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COVID-19 – KCE CONTRIBUTIONS

**AEROSOL-GENERATING
PROCEDURES**

VICKY JESPERS, DOMINIQUE ROBERFROID

This document is a rapid review of scientific literature retrieved from several publicly funded COVID-19 resource collections. The literature included in these repositories is not always peer-reviewed or externally validated. KCE synthesised the evidence in short time frames to respond to urgent questions and could therefore not follow its regular methodological procedures. This work is used to inform guidance of other governmental agencies (like Sciensano, CSS/HGR, AFMPS/FAGG and SPF/FOD).

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■ MAIN REPORT

1 PROBLEM DESCRIPTION

1.1 Background

Although the mechanisms of transmission of SARS-CoV-2 remain largely unknown, all respiratory viruses can be transmitted through direct contact, droplets and airborne routes.[1, 2] Further, faecal-oral or transmission through fomites, for example elevator buttons, restroom taps, might exist.[3] Respiratory secretions and saliva have been tested positive for SARS-CoV-2 virus shedding.[4, 5] Respiratory emissions are dichotomised into “large” and “small” droplets. Large droplets settle faster than they evaporate, contaminating the immediate vicinity of the infected individual. In contrast, small droplets evaporate faster than they settle and form particulates referred to as aerosols.[6] The time for droplets to evaporate depends on the ‘turbulence’ of the cloud produced by exhalations, sneezes, and coughs and as a result will affect the distance the aerosol will travel.[6] The biophysics, demonstrating a distance of up to 7-8m, have not been tested for SARS-CoV-2.[6] Airborne transmission was not reported in an analysis of 75,465 COVID-19 cases in China.[1, 7] A recent study demonstrated reduced coronavirus RNA in aerosols when a surgical face mask was used by patients with acute respiratory illness.[8] This indicates that onwards transmission with the use of a surgical face mask may be reduced.

Aerosol-generating procedures, any medical procedure that can induce the production of aerosols of various sizes, were defined in the aftermath of the severe acute respiratory syndrome (SARS)-CoV epidemic in 2003, as they were recognised as a risk for increased transmission of respiratory pathogens.[9, 10] As a result, WHO developed guidance for known pathogens (SARS, human cases of avian influenza infection) and unknown respiratory illnesses with an epidemic and pandemic potential.[9] The recommendations were updated in 2014 with a review of practical experience and lessons learnt from the pandemic influenza A (H1N1). For the first time the association between aerosol-generating procedures and risk of pathogen transmission was evaluated systematically.[11] The review also highlighted the following research gaps:

- a lack of information about the risk of acute respiratory infections (ARI) transmission from patients to health-care workers during aerosol-generating procedures, particularly with respect to pathogens other than SARS-CoV;
- a lack of precision in the definition of aerosol-generating procedures;
- the need to determine the minimum environmental ventilation requirements in terms of variable ventilation rate;
- the need for control of airflow direction for aerosol-generating procedures.

1.2 Belgian situation

Belgian health care workers in close contact with a possible or confirmed SARS-CoV-2 case (a distance of less than 1.5m) are advised to use a medical/surgical mask, a gown, gloves, and goggles or a face shield.[12] These recommendations are in line with WHO’s recent guidance on the rational use of personal protective equipment (PPE) in health care settings.[13]

WHO also stipulates that PPE should be used based on the risk of exposure (e.g. type of activity) and the transmission dynamics of the pathogen (e.g. contact, droplet or aerosol). WHO stresses that the overuse of PPE can have an impact on supply shortages and that rational use is advised.[13] Aerosol-generating medical procedures are recognised as high risk activities and medical masks and respirators (e.g. N95, FFP2 or equivalent standard) should be available.

2 OBJECTIVE

The aim of this fast review is to provide, on the basis of the literature, a complete list of aerosol-generating medical procedures. A secondary objective is to define which of the identified procedures carry the highest risk for transmission of a respiratory pathogen.

Research question 1: Which medical procedures are considered to be aerosol-generating?

Research question 2: What is the risk associated with aerosol-generating medical procedures for the transmission of respiratory viruses?

3 METHODS

We evaluated the literature in a non-systematic way for the definition of aerosol-generating medical procedures and searched international recognised bodies and government websites.

The websites were searched on April 1st till April 7th 2020.

The results of the 'definitions' are presented in a tabulated way by country / organisation.

For the second objective we updated the search of the review by Tran[11]. The updated search was performed between April 2th and April 7th and is described in Appendix 1. Due to time constraints we focused on the retrieved documents from 2020 and 2019. Papers answering the first research question and providing a definition were added to the table with definitions.

4 RESULTS

The following documents give a description of **aerosol-generating medical procedures** (Table 1).

Table 1 – Overview of guidance documents with definition of aerosol-generating medical procedures

Country/Organisation	Year	Title document	Link
WHO[9]	2007	Infection prevention and control of epidemic- and pandemic-prone acute respiratory diseases in health care[9]	https://www.who.int/csr/resources/publications/WHO_CD_EPR_2007_6/en/
WHO[2]	2014	Infection prevention and control of epidemic- and pandemic-prone acute respiratory diseases in health care[2]	https://apps.who.int/iris/bitstream/handle/10665/112656/9789241507134_eng.pdf?sequence=1
WHO[14]	March 19 th , 2020	https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance/infection-prevention-and-control [14]	https://www.who.int/emergencies/diseases/novel-coronavirus-2019/technical-guidance/infection-prevention-and-control
WHO[1]	March 29 th , 2020	Modes of transmission of virus causing COVID-19: implications for IPC precaution recommendations[1]	https://www.who.int/publications-detail/modes-of-transmission-of-virus-causing-covid-19-implications-for-ipc-precaution-recommendations
WHO[13]	March 19 th , 2020	Rational use of personal protective equipment for coronavirus disease (COVID-19): interim guidance[13]	https://apps.who.int/iris/handle/10665/331498
United Kingdom / NHS[15]	April 6 th , 2020	COVID-19: Guidance for infection prevention and control in healthcare settings[15]	https://www.gov.uk/government/publications/wuhan-novel-coronavirus-infection-prevention-and-control/covid-19-personal-protective-equipment-ppe
Health Protection Scotland and NHS[16]	March 2020	Aerosol generating procedures - literature review March (referred to in NHS version April 6 th) version 1.1	https://hpspubsrepo.blob.core.windows.net/hps-website/nss/2893/documents/1_tbp-lr-agp-v1.1.pdf
US / CDC[17]	2003	Public Health Guidance for Community-Level Preparedness and Response to Severe Acute Respiratory Syndrome (SARS) Version 2	https://www.cdc.gov/sars/guidance/infection/healthcare.html#aerosol
Belgium Sciensano[12]	April 3 th , 2020	Coronavirus update. FACT SHEET COVID-19 disease (SARS-CoV-2 virus)	https://action.spike.email/102902/Newsletter/6yid56fovqwvy5vrmnq6u357az5eepwjftahz35zf5rvx5ybirwa?utm_source=Measurement

			ail&utm_medium=email&utm_campaign=COVID19_EN&culture=nl-NL
Canada[18]	2016	Pratiques de Base et Précautions Additionnelles Visant à Prévenir la Transmission des Infections dans les Milieux de Soins	https://www.canada.ca/content/dam/phac-aspc/documents/services/publications/diseases-conditions/routine-practices-precautions-healthcare-associated-infections/pratiques-de-base-precautions-infections-aux-soins-de-sante-2016-FINAL-fra.pdf
Canada[19]	2020	Maladie à coronavirus (COVID-19)	https://www.canada.ca/fr/sante-publique/services/maladies/maladie-coronavirus-covid-19.html
The Netherlands[20]	2020	Richtlijnen COVID-19 Prioritering ademhalingsbeschermingsmaskers voor COVID-19	https://lci.rivm.nl/richtlijnen/covid-19 https://lci.rivm.nl/prioritering-ademhalingsbeschermingsmaskers-voor-covid-19
European Centre for Disease Prevention and Control (ECDC)[21]	2020	Infection prevention and control and preparedness for COVID-19 in healthcare settings - second update	https://www.ecdc.europa.eu/en/publications-data/infection-prevention-and-control-and-preparedness-covid-19-healthcare-settings
Articles from search update Tran[11]			
International Surviving Sepsis Campaign[22]	- 2020	Guidelines on the management of critically ill adults with Coronavirus Disease 2019 (COVID-19)	https://link.springer.com/article/10.1007/s00134-020-06022-5
Lui et al[23]	2020	Overview of guidance for endoscopy during the coronavirus disease 2019 (COVID-19) pandemic	https://www.ncbi.nlm.nih.gov/pubmed/32233034
Givi et al[24]	2020	Safety Recommendations for Evaluation and Surgery of the Head and Neck During the COVID-19 Pandemic	https://www.ncbi.nlm.nih.gov/pubmed/32232423

The retrieved definitions are listed in Table 2.

Table 2 – Definition of aerosol-generating medical procedures by organisation or country

Country /Organisation	Year	Definition of aerosol-generating procedure	Comments retrieved from the document
WHO[9]	2007	The term “aerosol-generating procedure associated with documented increase in risk of pathogen transmission” refers to the performance of the following procedures in acute respiratory distress (ARD) patients: • intubation and related procedures e.g. manual ventilation, suctioning • cardiopulmonary resuscitation • bronchoscopy • surgery and autopsy	
WHO[2]	2014	In this version NO definition is provided except as part of the review article by Tran[11] which is discussed and presented in the annex of this WHO guideline. Definition of aerosol-generating procedure: “An aerosol-generating procedure is defined as any medical procedure that can induce the production of aerosols of various sizes, including droplet nuclei.” The medical procedures considered in the review as aerosol-generating were: • tracheal intubation • non-invasive ventilation • tracheotomy • manual ventilation before intubation • suction before intubation • suction after intubation • manual ventilation after intubation • bronchoscopy • nebulizer treatment • manipulation of oxygen mask • manipulation of bilevel positive airway pressure (BiPAP) mask • defibrillation	Summary statement of the review by Tran[11]: • evidence, the best of which comes from studies of SARS-CoV, suggests a consistent association between pathogen transmission and tracheal intubation • a few studies reported an increased risk of SARS-CoV infection associated with tracheotomy, noninvasive ventilation, and manual ventilation before intubation. • there are only a few studies of very low quality • interpretation and practical application is difficult • no other procedures were found to be significantly associated with any increased risk of ARI transmission. The following recommendations were formulated for aerosol-generating procedures: <u>Recommendation:</u> Use PPE, including gloves, long-sleeved gowns, eye protection (goggles or face shields), and facial mask (surgical or procedure mask, or particulate respirators) during aerosol-generating procedures that have been consistently associated with an increased risk of transmission of ARI pathogens. The available evidence suggests that performing or being exposed to endotracheal intubation either by itself or in combination with other

		• chest compressions • insertion of nasogastric tube • collection of sputum sample • high-frequency oscillatory ventilation • high-flow oxygen • endotracheal aspiration • suction of body fluid • administration of oxygen • chest physiotherapy • mechanical ventilation	procedures (e.g. cardiopulmonary resuscitation or bronchoscopy) is consistently associated with increased risk of transmission. Quality of evidence: Very low to low. Strength of recommendation: Conditional. <u>Recommendation</u>: Use adequately ventilated single rooms when performing aerosol-generating procedures that have been consistently associated with increased risk of ARI transmission. Quality of evidence: Very low to low. Strength of recommendation: Conditional.
WHO[14]	March 19 th , 2020	In this document the focus is on ‘Airborne precautions’ for aerosol-generating procedures. A complete definition is not given; a list of examples is stated instead: “Some aerosol-generating procedures, such as tracheal intubation, non-invasive ventilation, tracheotomy, cardiopulmonary resuscitation, manual ventilation before intubation, and bronchoscopy, have been associated with an increased risk of transmission of coronaviruses.”	Airborne precautions: Ensure that HCWs performing aerosol-generating procedures: • perform procedures in an adequately ventilated room – that is, natural ventilation with air flow of at least 160 L/s per patient or in negative- pressure rooms with at least 12 air changes per hour and controlled direction of air flow when using mechanical ventilation; • use a particulate respirator at least as protective as a US National Institute for Occupational Safety and Health (NIOSH)-certified N95, European Union (EU) standard FFP2, or equivalent. When HCWs put on a disposable particulate respirator, they must always perform the seal check. Note that facial hair (e.g. a beard) may prevent a proper respirator fit; • use eye protection (i.e. goggles or a face shield); • wear a clean, non-sterile, long-sleeved gown and gloves. If gowns are not fluid-resistant, HCWs should use a waterproof apron for procedures expected to create high volumes of fluid that might penetrate the gown; • limit the number of persons present in the room to the absolute minimum required for the patient’s care and support.

