intervention period, 4.9% in the control period (p = 0.28)
Lekwijit et al. (2020)[187]	🔵	*In-hospital mortality:* 2.1% in low-severity patients, 13.3% in high-severity patients (not significant [NS])
Ludbrook et al. (2023)[188]	🔵	*30-day mortality:* 1.4% in intervention group (high-acuity postoperative unit), 2.6% in control group (general care unit) (p = 0.420) *90-day mortality:* 3.2% in intervention group (high-acuity postoperative unit), 5.4% in control group (general care unit) (p = 0.250)

Mitra et al. (2020)[189]		*In-hospital mortality:* 32% in the intervention group (after introduction of HAU), 37% in control group (medical/surgical ICU in tertiary-care hospital) *Adjusted risk ratio (RR) for ICU patients:* 0.86, 95%CI 0.79-0.95 (p = 0.003) *Adjusted RR for critically ill patients:* 0.80, 95%CI 0.72-0.89 (p < 0.001)
Ohbe et al. (2021)[190]		*In-hospital mortality (30 days):* 31.2% in the intervention group (HDU), 24.0% in the control group (ICU) (p < 0.001) *ICU/HDU mortality:* 21.3% in the intervention group (HDU), 14.9% in the control group (ICU) (p < 0.001)
Ohbe et al. (2022 a)[191]		*In-hospital mortality (30 days):* 24.2% in the intervention group (HDU), 18.3% in the control group (ICU) (p = 0.018)
Ohbe et al. (2022 b)[192]		*In-hospital mortality:* 5.5% in the intervention group (HDU), 5.0% in the control group (ICU) (p = 0.085)
Ohbe et al. (2023)[193]		*In-hospital mortality (total):* 31.8% in the intervention group (HDU), 30.9% in the control group (ICU) (95%CI -2.0 to 0.3) *SOFA score 2-4:* 12.4% in the intervention group (HDU), 15.7% in the control group (ICU) (p = 0.002) *SOFA score 5:* 17.3% in the intervention group (HDU), 18.7% in the control group (ICU) (p = 0.396) *SOFA score 6: 18.9*% in the intervention group (HDU), 20.1% in the control group (ICU) (p = 0.502) *SOFA score 7:* 25.0% in the intervention group (HDU), 25.8% in the control group (ICU) (p = 0.653) *SOFA score 8:* 27.9% in the intervention group (HDU), 26.5% in the control group (ICU) (p = 0.436) *SOFA score 9:* 31.8% in the intervention group (HDU), 33.1% in the control group (ICU) (p = 0.509) *SOFA score 10:* 35.0% in the intervention group (HDU), 32.4% in the control group (ICU) (p = 0.213) *SOFA score 11:* 40.7% in the intervention group (HDU), 40.0% in the control group (ICU) (p = 0.747) *SOFA score 12-14:* 51.9% in the intervention group (HDU), 47.6% in the control group (ICU) (p = 0.010) *SOFA score 15-24:* 71.2% in the intervention group (HDU), 66.6% in the control group (ICU) (p = 0.038)
Plate et al. (2018)[194]		*In-hospital mortality:* 3.4% in the intervention group (IMCU), 20.8% in the control group (ICU) (no statistical comparison)
Schwartz et al. (2022)[195]		*30-day mortality:* 25% in the intervention group (IMCU), 52.1% in the control group (ICU) (p = 0.05)
Solberg et al. (2014)[196]		*In-hospital mortality in the ICU:* 22.5% in intervention period, 16.6% in the control period (p = 0.02) *In-hospital mortality on the general ward:* 4.2% in the intervention period, 4.4% in control period (0.80)
Thietart et al. (2022)[198]		*In-hospital mortality:* 15% in intervention group (IMCU), 28% in control group (ICU) and 27% in second control group (medical ward) (no statistical comparison) *6-month mortality:* 31% in intervention group (IMCU), 44% in control group (ICU) and 45% in second control group (medical ward) (p < 0.001) *Multivariate analysis:* admission to a medical ward (HR 1.31, 95%CI 1.04 to 1.63) is associated with worse overall survival than admission to an IMCU, survival not significantly different between patients admitted to ICU and IMCU (HR 1.17, 95%CI 0.95 to 1.46)

Umegaki et al. (2024)[199]	🔴	*In-hospital mortality: 37.7%* in the intervention group (high care unit), 46.3% in control group (ICU 1) and 48.5% in control group (ICU 2) (p < 0.001) *Cox proportional hazards analysis:* adjusted HRs are 1.12 (95% CI 1.04 to 1.21, p < 0.001) for the type 2 ICU group and 1.17 (95% CI 1.08 to 1.26, p < 0.01) for the HCU group, compared to type 1 ICU group
Vester-Andersen et al. (2015)[200]	🔵	*30-day mortality:* 7.6% in the intervention group (IMCU) and 8.5% in the control group (surgical unit) (OR 0.91, 95%CI 0.38 to 2.16, p = 0.828)

🟢 *Reduction of mortality,* 🔵 *No significant effect on mortality,* 🔴 *Increase of mortality,* ⚫ *No statistical comparison*

10.3.3 Length of stay

Twenty-two publications studied the impact of establishing an IMCU on LOS.[175-181, 184-193, 195-197, 199, 201] Of these publications, eight reported a favourable effect on hospital LOS.[177, 179, 185, 186, 189, 190, 195, 201] Confalonieri et al.[177] found a considerable decrease in hospital LOS for patients suffering from acute respiratory failure, acute exacerbation of COPD, or community-acquired pneumonia admitted to a respiratory IMCU compared to those admitted to an internal medicine unit (9.3 vs. 12.1 days, respectively; p = 0.0001). Similarly, a decrease in average hospital LOS was found among adult patients with diabetic ketoacidosis, postoperative cardiac surgery patients, low-risk patients suffering from primary intracerebral haemorrhage or peritoneal cancer who underwent cytoreductive surgery with hyperthermic intraperitoneal chemotherapy, mechanically ventilated patients with pneumonia, and patients who underwent head and neck free flap reconstruction.[179, 185, 186, 189, 190, 195, 201] However, two studies identified a significant increase in hospital LOS for patients admitted to an IMCU.[175, 197] For example, Capuzzo et al.[175] observed that patients admitted to an ICU-IMCU had a longer LOS than those admitted to an ICU without IMCU (median 3.5, IQR 1.9 to 6.9 vs. median 2.6, IQR 1.8 to 4.3, respectively; p < 0.001). Furthermore, Sykora et al.[197] identified a significant increase in LOS for patients admitted to an IMCU compared to those admitted to a general unit (50.3 hours for medical-surgical patients, 108.3 hours for patients needing a higher level of care, 70.7 hours for patients admitted to an IMCU, p < 0.001).

Furthermore, six studies found a significant reduction in LOS in the ICU for patients undergoing transsphenoidal microsurgical resection of sellar lesions, postoperative cardiac surgery patients, low-risk patients suffering from primary intracerebral haemorrhage or suffering from peritoneal cancer who underwent cytoreductive surgery with hyperthermic intraperitoneal chemotherapy and sepsis patients.[184-186, 189, 195, 199] This decrease in ICU LOS is inherently plausible, considering that the implementation of a new step-up or step-down unit is anticipated to diminish the requirement for extended hospitalisations in the ICU.

Eight of the included publications reported statistically insignificant results on the effect of the creation of IMCU on LOS.[176, 178, 181, 184, 187, 188, 191, 192, 196, 199] In addition, three of the publications reported LOS metrics for patients with COVID-19, patients with sepsis and mechanically ventilated Medicare beneficiaries, but did not conduct any statistical comparisons.[180, 183, 193] Detailed results can be consulted in Table 61.

Table 61 – Impact of IMCU on length of stay

Author (year)	Impact	Detailed results
Capuzzo et al. (2014)[175]	🔴	*Hospital LOS (median):* 13.9 days (IQR 7.6-25) in the intervention group (ICUs with IMCU), 11 days (IQR 6.2-19) in the control group (ICUs without IMCU) (p < 0.001) *LOS of the ICU:* 3.5 days (IQR 1.6-6.9) in the intervention group (ICUs with IMCU), 2.5 days (IQR 1.8-4.3) in the control group (ICUs without IMCU) (p < 0.001)
Chartrain et al. (2017)[176]	🔵	*Hospital LOS (mean):* 12.0 days in the intervention group (after introduction of SDU transfer protocol), 13.0 days in the control group (before introduction of SDU transfer protocol) (p = 0.414), adjusted mean LOS OR -1.95, 95%CI -4.23-0.33 (p = 0.092) *ICU LOS (mean):* 19.9 days in the intervention group (after introduction of SDU transfer protocol), 16.6 days in the control group (before introduction of SDU transfer protocol) (p = 0.036), adjusted mean LOS OR 2.70, 95%CI -0.31-5.71 (p = 0.080)
Confalonieri et al. (2015)[177]	🟢	*Hospital LOS:* 9.3 days in the intervention group (respiratory IMCU), 12.1 days in the control group (internal medicine unit) (p = 0.0001)
Endo et al. (2022)[178]	🔵	*Hospital LOS (mean):* 22.0 days (IQR 12.0-43.0) in the intervention group (HDU), 26.0 days (IQR 14.0-48.0) in the control group (ICU) (p = 0.69) *ICU/HDU LOS (mean):* 5.0 days (IQR 3.0-10.0) in the intervention group (HDU), 7.0 days (IQR 4.0-14.0) in the control group (ICU) (p = 0.29)
Fernando et al. (2019)[179]	🟢	*Hospital LOS (median):* 5.0 days in the intervention group (SDU), 9.0 days in the control group (ICU) (p < 0.001)
Galdeano Lozano et al. (2022)[180]	⚫	*Hospital LOS (mean):* 7.2 days (no statistical comparison)
Gershengorn et al. (2020)[181]	🔵	*Hospital LOS (median):* 12 days (IQR 7-20) in the intervention period, 11 days (IQR 7-20) in the control period (p = 0.65)
Harlan et al. (2024)[183]	⚫	*LOS, not further specified (mean):* 10.4 days (SD 9.2) in rural ICMU group, 13.5 days (SD 15.0) in urban IMCU group, 9.6 days (SD 8.7) in rural ICU group and 11.7 days (SD 11.8) in urban ICU group (no statistical comparison)
Hunsaker et al. (2021)[184]	🔵🟢	*Hospital LOS (mean):* 4.8 days (SD 1.0) in the intervention group (ICU-based surgical SDU), 5.9 days (SD 2.8) in the control group (ICU), 4.4 days (SD 4.3) in the historical control group (p = 0.10) *ICU/IMCU LOS (mean):* 2.7 days (SD 1.0) in the intervention group (ICU-based surgical SDU), 4.1 days (SD 2.0) in the control group (ICU) (p = 0.004)
Labata et al. (2018)[185]	🟢	*Hospital LOS (mean):* 12.7 days (SD 11) in the intervention period, 13.5 days (SD 15) in the control period (p = 0.01) *ICU LOS (mean):* 2.9 days (SD 6) in the intervention period, 4.9 days (SD 11) in the control period (p < 0.001)
Laws et al. (2020)[186]	🟢	*Hospital LOS (median):* 3 (IQR 2-4) in the intervention group (neurologic SDU), 4 (IQR 2-5) in the control group (neurologic ICU) (p = 0.05) *ICU LOS (median):* 0 (IQR 0-0) in the intervention group (neurologic SDU), 1 (IQR 1-2) in the control group (neurologic ICU) (p = 0.001)
Lekwijit et al. (2020)[187]	🔵	*Remaining hospital LOS:* 5.1% in low-severity patients, 7.0% in high-severity patients (NS)

