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Health-care workers at higher risk of infection and severe infection from COVID-19:

1. [Wu \(2020\)](#): In China, 3.8% of HCPs developed infection. In just Wuhan, 63% of HCPs developed infection. Of those infected, 14.8% cases were classified as severe or critical.

Certain procedures and therapies generate more aerosols that can spread infection. These include endotracheal intubation, bronchoscopy, open suctioning, nebulization, manual ventilation before intubation (especially with poor seal), proning, disconnecting patient from ventilator, noninvasive positive pressure ventilation, tracheostomy, and cardiopulmonary resuscitation.

1. [Tran \(2012\)](#): Endotracheal intubation including manual ventilation prior to intubation is considered an aerosol-generating procedure. Other aerosol-generating procedures include noninvasive ventilation, bronchoscopy, tracheostomy, and cardiopulmonary resuscitation.
2. [Hui \(2019\)](#): Simulation study: "Exhaled air dispersion during HFNC and CPAP via different interfaces is limited provided there is good mask interface fitting."
3. [Kotoda \(2019\)](#): Simulation study: "Dispersion was limited to the proximal area of the face and nasal cannula, suggesting that high-flow nasal therapy does not increase the risk of droplet and contact infection."
4. [Brewster \(2020\) / Consensus Statement](#): Procedures/events with potential for aerosolization are identified, especially high risk if poor seal (eg, NIPPV or SGA) and if coughing is provoked.
5. [SCCM COVID-19 guidelines](#): Aerosol-generating procedures in the ICU—endotracheal intubation, bronchoscopy, open suctioning, nebulization, manual ventilation before intubation, proning, disconnecting patient from ventilator, noninvasive positive pressure ventilation, tracheostomy, and cardiopulmonary resuscitation.

Precautions should be taken to reduce risk to HCPs especially when aerosol-generating procedures are being performed for patients with confirmed or suspected COVID-19. These strategies include:

- a. Assessing for progressive respiratory failure early and avoiding emergency intubation
- b. Performing procedures in a negative pressure room
- c. Minimizing number of personnel inside the room
- d. Use of N95 or **higher level** respirator along with eye shields, gowns, and gloves
- e. Donning and doffing in CDC-advised sequence
- f. Cleaning and disinfecting surfaces promptly after the procedure using routine disinfecting and cleaning procedures

Precautions (CONTINUED)

- g. Using viral filters with ventilator circuits and if performing bag mask ventilation
- h. Ensuring the most experienced provider performs intubation
 - i. Performing true rapid sequence intubation, avoiding bag mask ventilation, with use of paralytics
 - j. Using video laryngoscopes for intubation
- k. Inflation of endotracheal tube cuff before ventilating
 - l. Monitoring employees if exposed to COVID-19 per WHO and CDC guidance

Early assessment:

1. [Wax Randy S, Christian Michael D \(2020\)](#): Early assessment and identification of patients likely to need intubation to avoid emergency intubation. Guan (02/2020): Mechanical ventilation initiated in more patients with severe disease than in those with nonsevere disease (NIV, 32.4% vs 0%; invasive ventilation, 14.5% vs 0%).
2. [Sehulster lynee, Chinn Raymond \(2003\)](#): Locating patients to negative pressure room or normal pressure room with strict door policy, also in line with SCCM guidelines.
3. [Brewster \(2020\) / Consensus Statement](#): Assemble airway team (airway operator, airway assistant, two to three runners [one in room and one outside the room]). Designated airway team leader should rehearse intubation strategy with team prior to beginning any intubation attempt.

Limiting team members involved in these procedures:

1. [Brewster \(2020\) / Consensus Statement](#): Limit number of providers in the room— only those directly involved in the process of airway management should be in the room. Use the most experienced available staff. Consider excluding staff who are vulnerable to infection from the airway team: >60 yrs, immunosuppressed, pregnant providers, or who have serious co-morbidities.