WHO[13]	March 19 th , 2020	Examples for aerosol-generating procedures are listed in the context of rational and appropriate use of personal protective equipment (PPE): <i>Examples are</i> • tracheal intubation • non-invasive ventilation • tracheostomy • cardiopulmonary resuscitation • manual ventilation before intubation • bronchoscopy For these procedures health care workers should use respirators, eye protection, gloves and gowns; aprons should also be used if gowns are not fluid resistant.	WHO states that PPE should be used based on the risk of exposure (e.g. type of activity) and the transmission dynamics of the pathogen (e.g. contact, droplet or aerosol). A table is provided with an overview of the recommended PPE (Appendix 2). In summary, health care workers performing aerosol-generating procedures on COVID-19 patients should use a respirator N95 or FFP2 standard, or equivalent, gown, gloves, eye protection and an apron.
WHO[1]	March 29 th , 2020	In the context of COVID-19, airborne transmission may be possible in specific circumstances and settings in which procedures or support treatments that generate aerosols are performed; <i>i.e.</i> • endotracheal intubation • bronchoscopy • open suctioning • administration of nebulized treatment • manual ventilation before intubation • turning the patient to the prone position • disconnecting the patient from the ventilator • non-invasive positive-pressure ventilation • tracheostomy • and cardiopulmonary resuscitation	
United Kingdom / NHS[15]	April 6 th , 2020	The following procedures are currently considered to be potentially infectious aerosol-generating procedures (AGPs) for COVID-19: • intubation, extubation and related procedures, for example manual ventilation and open suctioning of the respiratory tract (including the upper respiratory tract) • tracheotomy or tracheostomy procedures (insertion or open suctioning or removal)	Certain other procedures or equipment may generate an aerosol from material other than patient secretions but are not considered to represent a significant infectious risk. Procedures in this category include administration of pressurised humidified oxygen, entonox or medication via nebulisation. The consensus board 'The New and Emerging Respiratory Virus Threats Advisory Group' (NERVTAG) advised that

		• bronchoscopy and upper ENT airway procedures that involve suctioning • upper gastro-intestinal endoscopy where there is open suctioning of the upper respiratory tract • surgery and post mortem procedures involving high-speed devices • some dental procedures (for example, high-speed drilling) • non-invasive ventilation (NIV); Bi-level Positive Airway Pressure Ventilation (BiPAP) and Continuous Positive Airway Pressure Ventilation (CPAP) • High Frequency Oscillatory Ventilation (HFOV) • induction of sputum (cough)* • high flow nasal oxygen (HFNO) For patients with possible or confirmed COVID-19, any of these potentially infectious AGPs should only be carried out when essential. Where possible, these procedures should be carried out in a single room with the doors shut. Only those healthcare staff who are needed to undertake the procedure should be present. *The NHS recommendations discuss the use of nebulisers in the context of physiotherapy and not asthma. The induction of sputum possibly accompanied by coughing is considered aerosol-generating.	during nebulisation, the aerosol derives from a non-patient source (the fluid in the nebuliser chamber) and does not carry patient-derived viral particles. If a particle in the aerosol coalesces with a contaminated mucous membrane, it will cease to be airborne and therefore will not be part of an aerosol. Staff should use appropriate hand hygiene when helping patients to remove nebulisers and oxygen masks. Chest compressions and defibrillation (as part of resuscitation) are not considered AGPs; first responders (any setting) can commence chest compressions and defibrillation without the need for AGP PPE while awaiting the arrival of other clinicians to undertake airway manoeuvres."
Health Protection Scotland and NHS[16]	March 2020	This document is the review procedure that has been used by the NHS for the UK and Scotland. Aerosol Generating Procedures (AGPs) are defined as: • Intubation, extubation and related procedures e.g. manual ventilation and open suctioning • Tracheotomy/tracheostomy procedures (insertion/open suctioning/removal) • Bronchoscopy and upper ENT airway procedures that involve suctioning • Upper Gastro-intestinal Endoscopy where there is open suctioning of the upper respiratory tract • Surgery and post mortem procedures involving high-speed devices	The ocular route of transmission for pathogens spread by the droplet/airborne route, whilst plausible, lacks scientific evidence. This lack of evidence includes having very little certainty about what the incremental benefit may be of using eye protection routinely when using a FRSM/FFP3 respirator. Eye protection is considered to be necessary and worn if there is a risk of spraying or splashing of blood/body fluids from patient contact or procedure, and always when used with respirators during the performance of AGP.

		• Some dental procedures (e.g. high-speed drilling) • on invasive ventilation (NIV) e.g. Bi-level Positive Airway Pressure Ventilation (BiPAP) and Continuous Positive Airway Pressure Ventilation (CPAP) • High Frequency Oscillatory Ventilation (HFOV) • Induction of sputum or High flow nasal oxygen (HFNO) Aerosol Generating Procedures (AGPs) can produce droplets <5 microns in size which may cause infection if they are inhaled. These small droplets, containing infectious agents, can remain in the air, travel over a distance and still be infectious. AGPs should only be carried out when essential. Where possible, these procedures should be carried out in well-ventilated single rooms with the doors shut. Only those healthcare workers who are needed to undertake the procedure should be present.	
US / CDC[17]	2003	Procedures that stimulate coughing and promote the generation of aerosols include • aerosolized or nebulized medication administration • diagnostic sputum induction • bronchoscopy • airway suctioning • endotracheal intubation • positive pressure ventilation via face mask (e.g. BiPAP, CPAP) • high-frequency oscillatory ventilation	CDC recommended the following: Limit performance of aerosol-generating procedures on SARS patients to those that are considered medically necessary. Clinically appropriate sedation during intubation and bronchoscopy may minimize resistance and coughing during the procedure. Limit the number of healthcare workers in the room during an aerosol-generating procedure to those essential for patient care and support.
Belgium Sciensano[12]	/ April 3th, 2020	The evidence, the best of which comes from studies of SARS-CoV, suggests a consistent association between pathogen transmission and tracheal intubation.[11] In addition, a few studies reported an increased risk of SARS-CoV infection associated with tracheotomy, noninvasive ventilation, and manual ventilation before intubation. However, because these findings were identified from only a few studies of very low quality, interpretation and practical application are difficult. No other procedures were found to be significantly associated with an increased risk of acute respiratory infection transmission. On	

theoretical grounds however, the following procedures should be considered aerosol-generating procedures:

- Intubation, extubation and related procedures
- Tracheotomy/tracheostomy procedures
- Manual ventilation
- Open suctioning
- Bronchoscopy
- Non-invasive ventilation (NIV) e.g. Bi-level positive airway pressure (BiPAP) and Continuous positive airway pressure ventilation (CPAP)
- Surgery and post-mortem procedures in which high-speed devices are used
- High-frequency oscillating ventilation (HFOV) and High-flow nasal oxygen (HFNO)
- Some dental procedures (e.g. high-speed drilling).

Certain other procedures/equipment may generate an aerosol from material other than patient secretions and is unclear if they represent a significant infectious risk. Procedures in this category include administration of pressurized humidified oxygen and administration of medication via nebulization.

Canada[18]

2016

Interventions médicales générant des aérosols (IMGA) sont:

- l'intubation et les interventions connexes (p. ex. la ventilation manuelle, l'aspiration endotrachéale ouverte)
- la réanimation cardio-respiratoire
- la bronchoscopie
- l'induction de l'expectoration
- la thérapie avec aérosol par nébulisation
- la ventilation non invasive en pression positive (pression positive expiratoire continue ou à deux niveaux)

D'autres types d'IMGA pourraient entraîner la génération d'aérosols :

- la ventilation par oscillation à haute fréquence
 - les soins liés à la trachéostomie
 - la kinésithérapie de drainage
-

		• l'écouvillonnage du nasopharynx et les aspirats rhinopharyngés.	
The Netherlands[20]	2020	Gebruik FFP2 bij aerosolvormende handelingen: • Bronchoscopie • cardiopulmonale reanimatie • tracheale intubatie • niet-invasieve beademing • handmatige beademing • optiflow • tracheostomie, handelingen aan het tracheostoma en uitzuigen	Prioritering ademhalingsbeschermingsmaskers voor COVID-19. Ter bescherming van de zorgmedewerker: • chirurgisch mondneusmasker type IIR of FFP1-masker voor verzorging of andere intensieve blootstelling van COVID-19-patiënten; • FFP2-masker bij aerosolvormende handelingen bij COVID-19-patiënten.
International Surviving Sepsis Campaign. Alhazzani et al. [22]	2020	Aerosol-generating procedures in the ICU include: • endotracheal intubation • bronchoscopy • open suctioning • administration of nebulized treatment • manual ventilation before intubation • physical proning of the patient • disconnecting the patient from the ventilator • non-invasive positive pressure ventilation • tracheostomy • and cardiopulmonary resuscitation	Best practice statement: For healthcare workers performing aerosol-generating procedures on patients with COVID-19 in the ICU, it is recommended to use fitted respirator masks (N95 respirators, FFP2, or equivalent), as opposed to surgical/medical masks, in addition to other PPE (i.e. gloves, gown, and eye protection, such as a face shield or safety goggles). Performing aerosol-generating procedures on ICU patients with COVID-19 in a negative pressure room is recommended. Recommendation: For healthcare workers who are performing non-aerosol-generating procedures on mechanically ventilated (closed circuit) patients with COVID-19, it is suggested to use surgical/medical masks, as opposed to respirator masks, in addition to other PPE (i.e. gloves, gown, and eye protection, such as a face shield or safety goggles). Weak recommendation, low-quality evidence." Recommendations: For healthcare workers providing usual care for non-ventilated COVID-19 patients, we suggest using surgical/medical masks, as opposed to respirator masks, in addition to other personal protective equipment (i.e. gloves, gown, and eye protection, such as a face shield or safety goggles). Weak recommendation, low-quality evidence.