Ludbrook et al. (2023)[188]	🔵	*Hospital LOS (mean): 6.3 days (SD 8.1)* in intervention group (high-acuity postoperative unit), 6.7 days (SD 8.8) in control group (general care unit) (p = 0.710)
Mitra et al. (2020)[189]	🟢	*Hospital LOS (median):* 14.9 days (IQR 8.2-36.5) in the intervention group (after introduction of HAU), 16.7 days (IQR 7.1-36.7) in the control group (medical/surgical ICU in tertiary-care hospital) Sub-distribution hazard ratio (SHR) 1.26, 95%CI 1.14-1.39 (p<0.001) *ICU LOS (median):* 4.6 days (IQR 2.2-8.4) in the intervention group (after introduction of HAU), 4.4 days (IQR 2.0-9.0) in the control group (medical/surgical ICU in tertiary-care hospital) SHR 1.12, 95%CI 1.02-1.23 (p = 0.02)
Ohbe et al. (2021)[190]	🟢	*Hospital LOS (mean):* 33 days in the intervention group (HDU), 40 days in the control group (ICU) (p = 0.001)
Ohbe et al. (2022 a)[191]	🔵🔴	*Hospital LOS (mean):* 16 days (SD 15) in the intervention group (HDU), 17 days (SD 15) in the control group (ICU) (p = 0.074) *ICU/HDU LOS (mean):* 4 days (SD 4) in the intervention group (HDU), 3 days (SD 4) in the control group (ICU) (p < 0.001)
Ohbe et al. (2022 b)[192]	🔵	*Hospital LOS (mean):* 26 days (SD 23) in the intervention group (HDU), 29 days (SD 25) in the control group (ICU) (p = 0.087) *ICU/HDU LOS (mean):* 15 days (SD 10) in the intervention group (HDU), 16 days (SD 13) in the control group (ICU) (p = 0.330)
Ohbe et al. (2023)[193]	⚫	*Hospital LOS (mean):* 18 days in the intervention group (HDU), 22 days in the control group (ICU) (no statistical comparison)
Schwartz et al. (2022)[195]	🟢	*Hospital LOS (median):* 6 days in the intervention group (IMCU), 8 days in the control group (ICU) (p < 0.01) *ICU LOS (median):* 0 days in the intervention group (IMCU), 1 day in the control group (ICU) (p < 0.01)
Solberg et al. (2014)[196]	🔵	*ICU LOS (mean):* 7.7 days (SD 12.4) in the intervention period and 7.5 days (SD 14.5) in the control period (p = 0.74) *IMCU LOS (mean):* 3.4 days (SD 4.5)
Sykora et al. (2020)[197]	🔴	*Hospital LOS:* 50.3 hours for medical-surgical patients, 108.3 hours for patients who need a higher level of care, 70.7 hours for IMCU patients (p < 0.001)
Umegaki et al. (2024)[199]	🔵🟢	*Hospital LOS (mean):* 22.0 days (SD 21.3) in the intervention group (high care unit), 23.1 days (SD 23.8) in control group (ICU 1) and 22.3 days (SD 21.9) in control group (ICU 2) (p = 0.12) *ICU/IMCU LOS (mean):* 4.3 days (SD 3.9) in the intervention group (high care unit), 4.5 days (SD 3.5) in control group (ICU 1) and 4.2 days (SD 3.4) in control group (ICU 2) (p = 0.05)
Yang et al. (2020)[201]	🟢	*Hospital LOS (median):* 5 days (IQR 5-7) in the intervention group (specialty SDU) and 6 days (IQR 5-8) in the control group (non-specialty ICU) (p < 0.001). *Adjusting for oral cavity vs. other type of diagnosis:* Mean difference score (Mdiff)= -1.48, 95%CI -2.41 to -0.55 (p = 0.002)

🟢 *Reduction of LOS,* 🔵 *No significant effect on LOS,* 🔴 *Increase of LOS,* ⚫ *No statistical comparison*

10.3.4 Hospital readmission rate

The impact of the introduction of an IMCU on the hospital readmission rate was evaluated in six studies.[176, 185, 187, 188, 195, 201] After analysis, Labata et al.[185], Lekwijit et al.[187], Ludbrook et al.[188], Schwartz et al.[195] and Yang et al.[201] did not find any statistically significant effect of an IMCU on the hospital readmission rate for postoperative cardiac surgery patients, adult patients, patients undergoing elective or unplanned noncardiac surgery, low-risk patients with peritoneal cancer who underwent cytoreductive surgery with hyperthermic intraperitoneal chemotherapy, and patients undergoing free flap reconstruction of the head and neck, respectively. Similarly, Chartrain et al.[176] did not observe a statistically significant effect on the adjusted 90-day hospital readmission rate (odds ratio [OR] 1.96, 95%CI 0.48-8.01, p=0.348) for low-risk patients with aneurysmal subarachnoid haemorrhage. Detailed results with exact effect sizes and significance levels are provided in Table 62.

Table 62 – Impact of IMCU on hospital readmission rate

Author (year)	Impact	Detailed results
Chartrain et al. (2017)[176]	🔵	*90-day hospital readmission:* 8.0% in the intervention group (after introduction of SDU transfer protocol), 4% in control group (before introduction of SDU transfer protocol) (p = 0.347) *Adjusted 90-day hospital readmission:* OR 1.96 (95%CI 0.48-8.01, p = 0.348)
Labata et al. (2018)[185]	🔵	*30-day hospital readmission:* 4.3% in the intervention period, 4.2% in the control period (p = 0.89)
Lekwijit et al. (2020)[187]	🔵	*2-week hospital readmission:* 10.9% in low-severity patients, 16.0% in high-severity patients (NS) *30-day hospital readmission:* 17.1% in low-severity patients, 25.9% in high-severity patients (NS)
Ludbrook et al. (2023)[188]	🔵	*30-day hospital readmission:* 9.0% in intervention group (high-acuity postoperative unit), 12.0% in control group (general care unit) (p = 0.270) *90 day hospital readmission:* 21.0% in intervention group (high-acuity postoperative unit), 22.0% in control group (general care unit) (p = 0.850)
Schwartz et al. (2022)[195]	🔵	*30-day hospital readmission:* 18.8% in the intervention group (IMCU), 22.5% in the control group (ICU) (p = 0.74)
Yang et al. (2020)[201]	🔵	*30-day hospital readmission:* 12.0% in the intervention group (specialty SDU), 14.9% in the control group (non-specialty ICU) (p = 0.49)

🟢 *Reduction in 30-day hospital readmission rate,* 🔵 *No significant effect on 30-day hospital readmission rate,* 🔴 *Increase in 30-day hospital readmission rate,* ⚫ *No statistical comparison*

10.3.5 ICU (re)admission during IMCU stay

This review identified ten studies that included ICU readmissions as one of their study outcomes.[176, 177, 185-188, 191, 194, 196, 200] However, only one of these studies reported a statistically significant reduction in ICU readmissions for patients suffering from acute respiratory failure, acute exacerbation of COPD, or community-acquired pneumonia who were admitted to a respiratory IMCU.[177] Patients admitted to this respiratory IMCU exhibited a lower likelihood of being readmitted to the ICU compared to those admitted to an internal medicine unit (6% vs. 12%, p = 0.001).

Furthermore, three studies reported a non-significant decrease in ICU readmissions for IMCU patients[187, 196, 200], one study observed an non-significant increase in ICU readmissions[186], and one study observed the same prevalence of ICU readmissions for both the intervention and control groups.[185] Ludbrook et al.[188] found a higher rate of ICU readmissions during the high-acuity postoperative unit for patients undergoing elective or unplanned noncardiac surgery compared to the those hospitalised in a general unit (4.3% versus 2.9%). However, this difference was not significant (p = 0.420). Lastly, three studies reported ICU readmission rates but have not performed any statistical comparisons with patients admitted to other units.[176, 191, 194]

Table 63 – Impact of IMCU on ICU (re)admission during IMCU stay

Author (year)	Impact	Detailed results
Chartrain et al. (2017)[176]	⚫	*ICU readmission:* 29.8% (9 patients readmitted for suspected symptomatic vasospasm, 5 readmitted for routine postoperative monitoring following a subsequent procedure (no statistical comparison)
Confalonieri et al. (2015)[177]	🟢	*ICU readmission:* 6% in the intervention group (respiratory IMCU), 12% in the control group (internal medicine unit) (p = 0.0001)
Labata et al. (2018)[185]	🔵	*ICU readmission:* 2.2% in the intervention period, 2.2% in the control period (p = 0.93)
Laws et al. (2020)[186]	🔵	*Neurologic ICU readmission:* 7% in the intervention group (neurologic SDU), 2% in the control group (neurologic ICU) (p = 0.17)
Lekwijit et al. (2020)[187]	🔵	*ICU readmission within 2 days:* 3.8% in low-severity patients, 4.5% in high-severity patients (NS) *ICU readmission in 5 days:* 6.2% in low-severity patients, 7.1% in high-severity patients (NS)
Ludbrook et al. (2023)[188]	🔵	*ICU admission:* 4.3% in intervention group (high-acuity postoperative unit), 2.9% in control group (general care unit) (p = 0.420)
Ohbe et al. (2022 a)[191]	⚫	*ICU readmission:* 7% transferred after the second day of invasive mechanical ventilation (no statistical comparison)
Plate et al. (2018)[194]	⚫	*ICU readmission:* 6.2% at the neuro-surgical IMCU, 5.1% at the mixed surgical IMCU (no statistical comparison)
Solberg et al. (2014)[196]	🔵	*ICU readmission from general ward:* 4.6% in the intervention period, 5.2% in the control period (p = 0.56) *ICU readmission <48h:* 0.6% in the intervention period, 1.2% in the control period (p = 0.27)
Vester-Andersen et al. (2015)[200]	🔵	*ICU readmission:* 9.0% in the intervention group (IMCU) and 16.2% in the control group (surgical unit) (p = 0.068)

🟢 Reduction in ICU (re)admissions during IMCU stay, 🔵 No significant effect on ICU (re)admission during IMCU stay, 🔴 Increase in ICU (re)admission during IMCU stay, ⚫ No statistical comparison

10.3.6 Costs

Seven publications identified during this systematic review of the literature focused on the impact on costs following the introduction of an IMCU, of which the majority reported a cost-saving effect.[184, 190-195]

In particular, Hunsaker et al.[184] and Plate et al.[194] investigated the introduction of surgical IMCUs for patients undergoing transsphenoidal microsurgical resection of sellar lesions or trauma patients, respectively. Hunsaker et al.[184] reported an overall cost reduction of 12.5% for patients admitted to an IMCU compared to those admitted to an ICU. Although facility utilisation showed a modest decrease of 8.9% (p = 0.02) for IMCU patients, it represented a notable cost reduction. Furthermore, apart from imaging costs, other subtotals were also significantly lower for IMCU patients. Plate et al.[194] estimated a total cost saving of US$ 1 772 785 over four years due to the presence of IMCU for trauma patients (no statistical comparison), equalling US$ 393 952 per year. This trend was also observed in recent studies that focused on IMCU for invasive mechanically ventilated patients with COVID-19 or pneumonia, patients with AMI, and those undergoing cytoreductive surgery with hyperthermic intraperitoneal chemotherapy for peritoneal cancer.[190-193, 195] In the latter population, the cost reduction was mainly attributable to lower indirect fixed costs (median difference: US$ 5 330, p < 0.01), rather than direct variable costs (median difference: 3 315, p = 0.13).[195]