Personal protective equipment for staff, including N95 or higher level respirator, eye protection, gloves, and a gown:

1. [CDC](#): Includes appropriate PPE, hand hygiene, and application of all principles of infection prevention and control. [CDC](#): For aerosol-generating procedures—N95 or **higher level** respirator, eye protection, gloves, and a gown.
2. [CDC](#): The number of HCPs present during the procedure should be limited.
3. [Brewster \(2020\) / Consensus Statement](#): Use of direct observation (buddy) system to ensure correcting donning and doffing of PPE.

Personal protective equipment (CONTINUED)

4. [Donning sequence per CDC](#): Hand hygiene → Gown → Mask → Eye protection → Hat → Gloves in this order. Airway operator to wear double gloves. Buddy to ensure correct donning of PPE.
5. [Doffing sequence per CDC](#): Gloves → Gown → Hand hygiene → Hat → Eye protection → Mask → Hand hygiene in this order.
6. [Zamora \(2006\)](#): Participants wearing enhanced respiratory and contact precautions (E-ECP) more likely to experience skin and base-clothing contamination and larger total areas of contamination (all $P < 0.0001$). Participants donning PAPR committed more donning procedure violations ($P = 0.0034$). Donning and removing the PAPR system took longer than E-RCP garments ($P < 0.0001$).
7. [Smith \(2016\)](#): Systematic review and meta-analysis from 01/1990 to 12/2014—6 clinical studies (3 RCTs, 1 cohort study, and 2 case-control studies), and 23 surrogate exposure studies. N95 respirators appeared to have a protective advantage over surgical masks in laboratory settings but insufficient data to determine that N95 respirators superior to surgical masks in clinical settings.
8. [Govt. of Canada COVID-19 Interim Guidance \(as of 02/24/2020\)](#): An N95 respirator and facial protection are recommended for all HCWs present in a room where an AGP is being performed on a patient with signs and symptoms and exposure criteria consistent with COVID-19.
9. [SCCM COVID-19 guidelines](#): Fitted masks (N95, FFP2, etc) or PAPRs + gloves, gown, eye protection in ICU as opposed to surgical masks.
10. [WHO interim guidance 03/2020](#): For aerosol-generating procedures (eg, tracheal intubation, NIV, tracheostomy, CPR, manual ventilation before intubation, bronchoscopy). HCWs should use respirators, eye protection, gloves and gowns; aprons should also be used if gowns are not *fluid resistant*.

These procedures should occur in an airborne infection isolation room (AIIR).

1. [Govt. of Canada COVID-19 Interim Guidance \(as of 02/24/2020\)](#): “AGMPs should be performed in an AIIR whenever feasible. If AIIRs are unavailable, AGMPs should be carried out using a process and environment that minimizes the exposure risk for HCWs, ensuring that patients, visitors, and others in the healthcare setting are not exposed to SARS-CoV-2 (eg, single room with door closed and away from high-risk patients).”
2. [CDC](#): AGPs should ideally take place in an AIIR.
3. [Wax \(2020\)](#): Strategies short of meeting these airborne isolation standards, such as portable HEPA filters or negative air flow, can be considered to reduce risk in a single room.
4. [Wax \(2020\)](#): Anterooms with sufficient space to put on and remove PPE should be available adjacent to airborne isolation rooms; if not available, makeshift anterooms can be constructed.

AIIR (CONTINUED)

5. [SCCM COVID-19 guidelines](#): Perform aerosol-generating procedures in ICU patients in negative pressure rooms or with HEPA filters. Intubations, bronchoscopies, and NIV are highest risk.
6. [CDC](#): Clean and disinfect procedure room surfaces promptly as described in the section on environmental infection control (“Routine cleaning and disinfection procedures”).

Viral filters should be used for bagging and on ventilator circuit. A designed intubation tray/cart should be used, and a sealable hazard bag should be used for used airway equipment.