ECDC[21]	2020	The list of procedures is based on the paper by Alhazzani et al above and include: • endotracheal intubation • bronchoscopy, open suctioning • administration of nebulised treatment • manual ventilation before intubation • physical prone positioning of the patient • disconnecting the patient from the ventilator • non-invasive positive pressure ventilation • tracheostomy • cardiopulmonary resuscitation	
Lui et al[23]	2020	The definition that is used is that from the WHO. Other aerosol-generating procedures linked to feces are discussed: • Designated toileting facilities should be offered for suspected or confirmed cases • Hygiene measures such as closing the lid before flushing to reduce bioaerosol formation • The risk of other endoscopic procedures such as esophagogastroduodenoscopy (OGD), endoscopic retrograde cholangio-pancreatography (ERCP), endoscopic ultrasound (EUS), flexible laryngoscopy 46 and colonoscopy (CLN) have not been well studied. The British Society of Gastroenterology believes that upper GI endoscopy of all kinds must be regarded as an aerosol prone procedure. • The Safe Airway Society of Australia and New Zealand classifies gastroscopy as a procedure vulnerable to aerosol generation. • A patient who is not suspected to have COVID-19 and is clinically indicated for colonoscopy can be considered as non-high risk. There is no evidence available to suggest that colonoscopy is an aerosol prone procedure.	Emerging evidence suggests that SARS-CoV-2 can be detected in the feces of patients, leading to the distinct possibility of transmission by fecal-oral route. Objectively, during upper endoscopy the patient may aspirate, cough, retch and require oral suction which carries a risk for aerosolisation. The Wuhan practice (supported by the World Endoscopy Organization) which is in line with BSG, Milan group, the Canadian Association of Gastroenterology and the Safe Airway Society advise that such procedures be performed with healthcare personnel wearing full PPE with N95 respirators or equivalent, and water-resistant gowns. Patient discomfort and retching may be minimized by adequate sedation.

Table. Summary of Head and Neck Examination and Procedure Recommendations^a

Risk and definition	Patient wears	Clinician/staff wear
Nonprocedure encounters in non-immune-compromised patients		
High risk to clinician: any examination in: • Patients with active SARS-CoV-2 infection • Patients with influenzalike symptoms • Patients under evaluation for SARS-CoV-2 infection	Surgical mask	• Single-use N95 mask • Goggles or face shield • Gown • Gloves
Moderate risk to clinician: examination of ear, nose, mouth, or throat in asymptomatic patients	Nothing ^b	• Surgical mask with face shield to allow for reuse of mask • Gloves
Low risk to clinician: other examination in asymptomatic patients	Nothing ^b	• Mask optional • Gloves
Aerosol-generating interventional procedures		
Procedures including but not limited to the following: Intubation, extubation, office-based nasal and laryngeal endoscopy, bronchoscopy, gastrointestinal endoscopy, drainage of peritonsillar abscess, placement of nasal packing, foreign body management in the nose or airway, tracheostomy, tracheostomy care, powered instrumentation in mucosal head and neck surgery, possibly laparoscopic surgery		
High risk to clinician: consider delaying or discussing the following: • Patients with active SARS-CoV-2 infection • Patients with influenzalike symptoms • Patients under evaluation for SARS-CoV-2 infection	Surgical mask	• PAPR or single-use N95 mask and goggles or face shield • Gown • Double gloves
Low risk to clinician: • Patients who are asymptomatic and untested or SARS-CoV-2 negative in 48 h preceding surgery • If possible, test patients within 48 h of procedure	Nothing ^b	• N95 mask and eye protection (may be appropriate to reuse; must use face shield to allow reuse) • If unavailable, surgical mask with goggles or face shield • Gown • Double gloves
Non-aerosol-generating interventional procedures		
Soft tissue surgery exposes blood, which can have a viral count, but unless the blood is aerosolized by the use of energy devices, it would be expected to be lower risk. Suctioning away smoke and aerosolized tissue is recommended. To our knowledge, the infectiousness of aerosolized blood with SARS-CoV-2 is not yet known.		
High risk to clinician: consider delaying or discussing in: • Patients with active SARS-CoV-2 infection • Patients with influenzalike symptoms • Patients under evaluation for SARS-CoV-2 infection	Surgical mask	• Single-use N95 mask • Goggles or face shield • Gown • Gloves
Low risk to clinician: patients who are asymptomatic or SARS-CoV-2 negative in last 48 h	Nothing ^b	• Surgical mask • Goggles or face shield • Gown

In conclusion, the definitions that are used by the international and national bodies are mostly based on the WHO 2014 document referring to the review of Tran et al. Similarly, the definition proposed by Sciensano is in line with the retrieved information.

5 RISK OF AEROSOL-GENERATING PROCEDURES

We did not identify new evidence to answer the second research question. Below, we summarise the evidence from WHO on the paper by Tran and one paper by MacIntyre that may be of interest. [2, 11, 25]

Although knowledge evolves on which medical procedures can generate aerosols and are therefore risk procedures for the transmission of infectious particles of respiratory infections, evidence is very limited to define the level of risk associated with an individual aerosol-generating procedure.

The association between medical procedures that are known to produce aerosols and an increased risk of respiratory pathogen transmission was first evaluated with a systematic review by Tran et al.[11] This review has been used as a basis for recommendations by WHO in 2014 and by several other international and national organisations.[2] The review as summarised by WHO in 2014 is added in 0. WHO concluded the following: “The evidence, the best of which comes from studies of SARS-CoV, suggests a consistent association between pathogen transmission and tracheal intubation. In addition, a few studies reported an increased risk of SARS-CoV infection associated with tracheotomy, noninvasive ventilation, and manual ventilation before intubation. However, because these findings were identified from only a few studies of very low quality, interpretation and practical application is difficult. No other procedures were found to be significantly associated with any increased risk of ARI transmission.”

The understanding of the aerobiology of aerosol-generating procedures has since evolved and very recent studies in the context of COVID-19 are now presented online. These studies are needed to better understand the risk of aerosol-generating medical procedures and transmission in general.

We identified only one study from our updated search strategy in the publications.[25] This MacIntyre paper published in 2013 was retrieved through a review published in 2020 by Bartoszko et al. comparing the protective effect of medical masks to N95 respirators in health care workers.[26] From the four studies in the review, only this one study described a high percentage (>70%) of high-risk procedures in the health care workers and results are therefore presented below. Although the study does not provide an answer to the risk related to ‘individual’ procedures, it might be of interest for the comparison between continuous and targeted use of PPE.

MacIntyre et al. compares continuous use of medical masks, continuous use of N95 respirators or targeted (intermittent) use of N95 respirators for high-risk procedures or barrier nursing.[25] The health care workers were given a checklist of defined high-risk procedures, which included common aerosol-generating procedures. This checklist is not provided by the authors. Health care workers frequently undertook high-risk procedures (72% to 77%). The authors conclude that continuous use of N95 respirators was more efficacious against clinical respiratory illness transmission than intermittent use of N95 respirators or medical masks. They argue that although policies for health care workers may recommend use of medical masks alone or targeted N95 respirator use, continuous use of N95 respirators resulted in significantly lower rates of bacterial colonisation. There was no difference for influenza-like illness transmission or laboratory-confirmed viral infections

Table 3 – Results for risk of aerosol-generating medical procedures

Publication	Results
Tran et al.[11]	5 case-control and 5 retrospective cohort studies were identified which evaluated transmission of severe acute respiratory syndrome (SARS) to Health care workers (HCWs). Procedures reported to present an increased risk of transmission included [n; pooled OR(95%CI)] tracheal intubation [n=4 cohort; 6.6 (2.3, 18.9), and n=4 case-control; 6.6 (4.1, 10.6)], non-invasive ventilation [n=2 cohort; OR 3.1(1.4, 6.8)], tracheotomy [n=1 case-control; 4.2 (1.5, 11.5)] and manual ventilation before intubation [n=1 cohort; OR 2.8 (1.3, 6.4)]. Other intubation associated procedures, endotracheal aspiration, suction of body fluids, bronchoscopy, nebulizer treatment, administration of O₂, high flow O₂, manipulation of O₂ mask or BiPAP mask, defibrillation, chest compressions, insertion of nasogastric tube, and collection of sputum were not significant.
MacIntyre et al. 2013[25]	A cluster randomized clinical trial of 1,669 hospital-based HCWs in Beijing, China in the winter of 2009–2010 compared three policy options for the use of medical masks and N95 respirators in healthcare workers (HCWs) working in high-risk hospital wards (sixty-eight emergency departments and respiratory wards of 19 tertiary hospitals). Participants were randomized to medical masks, N95 respirators, or targeted use of N95 respirators while doing high-risk procedures or barrier nursing. The HCWs in the targeted use group were given a checklist of defined high-risk procedures, which included common aerosol-generating procedures.
	The rate of clinical respiratory illness (CRI) was highest in the medical mask arm (98 of 572; 17%), followed by the targeted N95 arm (61 of 516; 11.8%), and the continuous N95 arm (42 of 581; 7.2%)(P,0.05). Bacterial respiratory tract colonization in subjects with CRI was highest in the medical mask arm (14.7%; 84 of 572), followed by the targeted N95 arm (10.1%; 52 of 516), and lowest in the continuous arm (6.2%; 36 of 581) (P =0.02). After adjusting for confounders, only continuous use of N95 respirators remained significant against CRI and bacterial colonization, and CRI only, compared with targeted N95 use. Targeted N95 use was not superior to medical masks.

■ APPENDICES

APPENDIX 1. SEARCH STRATEGY

Search strategy updated search Tran[11].