Table 64 – Impact of IMCU on costs

Author (year)	Impact	Detailed results
Hunsaker et al. (2021)[184]		*Cost-reduction for SDU patients compared with control group:* imaging 78.4% (p = 0.20), supplies and implants 52.2 (p = 0.05), pharmacy 12.9% (p = 0.03), laboratory 23.3% (p < 0.001), other services 18.7% (p = 0.04), facility utilisation 8.9% (p = 0.02), total cost 12.5% (p = 0.01)
Ohbe et al. (2021)[190]		*Total hospital costs:* 14 319 USD in the intervention group (HDU), 16 028 USD in the control group (ICU) (p < 0.001)
Ohbe et al. (2022 a)[191]		*Total hospitalisation costs:* 5 290 000 yen in the intervention group (HDU), 7 290 000 yen in the control group (ICU) (p < 0.001)
Ohbe et al. (2022 b)[192]		*Hospitalisation costs (mean):* 20 056 US$ (SD 21 958) in the intervention group (HDU), 20 786 US$ (SD 12 376) in the control group (ICU) (p < 0.016)
Ohbe et al. (2023)[193]		*Total hospitalisation costs (mean, in million yen):* 1.81 (SD 1.87) in the intervention group (HDU), 2.45 (SD 2.47) in the control group (ICU) (p < 0.001) *SOFA score 2-4:* 1.66 (SD 1.55) in the intervention group (HDU), 2.36 (SD 2.60) in the control group (ICU) (p < 0.001) *SOFA score 5:* 1.79 (SD 1.57) in the intervention group (HDU), 2.42 (SD 2.35) in the control group (ICU) (p < 0.001) *SOFA score 6:* 1.81 (SD 1.74) in the intervention group (HDU), 2.38 (SD 2.00) in the control group (ICU) (p < 0.001) *SOFA score 7:* 1.76 (SD 1.67) in the intervention group (HDU), 2.46 (SD 2.58) in the control group (ICU) (p < 0.001) *SOFA score 8:* 1.93 (SD 1.90) in the intervention group (HDU), 2.40 (SD 2.82) in the control group (ICU) (p < 0.001) *SOFA score 9:* 1.86 (SD 1.85) in the intervention group (HDU), 2.53 (SD 2.59) in the control group (ICU) (p < 0.001) *SOFA score 10:* 1.86 (SD 1.88) in the intervention group (HDU), 2.41 (SD 2.21) in the control group (ICU) (p < 0.001) *SOFA score 11:* 1.93 (SD 1.80) in the intervention group (HDU), 2.53 (SD 2.27) in the control group (ICU) (p < 0.001) *SOFA score 12-14:* 1.88 (SD 2.20) in the intervention group (HDU), 2.59 (SD 2.40) in the control group (ICU) (p < 0.001) *SOFA score 15-24:* 1.72 (SD 2.46) in the intervention group (HDU), 2.47 (SD 2.59) in the control group (ICU) (p < 0.001)
Plate et al. (2018)[194]		*Total estimated costs:* US$ 2 659 177 in the intervention group (IMCU), US$ 7 464 417 in the control group (ICU), total costs US$ 10 123 594 If all trauma patients who were admitted to either one of the IMCUs would have been admitted to the ICU (in the hypothetical scenario that the hospital would not have had IMCU): total expenditure of US$ 11 896 378 (IMCU has thus potentially led to cost savings of US$ 1 772 785 in the total period, that is, US$ 393 952 per year)
Schwartz et al. (2022)[195]		*Total costs, median:* $30 845 (IQR $30 181 - $37 725) in the intervention group (IMCU) and $41 477 (IQR $33 303 - $51838, p < 0.01) in the control group (ICU) Primarily driven by a reduction in the median indirect fixed costs: $14 314 (IQR $12 206 - $18 266) vs. $8 984 (IQR $8 643 - $11 286, p < 0.01) rather than the direct variable cost: $20 943 (IQR $17 086 - $25 843) vs. $17 628 (IQR $17 145 - $21 071, p = 0.13) *Controlling for LOS and complications:* reduction of $2 208.68 per patient (95%CI $371.88 - $4 045.48, p = 0.02)

Reduction in costs, No significant effect on costs, Increase in costs, No statistical comparison

10.3.7 Adverse events

Seven of the identified studies evaluated the impact of the introduction of an IMCU on various adverse events.[176, 184, 185, 188, 190, 200, 201] The identified studies included patients with diverse medical conditions, including those with low-risk aneurysmal subarachnoid haemorrhage, patients undergoing transsphenoidal microsurgical resection of sellar lesions, postoperative cardiac surgery patients, for patients undergoing elective or unplanned noncardiac surgery, mechanically ventilated patients with pneumonia, high-risk patients undergoing emergency abdominal surgery[200] and patient undergoing head and neck free flap reconstruction. However, Ludbrook et al.[188] found a significant decrease in the incidence of medical emergency response complications in the days following the noncardiac surgery with 3.7% for patients admitted to the high-acuity postoperative unit (95% CI -7.3 to -0.3, p = 0.030). A detailed overview of the findings per adverse outcome for each publication is available in Table 65.

Table 65 – Impact of IMCU on adverse events

Author (year)	Impact	Detailed results
Chartrain et al. (2017)[176]		*Requiring vasospasm intra-arterial therapy:* 23.6% in the intervention group (after introduction of SDU transfer protocol), 18.5% in the control group (before introduction of SDU transfer protocol) (p = 0.300) *Hydrocephalus with external ventricular drain:* 61.1% in the intervention group (after introduction of SDU transfer protocol), 53.8% in the control group (before introduction of SDU transfer protocol) (p = 0.246) *Hydrocephalus with ventriculoperitoneal shunt:* 20.8% in the intervention group (after introduction of SDU transfer protocol), 12.3% in the control group (before introduction of SDU transfer protocol) (p = 0.135) *Acute respiratory failure:* 51.4% in the intervention group (after introduction of SDU transfer protocol), 50.8% in the control group (before introduction of SDU transfer protocol) (p = 0.539) *Tracheostomy required:* 12.5% in the intervention group (after introduction of SDU transfer protocol), 13.8% in the control group (before introduction of SDU transfer protocol) (p = 0.507) *Pulmonary oedema:* 6.9% in the intervention group (after introduction of SDU transfer protocol), 4.6% in the control group (before introduction of SDU transfer protocol) (p = 0.418) *Pulmonary embolism:* 1.4% in the intervention group (after introduction of SDU transfer protocol), 0.0% in the control group (before introduction of SDU transfer protocol) (p = 0.526) *Deep venous thrombosis:* 11.1% in the intervention group (after introduction of SDU transfer protocol), 6.2% in the control group (before introduction of SDU transfer protocol) (p = 0.237) *Pneumonia:* 11.1% in the intervention group (after introduction of SDU transfer protocol), 13.8% in the control group (before introduction of SDU transfer protocol) (p = 0.410) *Stress-induced cardiomyopathy:* 5.6% in the intervention group (after introduction of SDU transfer protocol), 4.6% in the control group (before introduction of SDU transfer protocol) (p = 0.557) *Ventriculitis:* 8.3% in the intervention group (after introduction of SDU transfer protocol), 7.7% in the control group (before introduction of SDU transfer protocol) (p = 0.572)
Hunsaker et al. (2021)[184]		*Intraoperative cerebrospinal fluid leak:* 40.7% in the intervention group (ICU-based surgical SDU), 48.1% in the control group (p = 0.60)

		Intraoperative fat harvest: 70.4% in the intervention group (ICU-based surgical SDU), 70.4% in the control group (ICU) (p = 1.00) *Intraoperative fascia harvest:* 25.9% in the intervention group (ICU-based surgical SDU), 37.0% in the control group (ICU) (p = 0.38) *Intraoperative lumbar puncture:* 29.6% in the intervention group (ICU-based surgical SDU), 48.1% in the control group (ICU) (p = 0.06) *Intraoperative alcohol:* 7.4% in the intervention group (ICU-based surgical SDU), 14.8% in the control group (ICU) (p = 0.40) *Postoperative visual deficits:* 33.3% in the intervention group (ICU-based surgical SDU), 37.0% in the control group (ICU) (p = 0.80) *Postoperative endocrine abnormalities:* 3.7% in the intervention group (ICU-based surgical SDU), 11.1% in the control group (ICU) (p = 0.30) *Transient diabetes insipidus:* 44.4% in the intervention group (ICU-based surgical SDU), 29.6% in the control group (ICU) (p = 0.26) *Postoperative complications:* 0.0% in the intervention group (ICU-based surgical SDU), 3.7% in the control group (ICU), 2.7% in historical control group (p = 0.70)
Labata et al. (2018)[185]	🔵	*Bleeding:* 2.9% in the intervention period, 3.4% in the control period (p = 0.59) *Dehiscence:* 1.4% in the intervention period, 1.2% in the control period (p = 0.72) *Per-intervention AMI:* 2.1% in the intervention period, 1.2% in the control period (p = 0.17) *Tamponade:* 1.4% in the intervention period, 0.9% in the control period (p = 0.25) *Atrioventricular block:* 4.3% in the intervention period, 3.4% in the control period (p = 0.40) *Atrial fibrillation:* 24.6% in the intervention period, 23.1% in the control period (p = 0.98) *Renal failure:* 17.0% in the intervention period, 21.4% in the control period (p = 0.09) *Intestinal ischaemia:* 0.9% in the intervention period, 0.9% in the control period (p = 0.95) *Stroke:* 1.8% in the intervention period, 2.2% in the control period (p = 0.35)
Ludbrook et al. (2023)[188]	🔵🟢	*Medical emergency response complications (first 3-24 hours postoperatively):* Mdiff 8.6% higher in intervention group high-acuity postoperative unit) compared to control group (general care unit) (95% CI 4.2 to 13.0, p = 0.080) *Medical emergency response complications (first day 2 to day 9 postoperatively):* Mdiff -3.7% lower in intervention group high-acuity postoperative unit) compared to control group (general care unit) (95% CI -7.3 to -0.3, p = 0.030)
Ohbe et al. (2021)[190]	🔵	*Acute respiratory distress syndrome:* 1.0% in the intervention group (HDU), 1.1% in the control group (ICU) (p = 0.580) *Catheter-related bloodstream infection:* 0.2% in the intervention group (HDU), 0.2% in the control group (ICU) (p = 0.700)
Vester-Andersen et al. (2015)[200]	🔵	*Postoperative complications:* 50.7% in the intervention group (IMCU), 43.7% in the control group (surgical unit) (p = 0.234)
Yang et al. (2020)[201]	🔵	*Postoperative complications:* 41.8% in the intervention group (specialty SDU), 45.9% in the control group (non-speciality ICU) (p = 0.51)

🟢 *Reduction in adverse events,* 🔵 *No significant effect on adverse events,* 🔴 *Increase in adverse events,* ⚫ *No statistical comparison*

10.4 Conclusion

The purpose of this systematic literature review was to provide a comprehensive overview of the impact of IMCUs on various outcomes of patient and hospital utilisation: mortality, LOS, hospital readmission in 30 days, ICU readmission during IMCU stay, costs, and adverse events. In addition, the review aimed to identify common features of different IMCU formats and provide an overview of the IMCU landscape. Previous literature has suggested that the results of IMCUs in terms of effectiveness, costs, and patient outcomes are inconclusive.[3, 4, 165-169] However, there has been no recent systematic general review of the literature on the effectiveness of IMCUs that is not specifically limited to a particular patient population or type of unit.

We reviewed a total of 28 publications, which exhibited varying degrees of methodological quality increasing the risk of bias. Among the included studies, ten were considered 'good', eight were rated as 'fair', and nine were rated as 'low'. These studies showed significant heterogeneity in terms of the patient populations targeted, admission criteria, the nomenclature used, the organisation of IMCUs, the study designs employed, and the settings in which they were conducted. Furthermore, a substantial number of studies in our sample utilised pre-post designs, which raises the possibility of changes in unit structures and functioning over time, potentially confounding the interpretation of outcomes. Additionally, several studies had small sample sizes or limited populations. Due to this significant heterogeneity and the lack of standardised definitions, it is challenging to compare and generalise the findings and draw clear conclusions. To enhance the validity and reliability of future studies, we recommend increased standardisation and the utilisation of peer-reviewed definitions and criteria in the design process. This would lower confounding factors and facilitate better comparisons/interpretations at all levels of analysis. Furthermore, additional research is needed to better understand the effectiveness of IMCUs and identify the factors that contribute to their success or failure.

Similarly to previously published research[3, 4, 165-169], the present review also yielded inconclusive results regarding the outcomes of mortality and LOS. Specifically, we have identified 24 publications that examined the impact of the introduction of an IMCU on mortality.[175-183, 185, 187-196, 198, 200, 202] Among these, four studies reported a decrease in mortality[175, 177, 189, 198], while 14 publications reported insignificant results[176, 179, 181, 182, 185, 187, 188, 192, 193, 195, 196, 198, 200, 202] and seven publications even observed a negative effect after the introduction of an IMCU.[178, 183, 190, 191, 193, 196] However, it is worth noting that a multinational cohort study conducted by Capuzzo et al.[175] in 17 European countries demonstrated a significant decrease in in-hospital mortality in favour of IMCU (adjusting for patient characteristics at admission such as illness severity, ICU and hospital characteristics) but at the same time they observed a significant increase in hospital and ICU LOS. Furthermore, the majority of the included publications did not find an statistically significant impact of the implementation of IMCU on hospital readmission rates and adverse events.[176, 184, 185, 187, 195, 200, 201 188, 190] These inconsistent and non-significant results may be due to differences in patient characteristics, types of intervention, units in comparison (ICU versus IMCU, IMCU versus general unit or rural versus urban ICU and IMCU units) confounding factors, and conditions under which the studies were conducted.