1. [Brewster \(2020\) / Consensus Statement](#): Viral filter must be placed in ventilator circuit or during bag mask ventilation.
2. [Brewster \(2020\) / Consensus Statement](#): Designated intubation tray or cart should be used.
3. [Brewster \(2020\) / Consensus Statement](#): Use sealable hazard bag for used airway equipment.

Specific recommended airway steps:

1. [Higgs A et al \(BJA 2018\)](#): Rapid sequence intubation.
2. [Higgs A et al \(BJA 2018\)](#): Preoxygenation with face mask for 5 minutes.
3. [Wax \(CJA 2020\)](#): Avoid ventilation prior to intubation if possible (unless deoxygenation occurs) to reduce the risk of aerosolization.
4. [Wax \(CJA 2020\)](#): Wait for paralysis to take effect before ETT insertion to avoid triggering cough and possible aerosolization.
5. [Aminnejad \(CJA 2020\)](#): Opinion piece advising use of lidocaine as a cough suppressant when intubating COVID-19 patients.
6. [Wax \(CJA 2020\)](#): Inflate ETT cuff before initiating ventilation after intubation.
7. [Wax \(CJA 2020\)](#): Remove outer glove to dispose of airway equipment in a sealed bag.
8. [Brewster \(2020\) / Consensus Statement](#): Dedicated VL for COVID-19 cases. Disposable blades advised. Can be a potentially limited resource. Once the patient is intubated, closed suction systems should be used to minimise aerosolization of the virus.
9. [SCCM COVID-19 guidelines](#): Airway to be performed by most experienced provider.
10. [Wax \(CJA 2020\)](#): Debrief and share lessons.

Noninvasive ventilation and heated high-flow nasal cannula can generate aerosols.

1. [Kumar A et al \(JAMA 2009\)](#): Experience with influenza A (H1N1) showed that NIV failed in 57-85% of patients, with failing patients having a higher ICU mortality than those treated with invasive mechanical ventilation.
2. [Cheung \(2004\)](#): There were no infections among the 105 health-care workers caring for the 20 patients with SARS receiving Kumar A et al for the Canadian Critical Care Trials Group H1N1 Collaborative. Critically Ill Patients With 2009 Influenza A (H1N1) Infection NIV.
3. [Yang \(2020\)](#): Single-center report on 52 critically ill patients from Wuhan. Higher mortality in patients treated with NIV as opposed to endotracheal intubation. Out of 29 patients placed on NIPPV at ICU admission, 22 (76%) progressed to invasive mechanical ventilation. The mortality rates for patients receiving NIV and invasive ventilation similar (79% and 86%, respectively).
4. [Brewster \(2020\) / Consensus Statement](#): "Use of a second-generation SGA device is recommended as higher seal pressure during positive pressure ventilation decreases the risk of aerosolization of the virus."
5. [SCCM COVID-19 guidelines](#): Acute hypoxic RF (AHRF) despite conventional O2: Suggest using HFNO over conventional O2 therapy. Also suggest, for AHRF, using HFNO over NIV. Suggesting for AHRF, if HFNO not available and no urgent indication for intubation, trial of NIV w/ close monitoring for worsening failure.
6. [Kotada et al \(2020\)](#): Assessment of the potential for pathogen dispersal during high-flow nasal therapy.

HCP should be monitored for symptoms following exposures from aerosol- generating procedures.

1. [WHO Exposure monitoring tool \(03/2020\)](#): "The form should be completed for all HCWs who have been exposed to a patient with confirmed COVID-19."
2. [CDC exposure risk statement](#): "Being present in the room for procedures that generate aerosols or during which respiratory secretions are likely to be poorly controlled (e.g., cardiopulmonary resuscitation, intubation, extubation, bronchoscopy, nebulizer therapy, sputum induction) on patients with COVID-19 when the healthcare providers' eyes, nose, or mouth were not protected, is also considered *high-risk*."