A. Cochrane search

B. Embase search

C. Medline – Ovid search

A. Cochrane search

Search Name: Aerosol generating procedure strategy

Date Run: 03/04/2020 22:55:00

Comment:

ID	Search Hits	
#1	[mh "Positive-Pressure Respiration"]	2635
#2	[mh "High-Frequency Ventilation"]	195
#3	[mh "ventilators, mechanical"]	262
#4	[mh ^"Ventilation"]	80
#5	[mh "Intubation, Intratracheal"]	4292
#6	[mh ^"suction"]	897
#7	[mh ^"Tracheostomy"]	183
#8	[mh ^"Bronchoscopy"]	667
#9	[mh ^"Thoracostomy"]	56
#10	[mh "Nebulizers and Vaporizers"]	2274
#11	[mh ^"Sputum"]	1247
#12	[mh ^"Oxygen Inhalation Therapy"]	1116
#13	[mh ^"Autopsy"]	44
#14	[mh "Respiratory Function Tests"]	23517
#15	[mh "Spirometry"]	1659
#16	[mh "cardiopulmonary resuscitation"]	1028
#17	[mh ^"respiration, artificial"]	3278
#18	[mh ^"Breathing exercises"]	760
#19	#1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17 OR #18	
		35931
#20	[mh ^"Physical Therapy Modalities"]	3563
#21	[mh ^"thorax"]	348
#22	#20 and #21	18
#23	#19 or #22	35935
#24	(ventilation or ventilator or ventilating or ventilatory):ab,ti25920	
#25	(respirator or respirators or (respirat* NEXT/2 (support or care))):ab,ti	
		1657

- #26 (intubation or intubated or extubation or extubated):ab,ti 19321
- #27 ((respiratory or airway or "air way" or open) NEAR/3 suction*):ab,ti 182
- #28 (nebulize* or nebulise* or aerosolize* or aerosolise*):ab,ti 4746
- #29 ("heat moisture" NEXT/2 exchange*):ab,ti 26
- #30 (bronchoscopy or tracheostomy or thoracostomy):ab,ti 2594
- #31 (chest NEAR/3 physiotherapy):ab,ti 507
- #32 (sputum NEAR/3 (induction or inducing)):ab,ti 194
- #33 (oxygen NEXT/2 therap*):ab,ti 2444
- #34 ((lung or pulmonary) NEXT/2 function NEXT/2 test):ab,ti 770
- #35 ((continuous or bilevel) NEAR/2 ("positive airway" or "positive pressure")):ab,ti 3638
- #36 ("cardiopulmonary resuscitation" or "artificial resuscitation" or "artificial respiration"):ab,ti 1641
- #37 (autopsy NEAR/3 ("lung tissue" or "lung tissues")):ab,ti 0
- #38 #24 OR #25 OR #26 OR #27 OR #28 OR #29 OR #30 OR #31 OR #32 OR #33 OR #34 OR #35 OR #36 OR #37 52545
- #39 #23 or #38 75358
- #40 [mh "Health personnel"] 8425
- #41 (((("health care" or healthcare) NEXT/1 (worker* or provider*)) or physiotherapist* or dentist* or nurse* or doctor* or physician* or "hospital personnel" or "health personnel" or "medical personnel" or "hospital worker" or "hospital workers" or staff or ((healthcare or "health care") NEXT/1 professional*) or "care giver" or "care givers" or caregiver* or paramedic* or therapist*):ab,ti 105622
- #42 #40 or #41 108227
- #43 [mh ^"Infectious Disease Transmission, Patient-to-Professional"] 59
- #44 [mh ^"occupational exposure"] 503
- #45 [mh ^"air microbiology"] 65
- #46 [mh ^"infectious disease transmission"] 107
- #47 [mh ^"airborne infection"] 0
- #48 [mh ^"infection control"] 524
- #49 [mh ^"infection control, dental"] 20
- #50 [mh "cross infection"] 1248
- #51 [mh ^"Disease Outbreaks"] 194
- #52 [mh ^"Aerosols"] 2041
- #53 ((aerosol* or cough* or droplet* or infection* or infectious or disease*) NEAR/3 (generat* or induc* or stimulat* or produc* or creat* or (respirable NEXT/1 range*) or dispers* or transmission or transmitted or transmit or spread* or disseminat* or count* or precaution* or control* or inhibit* or prevent* or reduc*)):ab,ti 35428
- #54 "cross infection":ab,ti 79
- #55 #44 OR #45 OR #46 OR #47 OR #48 OR #49 OR #50 OR #51 OR #52 OR #53 OR #54 39189
- #56 #39 and #43 7
- #57 #39 and #42 and #55 270

#58 #56 or #57 271

#59 (aerosol* NEAR/2 generat* NEAR/2 procedure*):ab,ti 4

#60 #58 or #59 273

#61 [mh "Health personnel"[mj]] 3432

#62 (((("health care" or healthcare) NEXT/1 (worker* or provider*)) or physiotherapist* or dentist* or nurse* or doctor* or physician* or "hospital personnel" or "health personnel" or "medical personnel" or "hospital worker" or "hospital workers" or staff or ((healthcare or "health care") NEXT/1 professional*) or "care giver" or "care givers" or caregiver* or paramedic* or therapist*):ti13963

#63 #61 or #62 15784

#64 #43 or #55 39211

#65 [mh ^"human influenza"] 2606

#66 [mh "Influenza A virus"] 839

#67 [mh ^"SARS virus"] 9

#68 [mh ^"Severe Acute Respiratory Syndrome"] 47

#69 [mh "tuberculosis"] 586

#70 [mh "pneumonia"] 3460

#71 #65 or #66 or #67 or #68 or #69 or #70 6844

#72 (influenza* or H1N1 or tuberculosis or pneumonia or pneumococcus or "severe acute respiratory syndrome" or SARS or ("acute respiratory" NEXT/2 infection*)):ab,ti 22982

#73 #71 or #72 24084

#74 ("covid19" or "covid2019" or "covid-19" or "covid-2019" or "ncov-2019" or "ncov-19" or "2019-ncov" or "19-ncov" or "sars-cov-19" or "sars-cov-2" or "sars-cov2" or "novel coronavirus"):ab,ti 27

#75 #73 or #74 24085

#76 #63 and #64 and #75 49

#77 #60 or #76 307

#78 #63 and #64 and #73 49

#79 #60 or #78 307

#80 #75 NOT #73 1

#81 #79 NOT #77 0

#82 #79 with Cochrane Library publication date Between Oct 2010 and Dec 2020, in Cochrane Reviews 11

#83 #79 with Publication Year from 2010 to 2020, in Trials 172

#84 #79 NOT (#82 OR #83) 124

B. Embase Session Results (7 Apr 2020)

No.	Query	Results
#177	#161 AND #172	9
#176	#143 AND #172	28
#175	#112 AND #172	4
#174	#94 AND #172	1
#173	#172 NOT ('conference abstract'/it OR 'conference paper'/it OR 'conference review'/it)	23
#172	#79 NOT [medline]/lim	39

#171 #161 AND #167 113
 #170 #143 AND #167 334
 #169 #112 AND #167 55
 #168 #94 AND #167 32
 #167 #166 NOT ('conference abstract'/it OR 'conference paper'/it OR 'conference review'/it) 570
 #166 #76 NOT [medline]/lim 2906
 #165 #164 NOT ('conference abstract'/it OR 'conference paper'/it OR 'conference review'/it) 438
 #164 #163 NOT [medline]/lim 2123
 #163 (#76 OR #79) AND #162 3742
 #162 #94 OR #112 OR #143 OR #161 11171960
 #161 #144 OR #145 OR #146 OR #147 OR #148 OR #149 OR #150 OR #151 OR #152 OR #153 OR #154 OR #155 OR #156 OR #157 OR #158 OR #159 OR #160 1006999
 #160 (algorithm* NEAR/3 (pharmacotherap* OR chemotherap* OR chemotreatment* OR therap* OR treatment* OR intervention*)):ab,ti,kw 16723
 #159 (algorithm* NEAR/3 (screening OR examination OR test OR tested OR testing OR assessment* OR diagnosis OR diagnoses OR diagnosed OR diagnosing)):ab,ti,kw 15461
 #158 (care NEAR/3 (standard OR path OR paths OR pathway OR pathways OR map OR maps OR plan OR plans)):ab,ti,kw 106754
 #157 recommendat*:ti,kw 51222
 #156 ((critical OR clinical OR practice) NEAR/3 (path OR paths OR pathway OR pathways OR protocol*)):ab,ti,kw 41607
 #155 consensus*:ti,kw 31899
 #154 cpg:ti,kw OR cpgs:ti,kw 9373
 #153 ((practice OR treatment*) NEAR/3 guideline*):ab 62512
 #152 standards:ti,kw OR guideline:ti,kw OR guidelines:ti,kw 150188
 #151 'position statement':ab,ti,kw OR 'policy statement':ab,ti,kw OR 'practice parameter':ab,ti,kw OR 'best practice':ab,ti,kw 46592
 #150 'health care planning'/de 99836
 #149 'guideline'/de 141
 #148 'practice guideline'/exp 536954
 #147 'consensus development'/de 23815
 #146 'consensus'/exp 67763
 #145 'clinical protocol'/exp 98114
 #144 'clinical pathway'/de 8314
 #143 #113 OR #114 OR #115 OR #116 OR #117 OR #118 OR #119 OR #120 OR #121 OR #122 OR #123 OR #124 OR #125 OR #126 OR #127 OR #128 OR #129 OR #130 OR #131 OR #132 OR #133 OR #134 OR #135 OR #136 OR #137 OR #138 OR #139 OR #140 OR #141 OR #142 8857400
 #142 'health services research'/de 33036
 #141 (case NEAR/3 (report OR reports OR study OR studies OR histories)):ab,ti,kw 1000246
 #140 'case report'/de 2539986

#139 'case series':ab,ti,kw 100668

#138 (prevalence NEAR/3 (study OR studies OR analysis OR analyses)):ab,ti,kw 54308

#137 (('non experiment' OR nonexperiment OR 'non experimental' OR nonexperimental) NEAR/3 (study OR studies OR design OR analysis OR analyses)):ab,ti,kw 1840

#136 (quasi NEAR/2 (experiment OR experiments OR experimental)):ab,ti,kw 16273

#135 'natural experiment':ab,ti,kw OR 'natural experiments':ab,ti,kw 2311

#134 ('cross sectional' NEAR/7 (study OR studies OR design OR research OR analysis OR analyses OR survey OR findings)):ab,ti,kw 370199

#133 ((multidimensional OR 'multi dimensional') NEAR/3 (study OR studies OR design OR analysis OR analyses)):ab,ti,kw 4255

#132 (descriptive NEAR/3 (study OR studies OR design OR analysis OR analyses)):ab,ti,kw 111479

#131 (population NEAR/3 (study OR studies OR analysis OR analyses)):ab,ti,kw 268042

#130 ('case referent' NEAR/3 (study OR studies OR design OR analysis OR analyses)):ab,ti,kw 672

#129 ((case NEAR/2 control):ab,ti,kw) OR ((case NEAR/2 comparison):ab,ti,kw) OR ((case NEAR/2 controlled):ab,ti,kw) 169112

#128 (retrospective NEAR/7 (study OR studies OR design OR analysis OR analyses OR cohort OR data OR review)):ab,ti,kw 788701

#127 ((longitudinal OR longterm OR 'long term') NEAR/7 (study OR studies OR design OR analysis OR analyses OR data OR cohort)):ab,ti,kw 378625

#126 (('follow up' OR followup) NEAR/7 (study OR studies OR design OR analysis OR analyses)):ab,ti,kw 210884

#125 (prospective NEAR/7 (study OR studies OR design OR analysis OR analyses OR cohort)):ab,ti,kw 636566

#124 (cohort NEAR/7 (study OR studies OR design OR analysis OR analyses)):ab,ti,kw 424363

#123 (observational NEAR/3 (study OR studies OR design OR analysis OR analyses)):ab,ti,kw 221449

#122 'quasi experimental study'/de 6666

#121 'observational study'/de 192882

#120 'cross-sectional study'/de 340332

#119 'case control study'/exp 170185

#118 'retrospective study'/de 899044

#117 'follow-up'/de 1533105

#116 'prospective study'/de 590815

#115 'longitudinal study'/de 137245

#114 'cohort analysis'/de 563147

#113 'epidemiology'/exp 3393226

#112 #95 OR #96 OR #97 OR #98 OR #99 OR #100 OR #101 OR #102 OR #103 OR #104 OR #105 OR #106 OR #107 OR #108 OR #109 OR #110 OR #111 2545386

#111 (('open label' OR 'open label') NEAR/5 (study OR studies OR trial*)):ti,ab,kw 61841

#110 (allocated NEAR/1 to):ti,ab,kw 49419

#109 nonrandom*:ti,ab,kw OR 'non random*':ti,ab,kw OR 'non-random*':ti,ab,kw OR 'quasi-random*':ti,ab,kw OR quasirandom*:ti,ab,kw 54271