IMCUs have generally higher patient-to-nurse ratios and more specialised equipment compared to general units, but still less compared to the ICU. This is makes it a potentially more cost-effective choice for patients not needing ICU facilities.[164] Literature dating back from before 2013 reveals a lack of consistency regarding the impact of implementing IMCU on costs. There are several reasons attributed to this lack of consistency. Firstly, the creation of additional IMCU beds may result in a previously non-existent demand for beds, leading to increased costs.[4] Additionally, IMCU patients, being generally lower-risk compared to ICU patients, consume a relatively lower proportion of ICU costs if they were admitted to ICU instead.[4] Moreover, since IMCU is more expensive than general care, the introduction of IMCU could inflate total hospital costs, especially if some patients would have been managed on a general unit in the absence of an IMCU. However, the findings of this systematic literature review suggest that the impact on costs is more straightforward compared to the other outcomes examined.[184, 190-195] The majority of the publications found a cost saving effect after the introduction of an IMCU for patients undergoing transsphenoidal microsurgical resection of sellar

lesions, trauma patients, COVID-19 or pneumonia patients requiring invasive mechanical ventilation, septic shock patients, AMI patients, and patients with peritoneal cancer undergoing cytoreductive surgery with hyperthermic intraperitoneal chemotherapy.[184, 191, 192, 195] Despite the introduction of IMCU leading to lower costs, it is important to highlight that this can be associated with certain unfavourable effects. For instance, Ohbe et al.[191] observed a significant decrease in hospitalisation costs between COVID-19 patients requiring invasive mechanical ventilation admitted to IMCU and ICU. However, there were higher in-hospital mortality rates and longer LOS in the IMCU for patients at the IMCU.[191]

These results suggest that IMCU care may be beneficial for certain patient groups, health conditions or therapies, but may not be suitable for others. This should be taken into account when reorganising the ICU landscape. For instance, a recent retrospective cohort study revealed that septic shock patients in the ICU group had significantly lower in-hospital mortality compared to those receiving IMCU care when their SOFA scores of greater than or equal to 12.[193] There were no significant differences in in-hospital mortality among patients with SOFA scores between 5-11. This may indicate that IMCU care may not be inferior to those in the ICU for patients with SOFA scores of 6-11. Given that total hospitalisation costs were lower in the IMCU group than in the ICU group, assigning patients with SOFA scores of 6-11 to IMCUs could represent a cost-effective alternative.

Moreover, the included publications lack sufficient detail on IMCU characteristics and organisational features to allow a full analysis of the organisation of different IMCU formats or to provide an overview of the IMCU landscape. The only commonly reported characteristic in the literature is the patient-to-nurse ratio (18 out of 23 publications, ranging from 1.5:1 to 5:1). The majority of the IMCUs in our selection report a patient-to-nurse ratio of either 4:1 or 2:1. According to the classification proposed by the World Federation of Societies of Intensive and Critical Care Medicine, these ratios correspond to a level I ICU and level III ICU, respectively.[203] A systematic literature review conducted by Plate et al.[3] provides a comprehensive description of IMCUs based on publications between 1983 and 2016. According to this review, the average patient-to-nurse ratio in IMCUs is 2.5:1, and the median number of beds is six. Common IMCU denominators are continuous haemodynamic monitoring and respiratory support, without mechanical ventilation and multiple vasoactive medications.[3]

11 DISCUSSION

The organisation and financing of intensive care units (ICUs) in Belgium play a critical role in ensuring the resilience, efficiency, access and quality of the healthcare system. The COVID-19 pandemic underscored the central importance of ICU capacity, workforce availability, and flexible resource management, revealing both strengths and vulnerabilities in critical care provision.

To comprehensively assess the current organisation and financing of ICUs in Belgium and to identify opportunities for improvement, a mixed-methods approach was adopted. This methodological framework combined quantitative and qualitative research techniques, allowing for a multidimensional analysis that integrates empirical evidence, insights from the literature, international experience and expert insights.

The current discussion aims to synthesise the key findings of this report, critically assess the challenges facing ICU organisation and financing in Belgium, and reflect on their implications in both routine and crisis care delivery.

11.1 A landscape with a high density of hospitals and intensive care units

A FRAGMENTED HOSPITAL AND ICU LANDSCAPE

The fragmented structure of the Belgian hospital system with a large number of hospitals, many of which are relatively small, contributes to the widespread distribution and high number of ICUs. Nearly all hospitals (98 out of 99 hospitals with acute care beds in 2022) operate at least one intensive care service, distributed over 120 hospital sites, with general intensive care units (ICUs) present in 119 of them. A subset of hospitals provide neonatal intensive care units (19 sites), paediatric intensive care units (9 sites) and burn care units (5 sites). While the report presents findings on general intensive care units, paediatric intensive care units and burn care units (with neonatal intensive care units being out of scope), the remainder of the discussion focuses on general intensive care units.

A majority of 90 hospital sites operate a single general ICU, while 29 sites have two or more. Sites with the highest number of units (up to seven) are typically part of university hospitals or general hospitals with a large number of licensed acute beds (450+). The size of these units, in terms of licensed beds, varies considerably across hospital sites. In December 2022, a majority (60.5%) of ICUs had no more than 12 licensed beds. Two sites fall below the legal minimum of six beds.

The distribution of general intensive care services across the country is uneven and does not fully align with population density. Hospitals with a single site, fewer than 200 licensed C/D/G/E beds, and only one intensive care unit are predominantly located in less densely populated regions. Other small hospitals with a small ICU (in general 6-10 beds) tend to be more concentrated in Brussels. In contrast, larger ICU services are generally found in hospitals with more than 450 licensed beds or in university hospitals, generally located in urban centres.

VARIATION IN INTENSIVE CARE ACTIVITY ACROSS BELGIAN HOSPITAL SITES

In 2022, there were 109 256 stays in general intensive care, with the majority occurring in older age groups and admissions being more frequent among men. Patients aged 60-79 account for just over half of all admissions, and among this group, admissions of male patients were more than 50% higher than those of female patients, largely due to a higher number of admissions related to cardiac surgery and respiratory conditions.

The number of intensive care stays per hospital site varied widely, ranging from 124 to 4 504 stays. Around 40% of sites (47 out of 119) recorded fewer than 500 stays in general intensive care units. Hospital sites in Wallonia reported fewer general intensive care stays compared to those in Brussels and Flanders, as reflected in notably lower median and quartile values.

In Flanders, hospital sites with fewer than 1 500 stays in general intensive care units exclusively have mixed units. In contrast, one single-unit site in Brussels and six in Wallonia, each with fewer than

500 stays, are designated as medical units, indicating that fewer than 25% of admissions involve surgical cases.

Lower levels of care intensity are found in hospitals with a single site and a single intensive care unit, as well as in hospitals and hospital sites with a smaller number of beds. In contrast, units predominantly providing high-technical care are concentrated in primary sites of university hospitals and larger hospital sites.

VARIATION IN ICU BED OCCUPANCY

Also occupancy rates vary by hospital size. Smaller hospital sites tend to have lower average occupancy in intensive care and greater variability in bed use compared to larger sites. Higher volatility in occupancy may be a source of inefficient use of resources. In 2022, mean bed occupancy equalled 66%, with higher levels in university hospitals (74%) and larger sites (69%), while sites with fewer than 200 beds averaged 61%. In about 59% of sites, occupancy rates reached 100% at least once, and in 71% of sites minimum occupancy rates dropped below 30%. Smaller hospital sites experience more extreme occupancy rates and greater variability, with many operating above licensed capacity at times and others running well below capacity for extended periods. Larger-sized and university sites display more stable occupancy patterns, with less variability and more consistent bed use.

HIGH ICU BED DENSITY IN AN INTERNATIONAL CONTEXT

Of the 2 487 licensed ICU beds in 2022, the majority (1 978 beds) are designated for general intensive care, while the remaining beds are assigned to specialised units such as neonatal (380 beds), paediatric (85 beds) and burn care (44 beds). Belgium counts 17.1 general intensive care beds per 100 000 population, which is relatively high compared to other countries, such as Sweden (4.92 adult ICU beds per 100 000 population), the Netherlands (5.74) or England (7.01). Nevertheless, some neighbouring countries, such as France (21.17) and Germany (28.10) have a larger ICU capacity.

However, Belgium's relatively high ICU bed count must be interpreted in light of the absence of a formal intermediate care system (see section 11.2). In the current setup, many patients who could typically be managed in intermediate care units in other healthcare systems, such as those requiring post-operative monitoring or those in recovery phases no longer needing intensive treatment, are instead treated in ICUs. Consequently, a proportion of ICU beds are used for intermediate-level care.

ROLE OF SMALL INTENSIVE CARE UNITS

Given that ICUs are indispensable for supporting critical hospital functions, such as emergency care, surgical recovery, and management of severe medical complications, it is a logical consequence that hospital sites with such services also have ICU capacity. ICUs are viewed as a local safety net and essential infrastructure, and their absence is often perceived as a threat to a hospital's ability to stabilise patients and maintain core acute care services.

However, the role and sustainability of small-sized ICUs in Belgium emerge as a contested issue among stakeholders. With most of these ICUs consisting of 6 to 12 beds, their proliferation has led to a fragmented distribution of ICU capacity (beds, equipment, staff, etc.) across the country. While these units ensure local access to critical care, many respondents questioned whether they are adequately equipped to provide high-quality, specialised care for critically ill patients.

Smaller ICUs were perceived by many stakeholders as functioning more like Post Anaesthesia Care Units (PACUs) rather than full-fledged ICUs, raising concerns about their ability to maintain the expertise, infrastructure, and medical readiness required for managing complex cases. The nursing activity analysis (see Chapter 4) demonstrated that hospitals with a single site and ICU, as well as those with fewer beds, tend to deliver lower-intensity care, whereas high-intensity, technologically advanced care is concentrated in primary sites of university hospitals and larger hospital facilities

Smaller ICUs demand proportionally greater medical and nursing resources, such as 24/7 on-call coverage, without necessarily having the patient volume to justify or sustain these inputs, potentially leading to inefficiencies in resource use.

THE ICU FUNCTION EXTENDS BEYOND A PHYSICAL HOSPITAL AREA

In Belgium, intensive care is a licensed 'function', which means that it goes beyond the boundaries of individual hospital units. However, this study focuses on intensive care at the unit level when examining aspects such as bed capacity, activity levels, and other unit-specific characteristics. Adding information on the involvement of ICU staff outside the unit, such as in resuscitations or early warning systems, is challenging due to the variability and informal nature of these roles across different hospitals. Unlike the clearly defined geographical ICU area, these activities often occur in various settings and are not consistently documented, making systematic data collection and analysis difficult.

11.2 Intermediate care units

The findings regarding lower care intensity in small ICUs raise important questions about the potential role of intermediate care units (IMCUs) in the Belgian hospital landscape. The evolving healthcare landscape in Belgium and abroad has seen a growing interest in IMCUs as a bridge between general hospital units and intensive care units. IMCUs are intended to serve patients who require more complex care and monitoring than is typically provided on general hospital units but do not (or no longer) meet the full criteria for ICU admission such as mechanical ventilation or continuous organ support. This dual role, as both a step-down and step-up facility, positions IMCUs as a potentially critical element in hospital resource optimisation and patient flow management.

IMCUs are broadly implemented across all studied countries, although their legal and organisational status varies. Models range from standalone to co-located units or IMCU beds integrated within ICUs. The clinical leadership is, depending on the national context provided by various types of specialists: the ICU physician, organ specific specialities, anaesthesiologists, etc. The regulation of nurse staffing and qualifications for IMCUs remains underdeveloped in several systems. Some countries are further advanced, with recommended ratios (e.g. Germany) or specific training programmes in place (e.g. the Netherlands), providing a blueprint for others.