#108 (control* NEAR/3 (study OR studies OR trial*)):ti,ab 690201

#107 ((tripl* OR trebl*) NEAR/2 (blind* OR dumm* OR mask*)):ti,ab,kw 1387

#106 ((singl* OR doubl*) NEAR/2 (blind* OR dumm* OR mask*)):ti,ab,kw 237921

#105 random*:ti,ab,kw OR sham:ti,ab,kw OR placebo*:ti,ab,kw 1708606

#104 'control group'/de 108292

#103 'placebo'/de 354504

#102 'single blind procedure'/de 38292

#101 'double blind procedure topic'/de 22

#100 'double blind procedure'/de 170980

#99 'randomization'/de 86001

#98 'controlled clinical trial topic'/de 10630

#97 'controlled clinical trial'/de 429647

#96 'randomized controlled trial topic'/de 176407

#95 'randomized controlled trial'/de 596717

#94 #80 OR #81 OR #82 OR #83 OR #84 OR #85 OR #86 OR #87 OR #88 OR #89 OR #90 OR #91 OR #92 OR #93 628027

#93 'meta analysis' OR 'systematic review' 442724

#92 cochrane:jt OR 'health technology assessment':jt OR 'evidence report':jt 23024

#91 medline:ti,ab,kw OR cochrane:ti,ab,kw OR pubmed:ti,ab,kw OR medlars:ti,ab,kw 266643

#90 'meta-analy*' OR metaanaly* OR 'systematic review*' OR 'biomedical technology assessment*' OR 'bio-medical technology assessment*' 482840

#89 'meta regression*':ab,ti,kw OR metaregression*:ab,ti,kw OR 'mega regression*':ab,ti,kw 10713

#88 'met analy*':ab,ti,kw OR metanaly*:ab,ti,kw OR 'health technology assessment*':ab,ti,kw OR hta:ab,ti,kw OR htas:ab,ti,kw 11434

#87 'mantel haenszel':ab,ti,kw OR peto:ab,ti,kw OR 'der simonian':ab,ti,kw OR dersimonian:ab,ti,kw OR 'fixed effect*':ab,ti,kw OR 'latin square*':ab,ti,kw 33717

#86 handsearch*:ab,ti,kw OR 'hand search*':ab,ti,kw 10903

#85 'data syntheses*':ab,ti,kw OR 'data extraction*':ab,ti,kw OR 'data abstraction*':ab,ti,kw 32444

#84 ((integrative NEAR/3 (review* OR overview*)):ab,ti,kw) OR ((collaborative NEAR/3 (review* OR overview*)):ab,ti,kw) OR ((pool* NEAR/3 analy*):ab,ti,kw) 37156

#83 ((quantitative NEAR/3 (review* OR overview* OR syntheses*)):ab,ti,kw) OR ((research NEAR/3 (integrati* OR overview*)):ab,ti,kw) 12696

#82 ((systematic* NEAR/3 (review* OR overview*)):ab,ti,kw) OR ((methodologic* NEAR/3 (review* OR overview*)):ab,ti,kw) 229496

#81 'systematic review'/de OR 'systematic review topic'/de OR 'systematic review (topic)'/de OR 'biomedical technology assessment'/de 273352

#80 'meta analysis'/exp OR 'meta analysis (topic)'/exp 220298

#79 #78 AND [2020]/py 135

#78 #55 OR #77 8690

#77 #58 AND #52 AND #71 3006

#76 #75 AND [2010-2019]/py 5135

#75 #55 OR #74 8698

#74 #58 AND #52 AND #73 3016

#73 #71 OR #72 749358

#72 covid19:ab,ti,kw OR covid2019:ab,ti,kw OR 'covid 19':ab,ti,kw OR 'covid 2019':ab,ti,kw OR 'ncov 2019':ab,ti,kw OR 'ncov 19':ab,ti,kw OR '2019 ncov':ab,ti,kw OR '19 ncov':ab,ti,kw OR 'sars cov 19':ab,ti,kw OR 'sars cov 2':ab,ti,kw OR 'sars cov2':ab,ti,kw OR 'novel coronavirus':ab,ti,kw 2366

#71 #69 OR #70 748515

#70 influenza*:ab,ti,kw OR h1n1:ab,ti,kw OR tuberculosis:ab,ti,kw OR pneumonia:ab,ti,kw OR pneumococcus:ab,ti,kw OR 'severe acute respiratory syndrome':ab,ti,kw OR sars:ab,ti,kw OR 'acute respiratory infection*':ab,ti,kw 536334

#69 #59 OR #60 OR #61 OR #62 OR #63 OR #64 OR #65 OR #66 OR #67 OR #68 552146

#68 'respiratory syncytial pneumovirus'/de 17236

#67 'pneumonia'/de 173161

#66 'streptococcus pneumoniae'/de 44352

#65 'drug resistant tuberculosis'/de 2272

#64 'lung tuberculosis'/de 84526

#63 'tuberculosis'/de 137390

#62 'parainfluenza virus infection'/de 1271

#61 'influenza'/exp 91609

#60 'influenza virus'/exp 63701

#59 'coronavirus infection'/exp 11793

#58 #56 OR #57 770060

#57 'health care worker*':ti OR 'healthcare worker*':ti OR 'health care provider*':ti OR 'healthcare provider*':ti OR 'physiotherapist*':ti OR 'dentist*':ti OR 'nurse*':ti OR 'doctor*':ti OR 'physician*':ti OR 'health personnel':ti OR 'medical personnel':ti OR 'hospital personnel':ti OR 'hospital worker*':ti OR 'staff':ti OR 'healthcare professional*':ti OR 'health care professional*':ti OR 'care giver*':ti OR 'caregiver*':ti OR 'paramedic*':ti OR 'therapist*':ti 398232

#56 'health care personnel'/exp/mj 516197

#55 #53 OR #54 6045

#54 (aerosol* NEAR/2 generat* NEAR/2 procedure*):ab,ti,kw 83

#53 #37 AND #40 AND #52 5999

#52 #41 OR #42 OR #43 OR #44 OR #45 OR #46 OR #47 OR #48 OR #49 OR #50 OR #51 956731

#51 'cross infection':ab,ti,kw 3320

#50 ((aerosol* OR cough* OR droplet* OR infection* OR infectious OR disease*) NEAR/3 (generat* OR induc* OR stimulat* OR produc* OR creat* OR 'respirable range*' OR dispers* OR transmission OR transmitted OR transmit OR spread* OR disseminat* OR count* OR precaution* OR control* OR inhibit* OR prevent* OR reduc*))ab,ti,kw 611763

#49 'aerosol'/de 57192

#48 'disease transmission'/de 98960

#47 'bacterial transmission'/de 13316

#46 'virus transmission'/de 59951

- #45 'hospital infection'/de 43474
- #44 'cross infection'/exp 21982
- #43 'infection control'/de 86094
- #42 'airborne infection'/de 1775
- #41 'occupational exposure'/de 80458
- #40 #38 OR #39 2360253
- #39 'health care worker*':ab,ti,kw OR 'healthcare worker*':ab,ti,kw OR 'health care provider*':ab,ti,kw OR 'healthcare provider*':ab,ti,kw OR 'physiotherapist*':ab,ti,kw OR 'dentist*':ab,ti,kw OR 'nurse*':ab,ti,kw OR 'doctor*':ab,ti,kw OR 'physician*':ab,ti,kw OR 'health personnel':ab,ti,kw OR 'medical personnel':ab,ti,kw OR 'hospital personnel':ab,ti,kw OR 'hospital worker*':ab,ti,kw OR 'staff':ab,ti,kw OR 'healthcare professional*':ab,ti,kw OR 'health care professional*':ab,ti,kw OR 'care giver*':ab,ti,kw OR 'caregiver*':ab,ti,kw OR 'paramedic*':ab,ti,kw OR 'therapist*':ab,ti,kw 1440696
- #38 'health care personnel'/exp 1541332
- #37 #21 OR #36 991520
- #36 #22 OR #23 OR #24 OR #25 OR #26 OR #27 OR #28 OR #29 OR #30 OR #31 OR #32 OR #33 OR #34 OR #35 444718
- #35 (autopsy NEAR/3 'lung tissue*'):ab,ti,kw 170
- #34 'cardiopulmonary resuscitation':ab,ti,kw OR 'artificial resuscitation':ab,ti,kw OR 'artificial respiration':ab,ti,kw 24289
- #33 ((continuous OR bilevel) NEAR/2 ('positive airway' OR 'positive pressure')):ab,ti,kw 15398
- #32 'lung function test*':ab,ti,kw OR 'pulmonary function test*':ab,ti,kw 28811
- #31 'oxygen therap*':ab,ti,kw 15795
- #30 (sputum NEAR/3 (induction OR inducing)):ab,ti,kw 1293
- #29 (chest NEAR/3 physiotherapy):ab,ti,kw 1516
- #28 bronchoscopy:ab,ti,kw OR tracheostomy:ab,ti,kw OR thoracostomy:ab,ti,kw 56415
- #27 'heat moisture exchange*':ab,ti,kw 79
- #26 nebulize*:ab,ti,kw OR nebulise*:ab,ti,kw OR aerosolize*:ab,ti,kw OR aerosolise*:ab,ti,kw 21125
- #25 ((respiratory OR airway OR 'air way' OR open) NEAR/3 suction*):ab,ti,kw 593
- #24 intubation:ab,ti,kw OR intubated:ab,ti,kw OR extubation:ab,ti,kw OR extubated:ab,ti,kw 99957
- #23 (respirator:ab,ti,kw OR respirators:ab,ti,kw OR respirat*:ab,ti,kw) AND support:ab,ti,kw OR 'respirat* care':ab,ti,kw 46043
- #22 ventilation:ab,ti,kw OR ventilator:ab,ti,kw OR ventilating:ab,ti,kw OR ventilatory:ab,ti,kw 220750
- #21 #1 OR #2 OR #3 OR #4 OR #5 OR #6 OR #7 OR #8 OR #9 OR #10 OR #11 OR #12 OR #13 OR #14 OR #15 OR #16 OR #17 OR #18 OR #19 OR #20 798285
- #20 'breathing exercise'/de 7664
- #19 'artificial ventilation'/de 134711
- #18 'resuscitation'/de 113347
- #17 'lung function test'/exp 192243
- #16 'autopsy'/de 155386

#15	'oxygen therapy'/de	30818
#14	'sputum examination'/de	1859
#13	'sputum analysis'/de	9115
#12	'sputum'/de	26083
#11	'nebulizer'/exp	9974
#10	'nebulization'/de	7172
#9	'thorax drainage'/de	9338
#8	'bronchoscopy'/exp	60054
#7	'tracheobronchial toilet'/de	3051
#6	'tracheostomy'/de	24354
#5	'suction'/de	10596
#4	'endotracheal intubation'/de	49800
#3	'intermittent positive pressure ventilation'/de	3354
#2	'high frequency ventilation'/de	3813
#1	'positive end expiratory pressure'/de	54822

C. Ovid MEDLINE

Database: Ovid MEDLINE(R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations, Daily and Versions(R) <1946 to April 02, 2020>

Search Strategy:

-
- 1 exp Positive-Pressure Respiration/ (25519)
 - 2 exp High-Frequency Ventilation/ (2814)
 - 3 exp ventilators, mechanical/ (8976)
 - 4 Ventilation/ (5627)
 - 5 exp Intubation, Intratracheal/ (38340)
 - 6 suction/ (12359)
 - 7 Tracheostomy/ (7274)
 - 8 Bronchoscopy/ (24891)
 - 9 Thoracostomy/ (1434)
 - 10 exp "Nebulizers and Vaporizers"/ (11169)
 - 11 Sputum/ (21145)
 - 12 Oxygen Inhalation Therapy/ (14159)
 - 13 Autopsy/ (41796)
 - 14 exp Respiratory Function Tests/ (232295)
 - 15 exp Spirometry/ (21664)
 - 16 exp cardiopulmonary resuscitation/ (17648)
 - 17 respiration, artificial/ (47919)
 - 18 Breathing exercises/ (3362)
 - 19 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 (461327)

- 20 Physical Therapy Modalities/ (36323)
- 21 thorax/ (21243)
- 22 20 and 21 (131)
- 23 19 or 22 (461402)
- 24 (ventilation or ventilator or ventilating or ventilatory).ti,ab,kf. (146597)
- 25 (respirator or respirators or respirat* support or respirat* care).ti,ab,kf. (11298)
- 26 (intubation or intubated or extubation or extubated).ti,ab,kf. (62606)
- 27 ((respiratory or airway or air way or open) adj3 suction*).ti,ab,kf. (399)
- 28 (nebulize* or nebulise* or aerosolize* or aerosolise*).ti,ab,kf. (14533)
- 29 heat moisture exchange*.ti,ab,kf. (58)
- 30 (bronchoscopy or tracheostomy or thoracostomy).ti,ab,kf. (34349)
- 31 (chest adj3 physiotherapy).ti,ab,kf. (857)
- 32 (sputum adj3 (induction or inducing)).ti,ab,kf. (776)
- 33 oxygen therap*.ti,ab,kf. (11211)
- 34 (lung function test* or pulmonary function test*).ti,ab,kf. (15648)
- 35 ((continuous or bilevel) adj2 (positive airway or positive pressure)).ti,ab,kf. (10101)
- 36 (cardiopulmonary resuscitation or artificial resuscitation or artificial respiration).ti,ab,kf. (16685)
- 37 (autopsy adj3 lung tissue*).ti,ab,kf. (119)
- 38 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32 or 33 or 34 or 35 or 36 or 37 (282521)
- 39 23 or 38 (602346)
- 40 exp Health personnel/ (505962)
- 41 (health care worker* or healthcare worker* or health care provider* or healthcare provider* or physiotherapist* or dentist* or nurse* or doctor* or physician* or health personnel or medical personnel or hospital personnel or hospital worker* or staff or healthcare professional* or health care professional* or care giver* or caregiver* or paramedic* or therapist*).ti,ab,kf. (1079892)
- 42 40 or 41 (1334145)
- 43 Infectious Disease Transmission, Patient-to-Professional/ (3841)
- 44 occupational exposure/ (53834)
- 45 air microbiology/ (7560)
- 46 infectious disease transmission/ (9043)
- 47 airborne infection/ (0)
- 48 infection control/ (23365)
- 49 infection control, dental/ (1127)
- 50 exp cross infection/ (58541)
- 51 Disease Outbreaks/ (78388)
- 52 Aerosols/ (30018)
- 53 ((aerosol* or cough* or droplet* or infection* or infectious or disease*) adj3 (generat* or induc* or stimulat* or produc* or creat* or respirable range* or dispers* or transmission or transmitted or transmit or spread* or disseminat* or count* or precaution* or control* or inhibit* or prevent* or reduc*)).ti,ab,kf. (437952)
- 54 cross infection.ti,ab,kf. (2981)

- 55 44 or 45 or 46 or 47 or 48 or 49 or 50 or 51 or 52 or 53 or 54 (643888)
- 56 39 and 43 (295)
- 57 39 and 42 and 55 (2742)
- 58 56 or 57 (2867)
- 59 (aerosol* adj2 generat* adj2 procedure*).ti,ab,kf. (77)
- 60 58 or 59 (2913)
- 61 exp *Health personnel/ (369761)
- 62 (health care worker* or healthcare worker* or health care provider* or healthcare provider* or physiotherapist* or dentist* or nurse* or doctor* or physician* or hospital personnel or health personnel or medical personnel or hospital worker* or staff or healthcare professional* or health care professional* or care giver* or caregiver* or paramedic* or therapist*).ti,kf. (379915)
- 63 61 or 62 (602245)
- 64 43 or 55 (645369)
- 65 human influenza/ (48368)
- 66 exp Influenza A virus/ (43035)
- 67 SARS virus/ (2915)
- 68 Severe Acute Respiratory Syndrome/ (4480)
- 69 exp tuberculosis/ (190457)
- 70 exp pneumonia/ (90805)
- 71 65 or 66 or 67 or 68 or 69 or 70 (349992)
- 72 (influenza* or H1N1 or tuberculosis or pneumonia or pneumococcus or severe acute respiratory syndrome or SARS or acute respiratory infection*).ti,ab,kf. (444475)
- 73 71 or 72 (523647)
- 74 (covid19 or covid2019 or covid-19 or covid-2019 or ncov-2019 or ncov-19 or 2019-ncov or 19-ncov or sars-cov-19 or sars-cov-2 or sars-cov2 or novel coronavirus).ab,ti,kf. (2823)
- 75 73 or 74 (524931)
- 76 63 and 64 and 75 (2340)
- 77 60 or 76 (4945)
- 78 63 and 64 and 73 (2331)
- 79 60 or 78 (4936)
- 80 meta-analysis.pt. (112929)
- 81 meta-analysis/ or systematic review/ or meta-analysis as topic/ or exp technology assessment, biomedical/ (212477)
- 82 ((systematic* adj3 (review* or overview*)) or (methodologic* adj3 (review* or overview*))).ti,ab,kf. (184003)
- 83 ((quantitative adj3 (review* or overview* or syntheses*)) or (research adj3 (integrati* or overview*))).ti,ab,kf. (10660)
- 84 ((integrative adj3 (review* or overview*)) or (collaborative adj3 (review* or overview*)) or (pool* adj3 analy*).ti,ab,kf. (25955)
- 85 (data syntheses* or data extraction* or data abstraction*).ti,ab,kf. (26281)
- 86 (handsearch* or hand search*).ti,ab,kf. (9107)
- 87 (mantel haenszel or peto or der simonian or dersimonian or fixed effect* or latin square*).ti,ab,kf. (25778)

- 88 (met analy* or metanaly* or health technology assessment* or HTA or HTAs).ti,ab,kf. (6715)
- 89 (meta regression* or metaregression* or mega regression*).ti,ab,kf. (8531)
- 90 (meta-analy* or metaanaly* or systematic review* or biomedical technology assessment* or bio-medical technology assessment*).mp,hw. (297438)
- 91 (medline or Cochrane or pubmed or medlars).ti,ab,hw. (213747)
- 92 (cochrane or health technology assessment or evidence report).jw. (16839)
- 93 (meta-analysis or systematic review).mp. (276844)
- 94 80 or 81 or 82 or 83 or 84 or 85 or 86 or 87 or 88 or 89 or 90 or 91 or 92 or 93 (435385)
- 95 (Randomized Controlled Trial or Controlled Clinical Trial).pt. (591893)
- 96 Randomized Controlled Trial/ (503147)
- 97 Randomized Controlled Trials as Topic/ (131765)
- 98 Controlled Clinical Trial/ (93595)
- 99 Controlled Clinical Trials as Topic/ (5498)
- 100 Random Allocation/ (102503)
- 101 Double-Blind Method/ (156897)
- 102 Single-Blind Method/ (28300)
- 103 Placebos/ (34797)
- 104 Control Groups/ (1665)
- 105 (random* or sham or placebo*).ti,ab,hw. (1473462)
- 106 ((singl* or doubl*) adj (blind* or dumm* or mask*)).ti,ab,hw. (234000)
- 107 ((tripl* or trebl*) adj (blind* or dumm* or mask*)).ti,ab,hw. (986)
- 108 (control* adj3 (study or studies or trial*)).ti,ab. (518576)
- 109 (Nonrandom* or non random* or non-random* or quasi-random* or quasirandom*).ti,ab,hw. (43198)
- 110 (allocated adj1 to).ti,ab,hw. (0)
- 111 ((open label or open-label) adj5 (study or studies or trial*)).ti,ab,hw. (33874)
- 112 95 or 96 or 97 or 98 or 99 or 100 or 101 or 102 or 103 or 104 or 105 or 106 or 107 or 108 or 109 or 110 or 111 (1767167)
- 113 epidemiologic methods.sh. (31288)
- 114 epidemiologic studies.sh. (8259)
- 115 cohort studies/ (258210)
- 116 longitudinal studies/ (132545)
- 117 prospective studies/ (533650)
- 118 follow-up studies/ (637184)
- 119 retrospective studies/ (809493)
- 120 case-control studies/ (280593)
- 121 cross-sectional study/ (322887)
- 122 observational study/ (77113)
- 123 quasi experimental study/ (646)
- 124 (observational adj3 (study or studies or design or analysis or analyses)).ti,ab,kf. (141266)

- 125 (cohort adj7 (study or studies or design or analysis or analyses)).ti,ab,kf. (275171)
- 126 (prospective adj7 (study or studies or design or analysis or analyses or cohort)).ti,ab,kf. (426829)
- 127 ((follow up or followup) adj7 (study or studies or design or analysis or analyses)).ti,ab,kf. (134545)
- 128 ((longitudinal or longterm or (long adj term)) adj7 (study or studies or design or analysis or analyses or data or cohort)).ti,ab,kf. (265296)
- 129 (retrospective adj7 (study or studies or design or analysis or analyses or cohort or data or review)).ti,ab,kf. (473418)
- 130 ((case adj control) or (case adj comparison) or (case adj controlled)).ti,ab,kf. (127649)
- 131 (case-referent adj3 (study or studies or design or analysis or analyses)).ti,ab,kf. (616)
- 132 (population adj3 (study or studies or analysis or analyses)).ti,ab,kf. (178678)
- 133 (descriptive adj3 (study or studies or design or analysis or analyses)).ti,ab,kf. (74433)
- 134 ((multidimensional or (multi adj dimensional)) adj3 (study or studies or design or analysis or analyses)).ti,ab,kf. (3596)
- 135 (cross adj sectional adj7 (study or studies or design or research or analysis or analyses or survey or findings)).ti,ab,kf. (282977)
- 136 ((natural adj experiment) or (natural adj experiments)).ti,ab,kf. (2076)
- 137 (quasi adj (experiment or experiments or experimental)).ti,ab,kf. (13289)
- 138 ((non experiment or nonexperiment or non experimental or nonexperimental) adj3 (study or studies or design or analysis or analyses)).ti,ab,kf. (1354)
- 139 (prevalence adj3 (study or studies or analysis or analyses)).ti,ab,kf. (36890)
- 140 case series.ti,ab,kf. (72111)
- 141 case reports.pt. (2087190)
- 142 (case adj3 (report or reports or study or studies or histories)).ti,ab,kf. (783291)
- 143 organizational case studies.sh. (12235)
- 144 113 or 114 or 115 or 116 or 117 or 118 or 119 or 120 or 121 or 122 or 123 or 124 or 125 or 126 or 127 or 128 or 129 or 130 or 131 or 132 or 133 or 134 or 135 or 136 or 137 or 138 or 139 or 140 or 141 or 142 or 143 (5403979)
- 145 exp clinical pathway/ (6635)
- 146 exp clinical protocol/ (165499)
- 147 exp consensus/ (12419)
- 148 exp consensus development conference/ (11857)
- 149 exp consensus development conferences as topic/ (2817)
- 150 critical pathways/ (6635)
- 151 exp guideline/ (33586)
- 152 guidelines as topic/ (39315)
- 153 exp practice guideline/ (26673)
- 154 practice guidelines as topic/ (115925)
- 155 health planning guidelines/ (4076)
- 156 (guideline or practice guideline or consensus development conference or consensus development conference, NIH).pt. (42872)
- 157 (position statement* or policy statement* or practice parameter* or best practice*).ti,ab,kf. (32248)