LOCAL FLEXIBILITY VERSUS STANDARDISATION OF IMCUs

Although intermediate care units are neither formally licensed nor separately financed in Belgium, many hospitals have established and operate such units in practice. The survey identified a total of 91 IMCUs in 52 hospital sites, with 5.2% of IMCUs being stroke units, 24.2% medical and/or surgical step-up or step-down units, 17.6% PACUs and 16.5% are cardiac or coronary care units. With a median of six beds, IMCUs are relatively small-scale. Similarly, based on data analysis of registered nursing activities in care episodes, we were able to identify 31 general care units in 26 hospital sites with a higher-intensity care profile. Of these 31 units, 8 specialised in cardiac care, 4 in post-anaesthesia care (PACUs), 4 in neurological disorders and stroke, and 4 in respiratory conditions. Additionally, 11 mixed units combined cardiac, neurological, and respiratory care, with 5 labelled as step-up or step-down units in the survey.

The organisational structure of IMCUs varies, but the majority are embedded within general hospital units, reflecting a strong tendency to integrate intermediate care within the broader hospital infrastructure rather than developing entirely separate entities. They are more often linked to general hospital units than to ICUs or emergency departments. These findings highlight the pragmatic approach hospitals take in structuring intermediate care, likely influenced by resource availability.

IMCUs: A PROMISING BUT INCONCLUSIVE SOLUTION BETWEEN INTENSIVE CARE AND GENERAL HOSPITAL UNIT CARE

Proponents of intermediate care units argue that step-down units can help prevent premature discharges from the ICU to general hospital units, a scenario that risks readmissions and suboptimal patient outcomes. Likewise, step-up admissions from general hospital units to intermediate care units could prevent clinical deterioration and reduce avoidable ICU admissions. In both cases, intermediate care functions as a buffer that helps optimise patient flow and preserves ICU capacity for those who need it most.

IMCUs could also serve as a flexible buffer in times of health crises, allowing for rapid adjustments in care capacity. With appropriate cross-training of staff, these units could support the ICU during periods of high demand, ensuring that staff maintain critical skills and competencies.

Despite their theoretical benefits and increasing implementation in hospital systems globally, the systematic literature review (see Chapter 10) highlighted that the real-world impact of IMCUs on patient outcomes and hospital efficiency remains unclear. The ambiguity in clinical outcomes may stem from inconsistent definitions, patient selection criteria, and differences in IMCU organisational models. In contrast, the findings related to costs reveal a more consistent pattern. Most studies that include cost data suggest that IMCUs can reduce hospital expenditures. These savings were most notable in specific patient populations. However, these savings may sometimes be offset by negative clinical consequences, including increased mortality or longer length of stay in less appropriate patient placements. It is important to note that the literature review includes studies up to January 2025, and this field is still evolving, as demonstrated by the article of Beaussier et al. (2025).[204]

The differential impact of IMCUs across patient groups highlights the importance of appropriate patient selection. Evidence suggests that patients with moderate illness severity, such as those with Sequential Organ Failure Assessment (SOFA) scores between 6 and 11, may benefit from IMCU care without compromising outcomes, while those with higher SOFA scores (≥12) may require the more intensive support available in ICUs. These findings suggest that IMCUs may offer an alternative to ICUs for certain patients, provided that admission criteria are carefully defined and clinically appropriate.

STAFFING LEVELS IN INTERMEDIATE CARE UNITS

In practice, staffing ratios in IMCUs are higher than in a general care unit, but lower than in an ICU. Several countries recommend that the patient-to-nurse ratio in IMCUs should not be higher than 4:1, with some countries recommending more stringent ratios. This ratio corresponds to the median scheduled number of patients per nurse in Belgian IMCUs identified in the survey, for the morning shift of a typical weekday. Evening, night and week-end shifts present larger ratios.

Importantly, the care of intermediate care patients is not inherently less labour-intensive than in the ICU. While ICU nursing frequently involves managing advanced technology and life-support systems, both settings require time-consuming activities such as early mobilisation, monitoring, and communication. Therefore, assuming that intermediate care requires fewer staffing resources is an oversimplification.

Variation in ICU case-mix across hospitals further complicates the matter. In some settings, ICU beds are predominantly occupied by patients with an intermediate care profile, which has implications for ICU nurse expertise and professional development. In smaller hospitals in particular, the dilution of critically ill cases may erode the intensive care skills of the nursing staff, undermining the readiness of ICUs to handle truly critical patients and compromising the intended purpose of ICU-level care. On the other hand, if an IMCU is established, this will also have implications for ICU staffing, as the intensity of care in the ICU is likely to increase.

CHALLENGES FOR THE IMPLEMENTATION OF INTERMEDIATE CARE UNITS

The current legal framework does not hinder hospitals from setting up IMCUs, and many hospitals already run specialised units like cardiac care units (CCUs), which serve comparable functions to IMCUs.

The formal implementation of IMCUs is not without challenges, particularly as it requires dedicated legislation and financing. Key concerns include defining medical responsibility (e.g. ICU physicians versus organ-specific specialists), maintaining continuity of care, and ensuring appropriate staffing models. Additionally, there are concerns about the attractiveness of intermediate care as a work setting, particularly for ICU-trained nurses who may prefer high-acuity, technology-driven environments. Therefore, a uniform national approach risks undermining local flexibility. Instead, hospital-level autonomy to tailor the structure, leadership, and integration of IMCUs to the specific

needs and capacities of each facility is seen as a more sustainable strategy. However, greater flexibility necessitates monitoring the quality of care and making it transparent.

11.3 Levels of intensive care services

DE FACTO APPLICATION OF ICU LEVELS IN BELGIUM

Belgium currently does not have a formalised or legally defined classification system for levels of ICUs, in contrast to several other countries where ICUs are stratified into levels based on the complexity of care provided, availability of specialised personnel, infrastructure, and technological capabilities. Despite this absence of official classification, a form of implicit or de facto stratification appears to exist and to influence the organisation and functioning of critical care across Belgian hospitals.

In practice, certain ICUs clearly operate at a higher level of specialisation and resource intensity than others. For example, university hospitals and large centres typically manage complex cases involving multi-organ failure, advanced life support technologies (e.g. ECMO), and 24/7 availability of intensivists. Meanwhile, smaller hospitals may provide more basic intensive care, with more limited staffing or equipment, and often refer more complex cases to larger centres.

The World Federation of Societies of Intensive and Critical Care Medicine (WFSICCM) proposed a three-level classification system for ICUs (see Chapter 1). When categorising Belgian intensive care services into these three levels based on ICU characteristics reported by the hospital survey respondents, the majority of surveyed hospital sites were classified as level 2 (invasive monitoring and delivering life support for a limited duration), while 15 of the 87 sites met the requirements for level 3. Level 3 ICUs provide the full range of monitoring and life-support technologies, act as regional hubs for managing critical illness, and often contribute to intensive care advancement through research and education. A level 1 ICU is capable of providing oxygen, non-invasive monitoring, and more intensive nursing care than on a general hospital unit; 19 hospital sites fulfilled the criteria of level 1. Although the results should be interpreted with caution because not all criteria to define a level were explored in the hospital survey, the self-reported results clearly show a de facto differentiation in levels.

The presence of an implicit system of care levels can also be inferred from the observed differences in staffing ratios, nursing care intensity, patient transfers, etc. Although this system often functions adequately in practice for the majority of cases, it carries inherent risks, such as critically ill patients not being managed by staff with the appropriate expertise, inefficient allocation of resources, delayed transfers for patients needing level 3 care, and issues of under- or overstaffing.

HIGHER LEVELS OF NURSING CARE INTENSITY IN LARGER HOSPITAL SITES

The nursing activity data reveal consistently high levels of basic nursing care across all types of intensive care units. At the same time, there is considerable variation in the intensity of care delivered, both between and within hospital sites. This variation spans several dimensions, including patient volume, technical care intensity, case mix, and unit specialisation.

Lower levels of care intensity, as reflected in lower technical scores and a smaller proportion of intensive NRGs, are typically observed in intensive care units in hospitals with a single site and a single ICU, as well as in hospitals or sites with fewer licensed beds. These units are more frequently classified as mixed or medical ICUs. In contrast, units delivering high-technical care are mainly concentrated in the primary sites of university hospitals and in larger hospital sites with more than 450 licensed C/D/E/G beds. University hospitals and larger-sized hospitals not only demonstrate higher average levels of care intensity but also exhibit greater variability across units. This is likely attributable to the presence of multiple ICUs within these hospitals, reflecting differences in specialisation, available treatment options, and patient case mix. For example, surgical ICUs, which are primarily located in larger and university hospitals, rank among the highest in technical care intensity, proportion of intensive NRGs, and time-competency points, underscoring their important role in managing patients requiring advanced surgical interventions.

All hospital sites manage a mix of patients with varying care needs and comorbidity burdens. However, the relative proportion of high-intensity patients tends to be lower in smaller sites and higher in mid-sized hospitals. The largest hospitals accommodate both highly technical care patients and those requiring high levels of basic care. This pattern reflects the presence of multiple ICUs and specialised units within these hospitals, where distinct patient groups, such as those requiring burn care, paediatric care, advanced surgical procedures, or complex medical management, necessitate different levels of intensive care.

Furthermore, variation in care intensity within hospital sites also highlights the heterogeneity of ICU services. Sites with a more pronounced intensive profile show a smaller gap in care intensity between a top and median intensive patient, indicating a more consistent exposure to high-intensity cases. In contrast, sites with a lower intensive profile exhibit greater variability, which may indicate less exposure to, and experience with, treatment of high-intensity patients.

THE ROLE OF ICU TRANSFERS

The transfer data (from an intensive care service in one hospital site to an intensive care service in another site) provide important insights into the organisation of care across hospitals. The analysis of intensive care transfers in Belgium in 2022 reveals distinct patterns in patient demographics, timing, and clinical drivers. A demographic example is that almost all transfers involving children and adolescents (ages 0–20) were between hospitals, highlighting the limited availability of paediatric ICU capacity at smaller facilities.

Transfers generally occurred early in the ICU stay, with a significant share taking place on the same day (15%) or within the first 24 hours (30%), highlighting early clinical decisions to escalate care. However, late transfers (beyond 14 days) also occurred (5-10%), potentially reflecting evolving care needs or complications, or an incorrect assessment. The shift from medical to surgical APR-DRG classifications post-transfer suggests that inter-hospital transfers were often motivated by the need for specialised surgical interventions (e.g. cardiac surgery, transplants) or complex procedures unavailable at the referring hospital.

In terms of hospital characteristics, inter-hospital transfers primarily originated from smaller hospitals (≤ 300 beds, 58%) and general mixed ICUs (87%), with many patients transferred to larger hospitals (> 450 beds, 22%) and university hospitals (51%). Within-hospital transfers were more concentrated in smaller hospitals and less frequently involved specialised ICU units. Geographically, ICU transfers often flowed from hospitals in less densely populated areas and smaller cities toward university hospitals and larger facilities in urban centres. Findings from the hospital survey indicate that the main reason for inter-hospital patient referrals is the lack of appropriate medical expertise in the referring institution.

These findings underscore the role of ICU transfers in facilitating access to advanced care and the implicit triaging mechanisms within the health system. They also point to the importance of timely referral and the centralisation of high-complexity treatments in specialised centres.

HOSPITAL VOLUME, DIAGNOSTIC COMPLEXITY, AND IN-HOSPITAL MORTALITY

An important insight from analysing inter-hospital variation in in-hospital mortality, used here as a proxy for ICU quality and safety, is the observed volume-outcome relationship specifically among patients with high comorbidity burdens. In this subgroup, hospitals treating larger numbers of complex patients tend to achieve lower in-hospital mortality rates. However, this association disappears when considering all ICU admissions regardless of complexity. This suggests that experience and expertise gained through managing more complex cases, rather than only volume, may be a critical driver of improved outcomes and hence should guide centralisation policies in critical care. Such planning should also account for the physical and operational integration of critical services, such as advanced imaging, interventional radiology, on-site surgical teams (e.g. neurosurgery).

Notably, the volume-outcome relationship varies by diagnosis. For example, conditions affecting the circulatory, respiratory and digestive systems show clear mortality benefits at higher volumes, while other groups such as septicaemia do not. Additionally, the analysis of standardised mortality rates

highlights regional disparities and an elevated mortality risk in university hospitals for certain diagnostic categories, both among all admissions and high comorbidity admissions. This heterogeneity implies that policy responses should be tailored to specific diagnostic groups rather than applying a universal approach.

Furthermore, hospital performance appears to be systemic: sites with high or low mortality for one condition tend to show similar patterns across other diagnoses. This consistency suggests that broader institutional factors, such as staffing expertise, availability of advanced technology, protocols, and organisational culture, may influence outcomes across multiple clinical areas.

Mortality remains a widely used outcome measure due to its direct relevance to patients and sensitivity to care quality and resource availability. However, interpreting mortality differences across hospital sites requires caution.[205] One of the key weaknesses in evaluating mortality as quality indicator with administrative data lies in the variability and accuracy of coding practices as well as in the absence of ICU-specific physiological data. Another important limitation is the exclusion of out-of-hospital deaths. Mortality in critically ill patients is influenced by many factors. On the one hand, not all differences in case mix are fully accounted for in analyses that lack detailed physiological data, making it difficult to accurately capture a patient's underlying (mortality) risk profile. On the other hand, admission policy and advanced care planning are shaped by clinical judgment, patient and family preferences, organisational capacity and protocol, and ethical considerations. These factors reflect broader institutional, societal and individual values and cannot be fully captured by a statistical model, limiting the ability to isolate the role of care quality in observed mortality variation.

Such policy- and preference-driven variation has important societal implications. It influences not only individual outcomes, such as survival and quality of life, but also the efficiency and fairness in resource use. Striking the right balance between providing qualitative intensive care to those most likely to benefit and avoiding potentially non-beneficial interventions is essential for ensuring sustainable care delivery, minimising unnecessary costs, and preserving access for patients with the greatest need.

Given these issues, mortality-based metrics should be supplemented with broader quality indicators, such as adherence to evidence-based protocols, infection rates, unplanned readmissions, and long-term patient-centred outcomes like functional status.

WIDESPREAD STAKEHOLDER SUPPORT FOR IMPLEMENTING A FORMALISED MULTI-LEVEL ICU SYSTEM IN BELGIUM

The stakeholder interviews revealed a growing consensus on the need to establish a multi-tiered intensive care system in Belgium, distinguishing between general and specialised (high-complexity) ICU levels. This differentiation is primarily motivated by concerns about the quality of care for patients requiring high-intensity treatment profiles and procedures. Despite Belgium's relatively high ICU bed density, the absence of a formalised tiered system may contribute to inefficiencies and inconsistent care quality, particularly for complex cases.

A key theme among respondents was the belief that high-intensity critical care should be centralised in well-resourced centres equipped with specialised infrastructure, advanced technology, and adequately trained staff. These centres should provide 24/7 in-house physician coverage with ICU expertise and support low patient-to-nurse ratios (e.g. 1:1) when necessary. Dispersing high-intensity care across all ICUs, including smaller hospitals, risks diluting clinical expertise and potentially undermining patient outcomes. Centralising such care is thus seen as essential not only for optimising results but also for consolidating and maintaining professional proficiency through frequent exposure to complex cases.

At the same time, many respondents stressed that differentiation should be applied at the level of individual patients rather than hospitals. They advocated for a system that matches care intensity to patient acuity, regardless of institutional setting. Implementing such an approach would require an ICU-specific classification system capable of dynamically assessing both severity of illness and the level of care required. This system should be linked to clear admission criteria, mandatory referral pathways, and appropriate financing and licensing standards.

An important consideration in this model is that while patients with high-acuity needs would be directed exclusively to specialised ICUs, these high-level units should still be able to admit less critical patients. This asymmetry was broadly supported by stakeholders, who saw it as a means of alleviating pressure on ICU staff. The opportunity to manage lower-acuity cases was considered beneficial for staff well-being and professional sustainability in an otherwise high-stress environment. Respondents also highlighted the complexity of stratifying patients based on severity and care intensity, noting that these factors do not always align and can evolve rapidly over time. Therefore, any classification must go beyond static hospital features and incorporate dynamic tools for real-time triage and patient assessment. Also the participants in the hospital survey pointed to the unpredictable and rapidly changing condition of critically ill patients, which requires ICUs to adjust care intensity swiftly. Opponents of stratifying ICUs into formal levels highlighted that formal levels could undermine this adaptability, making even temporary escalations in care dependent on patient transfers.

From a workforce perspective, critics warned that labelling certain ICUs as ‘lower-level’ may reduce their appeal to experienced clinicians. This could lead to a concentration of expertise in higher-level units, leaving lower-level ICUs vulnerable to a decline in staff competencies due to limited exposure to high-acuity cases. In the long term, this may weaken the system’s resilience during public health emergencies when broad, flexible clinical competencies are critical.

In sum, while there is widespread support for a multi-level ICU framework in Belgium, stakeholders emphasise the importance of a flexible, patient-centred approach that integrates nuanced clinical judgment, robust triage systems, and adaptable infrastructure to meet varying care needs effectively.

INTERNATIONAL MULTI-LEVEL ICU MODELS

An analysis of the seven European countries studied in this report reveals both convergence and divergence in how levels are defined and implemented. One of the criteria for selecting the countries was the presence of clearly defined ICU-level classifications.

Most countries studied (Denmark, Germany, Sweden, England) apply a three-level framework. These levels are broadly aligned with the complexity of care delivered and the hospital's available resources. In these systems, level 1 ICUs generally provide intermediate or step-down care, level 2 ICUs offer full ICU support for common critical conditions, and level 3 ICUs are reserved for the most complex, multi-organ failure patients, typically located in academic or tertiary centres.

Despite structural similarities, countries vary in how ICU levels are defined. Denmark, Sweden, and Germany use hospital-based criteria such as staffing, equipment, and available specialties, with Germany also linking levels to planning and reimbursement frameworks. England takes a patient-centred approach, assigning levels based on the intensity of care and organ support needs of the patient. Only level 3 patients are considered ICU cases, with levels 1 and 2 overlapping with intermediate or high-dependency care. France employs a two-tier system based on function and treatment duration. General ICUs manage short-term, single organ failure, while resuscitation units handle prolonged, multi-organ failure. This model offers clinical clarity but limits comparability with three-level systems. Italy and the Netherlands show less formalisation. Italy’s differentiation is mainly regional, though scientific societies have proposed a national four-level model. The Netherlands moved away from a formal tiered structure, opting instead for quality standards, though in practice, larger ICUs still manage the most complex cases. The degree to which ICU levels are implemented and regulated also varies.

An effective ICU-level system relies not only on classification but also on mechanisms for patient referral between levels. Countries like Denmark, England, and Sweden have formalised referral pathways to ensure timely access to higher-level care. These systems typically require higher-level ICUs to maintain spare capacity, supported by monitoring tools (e.g. Sweden's national bed tracking system) and structured transfer protocols, including mobile ICU transport in the Netherlands. Advanced therapies, such as ECMO, are generally restricted to top-tier ICUs due to their complexity and resource demands, reinforcing the need for clear referral criteria and centralised provision.

ROLE OF IMCUs IN MULTI-LEVEL ICU SYSTEM

IMCUs show substantial variation in formal recognition and regulation. In countries like England and the Netherlands, IMCUs are integrated within the intensive care continuum, formally recognised as part of a multi-tiered critical care model. In contrast, in countries such as France, Denmark, Germany, and Sweden, IMCUs are regulated separately or excluded from formal intensive care frameworks. This distinction reflects a broader tension between administrative classification and clinical practice, as IMCUs nonetheless serve ICU-like functions for patients not meeting full ICU admission criteria.

BUFFER CAPACITY IN ICU CARE

The COVID-19 pandemic highlighted the critical importance of surge capacity within healthcare systems, prompting renewed attention to the concept of ICU buffer capacity. Despite Belgium's relatively high density of ICU beds compared to other countries, respondents cautioned against interpreting this as a sign of overcapacity, particularly in the absence of a formal intermediate care system. Rather, they advocated for maintaining a degree of built-in flexibility, what some termed 'inefficiencies', to allow rapid adaptation during public health emergencies.

However, the tension between maintaining buffer capacity and ensuring efficient use of scarce staffing resources emerged as a key concern. While a permanent buffer of underutilised ICU beds might theoretically increase system resilience, respondents argued that such a strategy is untenable in light of ongoing personnel shortages. Many hospitals already face significant staffing constraints, leading to the cancellation of elective surgeries due to ICU nurse unavailability. Therefore, a model of underused ICU beds is considered both impractical and potentially wasteful.

As a more sustainable alternative, the upscaling of intermediate care units was frequently proposed. These units could function as adaptable surge platforms in crisis scenarios, provided that they are staffed by personnel with ongoing ICU experience. A rotational staffing model, where nurses and physicians work periodically in both ICU and intermediate care settings, was suggested as a way to preserve ICU-specific competencies while avoiding permanent overstaffing of high-intensity units.

In conclusion, while some redundancy in ICU capacity may be justified to safeguard against crises, this must be balanced with pragmatic workforce considerations. Investing in intermediate care infrastructure and staff rotation offers a feasible approach to ensuring system resilience without compromising everyday efficiency.

11.4 Staffing: the core determinant of intensive care capacity

The aim of establishing different levels of care within ICUs is fundamentally a policy tool to align patients' critical care needs with the appropriate medical and nursing expertise. ICU capacity is not only about the number of beds or availability of equipment, but also – or even more – about the presence of qualified staff to deliver care. This becomes especially evident during periods of staffing shortages. International comparisons show that most countries set minimum standards for nurse and physician qualifications, availability, and caseloads. In systems with formal ICU levels, these staffing requirements are tiered according to the intensity and complexity of care at each level.

PHYSICIANS WITH SPECIALISED TRAINING IN CRITICAL CARE MEDICINE: IMPLICIT CONNECTION TO CARE LEVELS

In most of the countries studied, ICU physicians are required to have specialised training in critical care medicine, typically through qualifications in intensive care or anaesthesiology, as seen in Denmark, France, Italy, and Sweden. However, this does not exclude physicians from other specialties from working in ICUs. Most countries also impose requirements regarding the caseload per ICU physician, with Germany reporting the highest staffing ratio (0.7 FTE per bed) and England the lowest (up to 12:1 patient-to-consultant ratio during the day). Although these ratios are generally not formally linked to ICU levels, some countries such as Germany and Denmark, recommend adjusting medical staffing based on patient needs or case complexity (e.g. burns, isolation, or extracorporeal procedures).

In Belgium, continuous on-site presence of a physician with ICU-specific expertise is mandatory, and staffing must reflect the intensity of care and patient acuity. Survey findings for Belgium show that most hospital sites always have at least one physician with an intensive care title present, with higher numbers typically found in sites that identify as having a specialised ICU.

NURSE STAFFING LEVELS ARE AN ESSENTIAL CRITERION TO DEFINE LEVELS: PATIENT OR UNIT LEVEL

Most countries also set minimum requirements for ICU-specific expertise among nursing staff. For example, at least 30% of nurses in Germany and 50% in England are required to have specialised ICU training, while Denmark has a non-binding target of 50%. In contrast, Italy formally requires only a bachelor's degree in nursing, with a master's in critical care recommended but not obligatory. Likewise, France does not mandate additional intensive care training for nurses.

In most countries, though not all (e.g. Denmark), the patient-to-nurse ratio or a related metric is a key criterion used to distinguish between ICU levels. In England, staffing is determined at the patient level, requiring a minimum 1:1 ratio for level 3 patients and 2:1 for level 2 patients. Germany follows a similar approach, with ratios ranging from 3:1 to 1:1 depending on patient acuity. In other countries, such as France, ratios are defined at the unit level – for example, a 2.5:1 bed-to-nurse ratio in resuscitation units and 4:1 in general ICUs.

Determining staffing at the patient level offers several advantages, such as ensuring a close alignment between patient needs and staff availability, while also reducing the risk of overstaffing when high-acuity patients are absent. This approach also allows hospitals to implement different care levels across units. In England, for example, high-dependency units serve as intermediate care settings for level 2 patients. Additionally, the most complex cases requiring 1:1 staffing can be concentrated in specific hospitals or ICUs, particularly where essential interdependent services are available.

The patient to nurse ratios for intermediate care units in Germany and Italy are 4:1 (also in England for the lowest level of patients in the ICU continuum). In Denmark and Sweden lower patient to nurse ratios are used for medium care units. Also thresholds to define the minimal percentage of the nursing teams that requires ICU-specific expertise exist in some countries. As is the case for patient-to-nurse ratios also these expertise levels are lower (e.g. 20% in Germany) compared to ICUs.