- 158 (standards or guideline or guidelines).ti,kf. (108012)
- 159 ((practice or treatment*) adj guideline*).ab. (28910)
- 160 (CPG or CPGs).ti,kf. (6699)
- 161 consensus*.ti,kf. (25572)
- 162 consensus*.ab. /freq=2 (24719)
- 163 ((critical or clinical or practice) adj2 (path or paths or pathway or pathways or protocol*)).ti,ab,kf. (19821)
- 164 recommendat*.ti,kf. (40123)
- 165 (care adj2 (standard or path or paths or pathway or pathways or map or maps or plan or plans)).ti,ab,kf. (57358)
- 166 (algorithm* adj2 (screening or examination or test or tested or testing or assessment* or diagnosis or diagnoses or diagnosed or diagnosing)).ti,ab,kf. (7379)
- 167 (algorithm* adj2 (pharmacotherap* or chemotherap* or chemotreatment* or therap* or treatment* or intervention*)).ti,ab,kf. (9557)
- 168 145 or 146 or 147 or 148 or 149 or 150 or 151 or 152 or 153 or 154 or 155 or 156 or 157 or 158 or 159 or 160 or 161 or 162 or 163 or 164 or 165 or 166 or 167 (599128)
- 169 94 or 112 or 168 or 144 (7223858)
- 170 78 and 169 (972)
- 171 limit 79 to yr="2010-2019" (2124)
- 172 94 and 171 (103)
- 173 112 and 171 (236)
- 174 144 and 171 (832)
- 175 168 and 171 (213)
- 176 limit 77 to yr="2020" (58)
- 177 94 and 176 (5)
- 178 112 and 176 (4)
- 179 144 and 176 (8)
- 180 168 and 176 (12)

APPENDIX 2. RECOMMENDED PPE DURING THE COVID-19 OUTBREAK

Table 4 – Recommended PPE during the COVID-19 outbreak, according to the setting, personnel, and type of activity^[13]

Setting	Target personnel or patients	Activity	Type of PPE or procedure
Health care facilities			
Inpatient facilities			
Patient room	Health care workers	Providing direct care to COVID- 19 patients	Medical mask Gown Gloves Eye protection (goggles or face shield)
		Aerosol-generating procedures performed on COVID-19 patients	Respirator N95 or FFP2 standard, or equivalent. Gown Gloves Eye protection Apron
	Cleaners	Entering the room of COVID-19 patients	Medical mask Gown Heavy duty gloves Eye protection (if risk of splash from organic material or chemicals) Boots or closed work shoes
	Visitors ^b	Entering the room of a COVID- 19 patient	Medical mask Gown Gloves
Other areas of patient transit (e.g. wards, corridors).	All staff, including health care workers.	Any activity that does not involve contact with COVID-19 patients	No PPE required
Triage	Health care workers	Preliminary screening not involving direct contact ^c .	Maintain spatial distance of at least 1 metre. No PPE required
	Patients with respiratory symptoms	Any	Maintain spatial distance of at least 1 metre. Provide medical mask if tolerated by patient.
	Patients without respiratory symptoms	Any	No PPE required

Laboratory	Lab technician	Manipulation of respiratory samples	Medical mask Gown Gloves Eye protection (if risk of splash)
Administrative areas	All staff, including health care workers.	Administrative tasks that do not involve contact with COVID-19 patients.	No PPE required
Outpatient facilities			
Consultation room	Health care workers	Physical examination of patient with respiratory symptoms	Medical mask Gown Gloves Eye protection
	Health care workers	Physical examination of patients without respiratory symptoms	PPE according to standard precautions and risk assessment.
	Patients with respiratory symptoms	Any	Provide medical mask if tolerated.
	Patients without respiratory symptoms	Any	No PPE required
	Cleaners	After and between consultations with patients with respiratory symptoms.	Medical mask Gown Heavy duty gloves Eye protection (if risk of splash from organic material or chemicals). Boots or closed work shoes
Waiting room	Patients with respiratory symptoms	Any	Provide medical mask if tolerated. Immediately move the patient to an isolation room or separate area away from others; if this is not feasible, ensure spatial distance of at least 1 metre from other patients.
	Patients without respiratory symptoms	Any	No PPE required
Administrative areas	All staff, including health care workers	Administrative tasks	No PPE required
Triage	Health care workers	Preliminary screening not involving direct contact ^c .	Maintain spatial distance of at least 1 metre. No PPE required

	Patients with respiratory symptoms	Any	Maintain spatial distance of at least 1 metre. Provide medical mask if tolerated.
	Patients without respiratory symptoms	Any	No PPE required
Community			
Home	Patients with respiratory symptoms	Any	Maintain spatial distance of at least 1 metre. Provide medical mask if tolerated, except when sleeping.
	Caregiver	Entering the patient's room, but not providing direct care or assistance	Medical mask
	Caregiver	Providing direct care or when handling stool, urine, or waste from COVID-19 patient being cared for at home	Gloves Medical mask Apron (if risk of splash)
	Health care workers	Providing direct care or assistance to a COVID-19 patient at home	Medical mask Gown Gloves Eye protection
Public areas (e.g. schools, shopping malls, train stations).	Individuals without respiratory symptoms	Any	No PPE required
Points of entry			
Administrative areas	All staff	Any	No PPE required
Screening area	Staff	First screening (temperature measurement) not involving direct contact ^c	Maintain spatial distance of at least 1 metre. No PPE required
	Staff	Second screening (i.e. interviewing passengers with fever for clinical symptoms suggestive of COVID-19 disease and travel history)	Medical mask Gloves
	Cleaners	Cleaning the area where passengers with fever are being screened	Medical mask Gown Heavy duty gloves Eye protection (if risk of splash from organic material or chemicals). Boots or closed work shoes
Temporary isolation area	Staff	Entering the isolation area, but not providing direct assistance	Maintain spatial distance of at least 1 metre. Medical mask Gloves
	Staff, health care workers	Assisting passenger being transported to a health care	Medical mask Gown

		facility	Gloves Eye protection
	Cleaners	Cleaning isolation area	Medical mask Gown Heavy duty gloves Eye protection (if risk of splash from organic material or chemicals). Boots or closed work shoes
Ambulance or transfer vehicle	Health care workers	Transporting suspected COVID- 19 patients to the referral health care facility	Medical mask Gowns Gloves Eye protection
	Driver	Involved only in driving the patient with suspected COVID-19 disease and the driver's compartment is separated from the COVID-19 patient	Maintain spatial distance of at least 1 metre. No PPE required
		Assisting with loading or unloading patient with suspected COVID-19	Medical mask Gowns Gloves Eye protection
		No direct contact with patient with suspected COVID-19, but no separation between driver's and patient's compartments	Medical mask
	Patient with suspected COVID-19.	Transport to the referral health care facility.	Medical mask if tolerated
	Cleaners	Cleaning after and between transport of patients with suspected COVID-19 to the referral health care facility.	Medical mask Gown Heavy duty gloves Eye protection (if risk of splash from organic material or chemicals). Boots or closed work shoes
Special considerations for rapid-response teams assisting with public health investigations^d			
Community			
Anywhere	Rapid-response team investigators	Interview suspected or confirmed COVID-19 patients or their contacts.	No PPE if done remotely (e.g. by telephone or video conference). Remote interview is the preferred method.
		In-person interview of suspected or confirmed COVID-19 patients without direct contact	Medical mask Maintain spatial distance of at least 1 metre.
			The interview should be conducted outside the house

		or outdoors, and confirmed or suspected COVID-19 patients should wear a medical mask if tolerated.
In-person interview with asymptomatic contacts of COVID-19 patients		Maintain spatial distance of at least 1 metre. No PPE required The interview should be performed outside the house or outdoors. If it is necessary to enter the household environment, use a thermal imaging camera to confirm that the individual does not have a fever, maintain spatial distance of at least 1 metre and do not touch anything in the household environment.

APPENDIX 3. RISK OF TRANSMISSION - SUMMARY REVIEW (TRAN)

WHO GUIDELINES 2014 : Infection prevention and control of epidemic- and pandemic-prone acute respiratory infections in health care [2]

Annex L Summaries of relevant systematic reviews of the literature

L.1 *Summary of Aerosol-generating procedures and risk of transmission of acute respiratory diseases: A systematic review*

Systematic review objective

The 2011 review *Aerosol-generating procedures and risk of transmission of acute respiratory diseases: A systematic review* (149) assessed the clinical evidence on the risk of transmission of ARIs to health-care workers exposed to aerosol-generating clinical procedures compared with the risk to workers not exposed to the same procedures.

Methods

The authors used a predefined strategy to search electronic health-care databases including PubMed, MEDLINE, EMBASE, CINAHL, The Cochrane Library (Issue 10, 2010), University of York Centre for Reviews and Dissemination databases, EuroScan, LILACS, Indian Medlars, Index Medicus for South East Asia and international health technology agencies; they also conducted a focused Internet search. Information sources were limited to health technology assessments, systematic reviews, meta-analyses, randomized controlled trials (RCTs), non-randomized controlled studies and guidelines published between 1 January 1990 and 22 October 2010. The search strategy contained no language limitation. Studies included in the review were those that examined the relevant study population (health-care workers caring for patients with ARIs), intervention (provision of care for patients undergoing aerosol-generating procedures), comparator (provision of care for patients not undergoing aerosol-generating procedures) and outcome (transmission of ARI from patient to health-care worker).

Of the 1862 abstracts identified by electronic search and screened against inclusion criteria, 86 citations were retrieved. Of these, 10 relevant non-randomized studies (5 case-control and 5 retrospective cohort studies) met the criteria for inclusion in the systematic review (Fig. L.1). The quality of evidence was rated using the GRADE framework (47).

Results and conclusions

All studies included in the review assessed the transmission of SARS-CoV to health-care workers associated with the performance of potentially aerosol-generating procedures while caring for ill patients in hospital or intensive care unit settings during the SARS outbreaks of 2002–2003.