VARIATION IN NURSE STAFFING LEVELS IN BELGIUM SUGGESTS IMPLICIT DIFFERENTIATION OF CARE LEVELS

In Belgium, variation in nurse staffing levels may reflect an implicit application of ICU care levels, despite the absence of formal differentiation in licensing standards. Current regulations apply a uniform standard, requiring a minimum of two nurses per six ICU beds, approximately equivalent to a 3:1 patient-to-nurse ratio. Apart from head nurses, there are no mandatory requirements for ICU-specific qualifications. Nevertheless, a significant proportion of ICU nurses in Belgium hold an intensive care qualification, with 80% meeting this criterion in 2022 (KCE Report 353).[10]

Our survey shows that in most Belgian ICUs, the scheduled patient-to-nurse ratio typically falls between 2 and 3 patients per nurse, regardless of the shift. KCE Report 353 reported an average ratio of 2.3, with values ranging from 1.5 to 3.9. However, several factors must be considered when interpreting these ratios in the Belgian context:

- The Belgian licensing standard of 3 patients per nurse is higher than most countries studied: the patient-to-nurse ratios of 3:1 or higher are typically limited to specific patient categories or lower levels of care. For example, in Lazio (Italy), a 3:1 ratio applies to patients requiring monitoring and non-invasive therapies, while in Sweden, bed-to-nurse ratios ranging from 4:1 to 2:1 are designated for the lowest ICU level.
- The survey results show that while some ICUs staff according to the licensing norm of 3:1, others schedule lower ratios, such as 2:1. This results in a national average patient-to-nurse ratio of 2.3 in 2022. The survey also indicates that staffing levels are generally higher during evening shifts and even more so at night, with ratios exceeding 3:1 in about a quarter of ICUs. In contrast, 1:1

ratios, standard for the highest ICU levels in other countries, are not typically scheduled in Belgium.

- When a 1:1 patient-to-nurse ratio is needed, ICUs typically reduce the patient load per nurse by temporarily closing beds and/or increasing staffing through an ICU-specific float pool. This approach is likely driven by the financing system: each financed ICU bed corresponds to 2.5 FTEs, which is insufficient to support continuous 1:1 staffing. Moreover, capping the number of financing points per ICU bed at 5 may disproportionately impact hospitals with the most intensive care profiles, as they may require 1:1 staffing more frequently.
- While there is considerable variation in care intensity across ICUs, it remains unclear whether this corresponds to differences in staffing levels. Assessing this would require a monitoring system that captures both staffing data and patient acuity. Although such a system for staffing data existed in the past, staffing levels have no longer been recorded in the Belgian Nursing Minimum Data Set since 2017.
- Patient-to-nurse ratios must be understood within the broader organisational framework. The lack of a formalied intermediate care level creates a significant gap between the staffing levels of general units and ICUs. Although some hospitals establish intermediate care units, often financed through supplementary budget points, this practice is not widespread. Consequently, some of the variation in care intensity within and between ICUs may be due to the admission of patients with intermediate care needs in ICUs or the prolonged stay of ICU-level patients whose condition no longer requires intensive care but rather an intermediate level. As a result, some stakeholders argued that certain ICUs may appear overstaffed, while others caution that international comparisons of patient-to-nurse ratios should be interpreted with care. In systems without intermediate care units, staffing demands differ significantly across patients, as even highly specialised ICUs must care for patients who, at various points in their stay, fall into an intermediate care category.
- KCE Report 353 highlighted that providing continuous care for the most critically ill patients is highly stressful for nurses.[10] Therefore, alternating between caring for severely ill patients and those with less acute conditions to support their overall well-beingwas considered essential.

When introducing a system of care levels, aligning staffing levels with those levels is essential for improving the quality of care in Belgium. Drawing on international best practices and adapting them to the Belgian healthcare context can help ensure that ICUs are better equipped to meet the complexities of critical care. A combined approach at both the patient and unit level appears warranted. This could involve implementing a broader range of patient-to-nurse ratios, such as from 1:1 to 4:1, based on patient acuity, alongside the establishment of formal levels at the unit level. For example, care for patients requiring a 1:1 patient-to-nurse ratio could be limited to units classified at the highest ICU level, based on criteria such as interdependencies with other specialised services. These units could also accommodate patients with lower acuity profiles. Conversely, the system could designate units primarily focused on intermediate care profiles, staffed accordingly.

This approach may also help ease financial pressures on these units. The impact on the required staff at the macro level of the implementation of a model with different patient-to-nurse ratios for different levels needs to be assessed. This can be done based on the methodology applied in KCE report 325.[11] Yet, it should be noted that this requires data on the current staffing levels (e.g. an estimation based on survey data as in Chapter 7 or re-instalment of the monitoring of staffing levels within the VG-MZG / DI-RHM) as well as a the simulation of different scenarios including assumptions on the number of units per level and the average required patient-to-nurse ratio per level. Ultimately, a structured strategy is needed, one that combines flexible staffing tailored to patients' varying needs with aligned financial incentives and robust monitoring.

11.5 Adequacy of current payment mechanisms in reflecting ICU case mix and patient acuity

The financing of intensive care services in Belgian hospitals plays a critical role in shaping ICU capacity and organisation. ICU funding is embedded within the broader hospital budget system, relying on a combination of general hospital basic points and supplementary ICU-specific points. Unlike other hospital services, ICUs do not receive separately calculated basic points. Instead, a portion of the overall basic points and justified C-, D-, and E-beds, is allocated to finance intensive care. Supplementary points, allocated via three decile-based indicators (resuscitation acts, Nursing Related Group (NRG) profile and the hospital's pathology-adjusted percentage of intensive care days (NPERCIZ)), are intended to fund the required staffing (2 FTE nursing staff per bed). The term 'supplementary points' is confusing because the operation of an intensive care bed – with the required staffing – demands five basic points for adequate financing.

ALIGNMENT OF RESOURCES WITH PATIENT ACUITY IN ICUs NOT SUFFIICENT ACCORDING TO STAKEHOLDERS

The existing financing mechanisms for ICUs were a central topic of stakeholder discussions, particularly regarding their ability to reflect differences in case mix and patient acuity. There is a widespread belief among stakeholders that the current system does not adequately account for the varying levels of care intensity across ICUs. Although the current system with basic and supplementary points incorporates the principle of differentiating between ICUs, it is seen as inadequate in compensating for variations in patient acuity. For example, the uniform 3:1 bed-to-nurse ratio (at least two nurses per full set of six beds) fails to consider differences in the severity of patient conditions. High-acuity patients who are typically treated in tertiary ICUs, require more intensive staffing (a 1:1 ratio may be necessary), advanced infrastructure, and continuous medical expertise.

Another concern is the gap between the number of financed intensive care beds and the number of operational beds. For example, among the hospitals that reported the number of operational beds in the survey and for which data on financed beds are available (70 hospitals), there are 1 531 operational beds and 1 004 financed beds (66%). At the hospital level, the ratio of financed to operational beds varies between 17% and 130%. This discrepancy forces hospitals to cross-subsidise ICU activity with income from more profitable services (e.g. cardiovascular surgery or lab services). The existing flexibility in budget allocation allows hospitals to distribute resources according to their priorities, but this practice lacks transparency and may not always align with patient care demands.

COMPLEX ICU FINANCING SYSTEM HINDERS ASSESSMENT OF ALIGNMENT WITH PATIENT ACUITY

Chapter 3 has illustrated the complex nature of ICU financing in Belgium. The analysis of hospital-level intensive care financing in Belgium shows some notable findings, suggesting that the current financing model does not fully align with the complexity and diversity of ICU care provision across hospitals.

First, while it is expected that larger hospitals would have a higher share of financed ICU beds within justified C-, D-, and E-beds, some smaller hospitals also show high ICU bed shares. ICUs function as a critical extension of broader hospital services, and their utilisation often mirrors the volume and complexity of general inpatient care. Hospitals that provide a higher proportion of complex, high-risk, or surgical treatments are more likely to require intensive care support, resulting in a close alignment between general and ICU activity.

Discrepancies between licensed and financed ICU beds further underscore the misalignment. In some hospitals, fewer than 25% of licensed beds are financed, while others report financed beds exceeding licensed capacity by over 25%. One advantage of the current system is that it finances ICU activity rather than just ICU structures. This can be a more efficient way for the government to allocate resources. A drawback of purely activity-based financing is that it can create an incentive for hospitals to retain more complex patients for financial reasons. This could unintentionally reinforce fragmentation in the system, as hospitals may be less inclined to refer patients to more appropriate levels of care. For effective healthcare planning, however it is essential to have a clear understanding of the actual number of operational ICU beds, including their staffing levels.

Third, while the allocation of supplementary point increases with justified C-, D- and E-beds, the cap of five points per ICU bed disproportionately impacts hospitals with high-intensity caseloads. And conversely, hospitals with a low number of financed ICU beds are still required to maintain a minimum capacity of six beds, even though they may not receive adequate financing for this.

Fourth, the use of multiple ICU financing indicators (resuscitation acts, NRG profile, NPERCIZ) reveals moderate overall alignment, particularly at the extremes of the distribution. However, differences in decile rankings across indicators, especially between NRG and NPERCIZ, highlight the lack of a unified, transparent measure of ICU performance or resource need. While university and larger hospitals show greater stability in rankings, the broader spread seen in smaller hospitals underscores the heterogeneity of their ICU functions, potentially reflecting varied roles (e.g. stabilisation, post-operative recovery) that are not adequately captured by current metrics or potential vulnerability of metrics to registration creep.

Fifth, correlations between ICU financing indicators and actual care intensity (e.g. nursing complexity, severity of illness) remain modest. Although higher NRG deciles are generally associated with more complex nursing care, significant within-decile variation suggests that NRG decile rankings may only partially capture real care needs. Similarly, the NPERCIZ metric shows weak associations with comorbidity burden and time in ICU-to-total LOS ratios, raising concerns about its suitability as a robust measure of ICU case complexity.

Lastly, we observed that hospitals in the higher NPERCIZ deciles tend to have a high proportion of ICU stays associated with neurosurgical and cardiac surgical procedures. These surgical procedures generally involve several days in the ICU during their hospital stay. As a result, hospitals with a high volume of such cases often rank higher in the NPERCIZ decile. However, this does not necessarily indicate that these ICU stays are particularly complex or involve high patient acuity; the ranking is primarily influenced by case mix and ICU bed utilisation rather than clinical severity.

Importantly, hospital size and type remain strong determinants of ICU financing profiles. University hospitals consistently occupy higher deciles and receive a larger share of supplementary points from intensive care, reflecting their role in managing more complex and resource-intensive cases. In contrast, smaller hospitals show greater variability across deciles and indicators, suggesting that the financing system accounts for heterogeneity in ICU service delivery at these sites.

Overall, while the financing system provides incentives for high-intensity care, its indirect structure (financing is based on justified C-, D- and E-beds), complexity, and decile-based thresholds may hinder optimal alignment between financing and actual service needs. More direct, transparent, and clinically grounded mechanisms based on ICU-specific data could help ensure that ICU capacity and financing are better matched to patient needs and hospital capabilities.

INTERNATIONALLY, ICU FINANCING IS COMMONLY INTEGRATED WITHIN DRG-BASED PAYMENT SYSTEMS

Across the examined countries, reimbursement mechanisms for ICUs reveal significant variation. While diagnosis-related group (DRG) systems remain the backbone of general hospital financing in all countries studied, their application to ICU services differs considerably in scope and structure.

In four of the seven countries (France, Denmark, Germany, and the Netherlands), ICU care is integrated, at least partially, within the DRG framework. This integration is typically complemented by activity-based or per diem payments that seek to address the added costs of critical care. For example, France applies a hybrid model combining DRGs with per diem payments that vary based on unit type, patient severity, and medical procedures. Denmark and Germany classify ICU cases by severity and organ failure complexity, resulting in differential DRG payments. The Netherlands adds supplementary payments on top of DRGs, recognising the disproportionate costs of intensive care, although differentiation is not based on care levels but rather on institutional arrangements (small versus large ICUs).

However, these DRG-based models have come under scrutiny. Critics argue that volume-based incentives, particularly in systems relying on per diem payments, may promote inefficiencies, such as

unnecessarily prolonged ICU stays or the exclusion of complex patients who do not meet strict eligibility criteria. This has prompted several countries to initiate reforms. France and Germany, for instance, are transitioning toward mixed models that combine global budgets with activity-based elements to better account for fixed costs and reduce economic pressure on hospitals.

In contrast, England, Sweden, and Italy largely fund intensive care outside the DRG system. These countries employ a mix of historical budgeting (e.g. Sweden), local negotiation (e.g. England), or function-based financing (e.g. Italy), often designed to reflect the unpredictable and resource-intensive nature of ICU care. While such approaches offer greater flexibility and potentially better alignment with actual resource use, they may also lack transparency and consistency in cost estimation across institutions.

A key limitation across most systems is the lack of explicit reimbursement differentiation based on ICU level. Although indirect distinctions arise, since complex procedures are more likely to be performed in higher-level ICUs, formal financial recognition of ICU tiering is rare. Denmark and Germany represent exceptions, where only certain ICU levels can bill for specific DRG codes or procedures. In France, although resuscitation units receive higher per diem rates, eligibility is tightly tied to clinical criteria rather than structural designation.

While DRG-based financing remains the main financing mode in many countries, there is a clear trend toward hybrid models that blend case-based payments with global or function-based funding. The shift acknowledges the need to finance ICU services not only based on volume but also on capacity and complexity.

A MIXED PAYMENT MODEL FOR ICUs IN BELGIUM?

Belgium considers a reform in the way hospitals are financed, from a budget allocation based on DRGs to a DRG-based payment per case. The suitability of DRG-based lump sum payments for ICU care was challenged by the consulted stakeholders. Given the inherently variable and unpredictable nature of intensive care, standardised payments tied to specific diagnoses are often seen as ill-suited. While certain predictable care pathways, such as routine post-operative ICU stays, may align with lump sum models, the majority of ICU cases, particularly those involving high-acuity or complex conditions, necessitate more flexible reimbursement mechanisms that can accommodate the diverse resource demands of critically ill patients.

The consulted stakeholders underscored the need for a mixed payment model that aligns with a clearly defined organisational structure. If policymakers adopt a multilevel ICU system concentrating complex care in tertiary centres, the payment system must reflect this by redistributing resources accordingly. Respondents supported a combination of fixed payments (to ensure 24/7 readiness and infrastructure support), variable payments (linked to case-mix and resource use), and performance-based components (to incentivise quality and collaboration, such as timely transfers).

11.6 Informational challenges

ICU BED NUMBERS REMAIN UNCLEAR

The organisation of intensive care units in Belgium faces several informational challenges that complicate both oversight and strategic planning. One of the most fundamental issues is the lack of clear, consistent data regarding the exact number of ICU beds. This is largely due to the fact that ICU beds are not categorised independently, but are embedded within surgical, internal medicine, and paediatric beds. Furthermore, discrepancies between licensed, financed, and operational beds create confusion and hinder accurate capacity assessments. For example, the number of licensed bed in the MZG – RHM and the number used by the Hospital and Transport Surge Capacity (HTSC) Committee are not the same for all hospitals. Except for the survey results, no data are available on the number of operational and available beds. In 59 ICUs, at least one bed was closed at the time of the survey, primarily due to nursing staff shortages. On average, 1.4 beds were closed per ICU, with the number ranging from 0 to 12 beds. However, there is no real-time data available on bed closures or staffing shortages, making it difficult to monitor and respond to these issues promptly.

While several countries have national registries collecting ICU data, only a few systematically track real-time bed availability, which is crucial for capacity management and patient transfers. Since the COVID-19 pandemic, the DIVI Intensive Care Register in Germany reports daily data on available and occupied ICU beds (including ECMO) and makes this information publicly accessible. France is developing a national registry to track healthcare capacity, including ICU beds, with expected daily updates. During the pandemic, a temporary national system provided near real-time data on ICU capacity, but access was restricted to authorised professionals. In Sweden, England, Denmark, and the Netherlands, national ICU registries exist but primarily focus on clinical and outcome data rather than real-time bed tracking. Updates are less frequent or retrospective, limiting their use for immediate capacity planning. In the Netherlands, a capacity module is included to offer insights into nursing workload, aiming to optimise nurse deployment. This module incorporates data from the Nursing Activity Score (NAS). Italy lacks a national system for monitoring ICU bed availability, relying instead on local or voluntary initiatives.

Without a unified and transparent method for bed counting in Belgium, it is difficult to develop evidence-based policies or ensure appropriate resource allocation. The lack of a clear overview of available data complicates patient transfers, as it hinders timely and informed decision-making about bed availability and capacity.

ABSENCE OF A CENTRAL REGISTRY FOR PATIENT ACUITY DATA

Beyond the uncertainty around bed numbers, there is also limited visibility into key characteristics of ICU activity, such as patient acuity, staffing levels and expertise. Although Belgium maintains a relatively high density of ICU beds per capita compared to international standards, it remains unclear how intensively or appropriately this capacity is used.

Several countries maintain national ICU registries that systematically collect detailed clinical data to monitor patient characteristics, severity, and outcomes, although the scope and real-time availability vary. For example, in Sweden, the Intensive Care Registry records clinical data including SAPS 3, the Sequential Organ Failure Assessment (SOFA) score, and standardised mortality ratios, with full participation from all ICUs nationwide. England's Case Mix Programme collects patient demographics, hospital stay information, and severity of illness scores like APACHE-2, and produces publicly available annual and quarterly benchmark reports. The Netherlands' National Intensive Care Evaluation registry gathers extensive clinical data, including demographics, admission and discharge details, physiological measures, reasons for admission, and severity scores such as APACHE-2 and SAPS-2. These registries provide essential clinical insights for quality monitoring, outcome evaluation, and research.

In the absence of standardised, ICU-specific indicators in Belgium, hospitals cannot be reliably compared in terms of clinical performance or efficiency. The current data infrastructure does not support systematic evaluations of quality of care, patient outcomes, or staffing adequacy relative to the acuity levels of the patients being treated. Although the Minimal Hospital Data (MZG – RHM) underpins hospital financing, stakeholders repeatedly identified it as insufficient for ICU-specific analysis. Key limitations include its administrative focus, lack of clinical granularity, especially on patient acuity, and significant reporting delays of up to two years. For example, patients with cancer make up a significant share of the study population. However, these patients are not necessarily admitted to intensive care because of the neoplasm itself, but rather with a neoplasm and due to another acute condition. Moreover, staffing data per nursing unit per registration day of the VG-MZG / DI-RHM are no longer available because the registration is no longer compulsory. These gaps in timely, detailed data hinder the system's capacity to monitor ICU performance and implement targeted improvements.

This lack of transparency poses challenges not only for policy makers, but also for hospitals seeking to improve their services. While ICU care is resource-intensive and absorbs a significant portion of hospital budgets, there is no comprehensive registry capturing activity levels, outcomes, or even basic quality metrics at the national level. Stakeholders have repeatedly called for the development of an ICU-specific data system that could support benchmarking, accountability, and clinical quality

improvement. The MICA registry is occasionally mentioned as a potential foundation, but concerns remain about its current scope, implementation feasibility, and stakeholder buy-in.

COMPARING NAS AND VG-MZG / DI-RHM AS ICU WORKLOAD INSTRUMENTS

An accurate measurement of ICU nursing workload is crucial for making well-informed staffing decisions. In the Belgian hospital setting, two instruments are available: the NAS (Nursing Activities Score) and the Nursing Minimum Data Set (VG-MZG / DI-RHM). The NAS is an ICU-specific instrument and is seen as the international gold standard. Both instruments were compared in a convenience sample of 8 hospitals to assess whether the latter could serve as a substitute for the NAS in measuring ICU nursing workload and to evaluate whether ICU workload measurement in the VG-MZG / DI-RHM could be improved by integrating specific NAS items.

The results of the comparison were rather disappointing. The correlation between NAS and VG-MZG / DI-RHM workload scores is weak, probably due to differences in data granularity and potential over- or underreporting.

Moreover, the data analyses demonstrated that both systems have shortcomings. NAS includes some items with low discriminative value or outdated definitions and does not fully reflect current ICU practices. The VG-MZG / DI-RHM lacks ICU-specific sensitivity and is based on 24-hour care episodes rather than shift-level data, which limits its usefulness for day-to-day staffing but is sufficient for broader budget allocation. Broader use of the NAS would require structured implementation, training, and automation to reduce administrative burden.

11.7 Prerequisites for reforming the ICU landscape

The lack of an official framework creates several challenges. Firstly, it hinders transparent benchmarking, planning, and resource allocation. Without standardised ICU levels, it is difficult to ensure that patients are treated in the most appropriate setting and to evaluate the adequacy of critical care capacity nationally. Secondly, the absence of formal criteria may contribute to variability in care quality, especially in situations where resource limitations are not explicitly recognised or addressed. Thirdly, it impedes the development of targeted training programmes and workforce planning, making it harder to ensure that staff are deployed and supported according to the complexity of care required. It also complicates financing, as current reimbursement mechanisms struggle to reflect differences in patient acuity and ICU function, leading to inefficiencies and potential underfunding of high-intensity units. Lastly, it constrains the scalability and adaptability of critical care services during crises, such as pandemics, when clear definitions and interoperable systems are crucial for coordinated national responses.

Nonetheless, the implicit use of ICU levels suggests that healthcare professionals and institutions already recognise the need for differentiation and have adapted informally to fill the policy gap. This presents an opportunity for policymakers: building on existing practices and professional consensus, Belgium could benefit from establishing a clear ICU classification system. Formalising ICU levels can support more appropriate patient triage, optimise staff and equipment deployment, and improve the transparency and comparability of care delivery across hospitals. The current informal stratification of care already reflects clinical realities, and institutionalising this through official designation can serve as a lever for broader systemic improvements.

Reforming the organisation of ICUs cannot be considered in isolation, as ICUs are deeply embedded in the wider hospital system. Respondents across the Belgian healthcare landscape emphasised that ICU reform must be part of a broader hospital reform. The interdependence between ICUs and other acute services means any changes to ICU provision will have cascading effects on the delivery of emergency and complex care.

Successful reform requires more than classification. It demands enabling infrastructure and governance: a reliable and well-resourced inter-hospital transport system to support safe and timely escalation of care; differentiated staffing models that ensure both quality and sustainability; and financing mechanisms that reward complexity while protecting baseline access. The definition of care

levels must also be supported by data, collected consistently and used transparently, to guide decision-making and foster accountability across the system.

Financial feasibility emerged as a key concern. Given that significant system-wide investment is unlikely, any reform would require a redistribution of existing budgets, likely favouring high-level ICUs while reducing resources for smaller or lower-acuity units. Reducing overall ICU capacity was widely viewed as unacceptable, reflecting lessons learned from the COVID-19 pandemic. Instead, there was strong support for maintaining flexible capacity that can be rapidly scaled in times of crisis, for example, by converting IMCUs into ICU beds when necessary.

12 CONCLUSION

ICUs are essential to modern hospital care, enabling complex and life-saving interventions. Belgium's relatively high ICU capacity reflects its fragmented hospital landscape, where many institutions operate ICUs regardless of size or coordination needs. Yet, despite their strategic role and high costs, there remains limited insight into ICU performance, particularly regarding patient acuity, care intensity, and outcomes.

This report highlights considerable variation in the intensity of care across ICUs. While some of this reflects differences in patient needs, it also points to informal differences in function and expertise that are not captured in current policy or financing frameworks. This supports the case for a more formalised, tiered ICU system distinguishing between high-intensity specialised centres, general ICUs, and a clearly defined intermediate care level. Such stratification could align infrastructure, staffing norms and financing with clinical reality.

To enable this shift, Belgium must prioritise collecting ICU-specific medical and nursing data through targeted indicators that balance clinical relevance with administrative feasibility.

Ultimately, an ICU bed is not just a physical resource but it represents a package of skilled staff, infrastructure, and clinical capacity. Improving transparency, aligning financing with care needs, and strengthening system-wide coordination are essential to ensure the future resilience and efficiency of ICU care in Belgium.

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