The most consistent statistically significant association of an increased risk of SARS transmission to workers was found in tracheal intubation (eight studies) (Table L.1 and Fig. L.2). Increased risk of SARS transmission was also reported in non-invasive ventilation (two studies), tracheotomy (one study), and manual ventilation before intubation (one study); however, these findings were identified from a limited number of very low quality studies, which makes interpretation difficult. There was no significant difference in the risk of SARS transmission between exposed and unexposed health-care

workers for all other procedures evaluated – suction before intubation, suction after intubation, manual ventilation after intubation, bronchoscopy, nebulizer treatment, manipulation of oxygen mask, manipulation of bilevel positive airway pressure (BiPAP) mask, defibrillation, chest compressions, insertion of nasogastric tube, collection of sputum sample, high-frequency oscillatory ventilation, high-flow oxygen, endotracheal aspiration, suction of body fluid, administration of oxygen, chest physiotherapy and mechanical ventilation (Table L.1). All studies were rated very low quality according to GRADE criteria (47).

The findings suggest that some procedures potentially capable of generating aerosols are associated with increased risk of SARS transmission to health-care workers, with the most consistent association being across multiple studies identified with tracheal intubation. Other associations included non-invasive ventilation from two studies, and manual ventilation before intubation and tracheotomy, each from single studies. The authors note that these results must be interpreted in the context of the very low quality of the studies. A significant research gap was identified in this area: studies of higher methodological quality are required to provide more precise information about the risk of aerosol generation and the risk of transmission of microbes causing specific acute respiratory diseases, including influenza, from patients undergoing aerosol-generating procedures to health-care workers.

Figure L.1 Selection of publications for *Aerosol-generating procedures and risk of transmission of acute respiratory diseases: A systematic review*

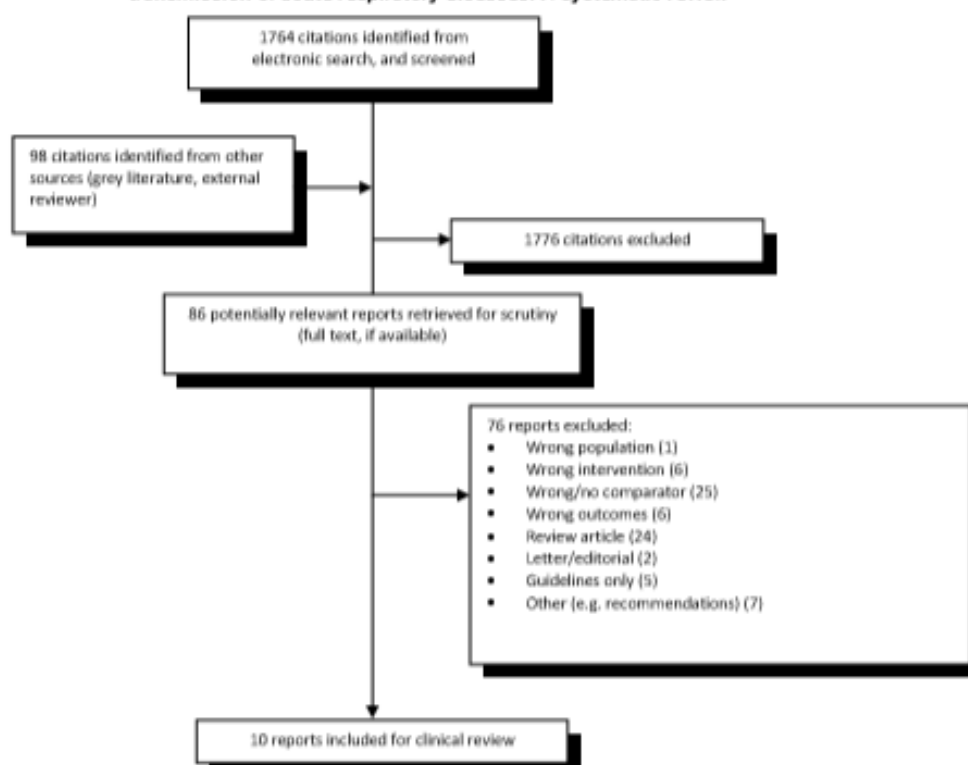


Table L.1 Summary of results from studies selected in the systematic review *Aerosol-generating procedures and risk of transmission of acute respiratory diseases: A systematic review*

Aerosol-generating procedures	Odds ratio* (95% CI)
Tracheal intubation (4 cohort studies)	3.0 (1.4, 6.7)
	22.8 (3.9, 131.1)
	13.8 (1.2, 161.7)
	5.5 (0.6, 49.5)
Pooled estimate ($I^2 = 39.6\%$)	6.6 (2.3, 18.9)
Tracheal intubation (4 case-control studies)	0.7 (0.1, 3.9)
	9.2 (4.2, 20.2)
	8.0 (3.9, 16.6)
	9.3 (2.9, 30.2)
Pooled estimate ($I^2 = 61.4\%$)	6.6 (4.1, 10.6)
Suction before intubation (2 cohort studies)	13.8 (1.2, 161.7)
	1.7 (0.7, 4.2)
Pooled estimate ($I^2 = 59.2\%$)	3.5 (0.5, 24.6)
Suction after intubation (2 cohort studies)	0.6 (0.1, 3.0)
	1.8 (0.8, 4.0)
Pooled estimate ($I^2 = 28.8\%$)	1.3 (0.5, 3.4)
Nebulizer treatment (3 cohort studies)	6.6 (0.9, 50.5)
	0.1 (0.0*, 1.0)
	1.2 (0.1, 20.7)
Pooled estimate ($I^2 = 73.1\%$)	0.9 (0.1, 13.6)
Manipulation of oxygen mask (2 cohort studies)	17.0 (1.8, 165.0)
	2.2 (0.9, 4.9)
Pooled estimate ($I^2 = 64.8\%$)	4.6 (0.6, 32.5)
Bronchoscopy (2 cohort studies)	3.3 (0.2, 59.6)
	1.1 (0.1, 18.5)
Pooled estimate ($I^2 = 0\%$)	1.9 (0.2, 14.2)
Non-invasive ventilation (2 cohort studies)	2.6 (0.2, 34.5)
	3.2 (1.4, 7.2)
Pooled estimate ($I^2 = 0\%$)	3.1 (1.4, 6.8)
Insertion of nasogastric tube (2 cohort studies)	1.7 (0.2, 11.5)
	1.0 (0.2, 4.5)
Pooled estimate ($I^2 = 0\%$)	1.2 (0.4, 4.0)

Summaries of relevant systematic reviews of the literature

Aerosol-generating procedures	Odds ratio* (95% CI)
Chest compressions (1 case-control study)	4.5 (1.5, 13.8)
Chest compressions (2 cohort studies)	3.0 (0.4, 24.5)
	0.4 (0.0**, 7.8)
Pooled estimate ($I^2 = 27.3\%$)	1.4 (0.2, 11.2)
Defibrillation (2 cohort studies)	0.5 (0.0**, 12.2)
	7.9 (0.8, 79.0)
Pooled estimate ($I^2 = 55.3\%$)	2.5 (0.1, 43.9)
Chest physiotherapy (2 cohort studies)	1.3 (0.2, 8.3)
	0.5 (0.1, 3.5)
Pooled estimate ($I^2 = 0\%$)	0.8 (0.2, 3.2)
High-frequency oscillatory ventilation (1 cohort study)	0.7 (0.1, 5.5)
High-flow oxygen (1 cohort study)	0.4 (0.1, 1.7)
Tracheotomy (1 case-control study)	4.2 (1.5, 11.5)
Intubation, tracheotomy, airway care, and cardiac resuscitation (1 case-control study)	6.2 (2.2, 18.1)
Manipulation of BiPAP mask (1 cohort study)	4.2 (0.6, 27.4)
Endotracheal aspiration (1 cohort study)	1.0 (0.2, 5.2)
Suction of body fluid (1 case-control study)	1.0 (0.4, 2.8)
Administration of oxygen (1 case-control study)	1.0 (0.3, 2.8)
Mechanical ventilation (1 cohort study)	0.9 (0.4, 2.0)
Manual ventilation before intubation (1 cohort study)	2.8 (1.3, 6.4)
Manual ventilation after intubation (1 cohort study)	1.3 (0.5, 3.2)
Manual ventilation (1 cohort study)	1.3 (0.2, 8.3)
Collection of sputum sample (1 cohort study)	2.7 (0.9, 8.2)

BiPAP: bilevel positive airway pressure; CI: confidence interval

* actual value is 0.01; ** actual value is 0.02

* Studies included in this table met the criteria for inclusion in a systematic review of the evidence (i.e. they measured the risk of SARS transmission to health-care workers who were exposed to the listed procedures compared to workers who were not exposed the same procedures). Inclusion in this table is not a validation of study quality.

Figure L.2A Risk of SARS transmission to health-care workers exposed to tracheal intubation

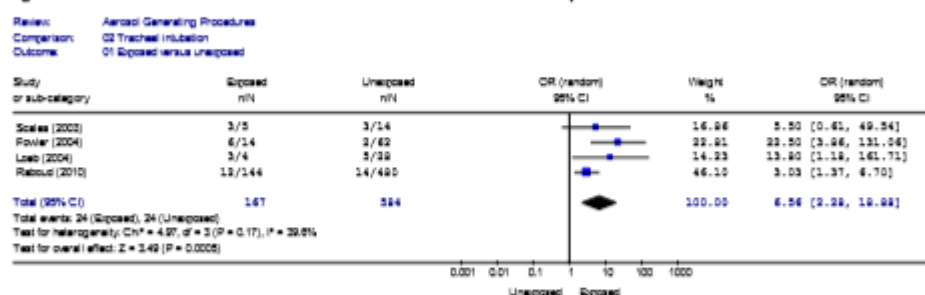
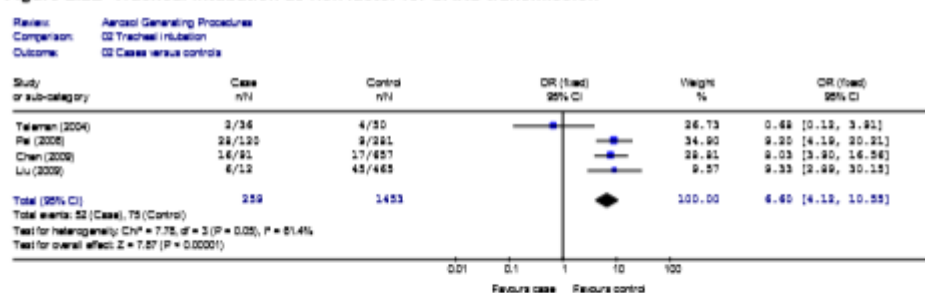


Figure L.2B Tracheal intubation as risk factor for SARS transmission



CI, confidence interval; n, number of events; N, sample size; OR, odds ratio; SARS, severe acute respiratory syndrome

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Colophon

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Authors:	Vicky Jespers, Dominique Roberfroid
Reviewer(s):	Irina Cleemput
At the request of:	Hoge Gezondheidsraad
Disclaimer:	This document is a rapid review of scientific literature retrieved from several publicly funded COVID-19 resource collections. The literature included in these repositories is not always peer-reviewed or externally validated. KCE synthesised the evidence in short time frames to respond to urgent questions and could therefore not follow its regular methodological procedures. This work is used to inform guidance of other governmental agencies (like Sciensano, CSS/HGR, AFMPS/FAGG and SPF/FOD).
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