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What's New

Perioperative considerations for patients with COVID-19 (March 2020)

Frequent hand hygiene and proper use of personal protective equipment (PPE) are essen…
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INTRODUCTION

The novel coronavirus disease 2019 (COVID-19 or nCoV) and other respiratory infectious agents can be transmitted to clinicians involved in their care, particularly during aerosol-generating procedures (eg, endotracheal intubation and extubation). Infection control to limit transmission is an essential component of care in patients with suspected or documented COVID-19. This topic will discuss airway management and other aspects of anesthetic care for patients with suspected or confirmed COVID-19, with a focus on infection control.

Understanding of COVID-19 is evolving rapidly. UpToDate has added information on many aspects of COVID-19, including general infection control measures, medical and intensive care, and specialty care, in topic reviews linked here and others. Anesthetic concerns for regional anesthesia, obstetric anesthesia, and gastrointestinal endoscopy in patients with COVID-19 are discussed separately.

- (See "Coronavirus disease 2019 (COVID-19): Epidemiology, virology, clinical features, diagnosis, and prevention".)
- (See "Coronavirus disease 2019 (COVID-19): Infection control in health care and home settings".)
- (See "Coronavirus disease 2019 (COVID-19): Critical care and airway management issues".)
- (See "Overview of neuraxial anesthesia", section on 'Patients with suspected or confirmed COVID-19'.)

- (See "Overview of peripheral nerve blocks", section on 'Patients with suspected or confirmed COVID-19'.)
- (See "Neuraxial analgesia for labor and delivery (including instrumented delivery)", section on 'Patients with suspected or confirmed COVID-19'.)
- (See "Anesthesia for gastrointestinal endoscopy in adults", section on 'Endoscopy in patients with suspected or confirmed COVID-19'.)

The use of anesthesia machines for intensive care ventilation is also discussed separately. (See "Coronavirus disease 2019 (COVID-19): Intensive care ventilation with anesthesia machines".)

Many US and international organizations and professional societies have issued guidelines or recommendations for perioperative care during the COVID-19 pandemic. This topic relies heavily on such recommendations, which are based on expert opinion and what is known about transmission of this and other viruses [1-14]. Many of these guidelines are updated frequently, as understanding of COVID-19 evolves. (See 'Society guideline links' below.)

PREOPERATIVE COVID-19 TESTING FOR ELECTIVE SURGERY

Elective surgery has not been performed during the COVID-19 pandemic, but as the pandemic wanes, some institutions are starting to perform elective procedures. Elective procedures should not be performed in patients who are symptomatic with COVID-19, who are suspected of having COVID-19, or who are likely to be still shedding virus after COVID-19 infection. Elective surgery should be avoided because patients with COVID-19 may have high rates of perioperative morbidity and mortality [15,16], and they place operating room (OR) staff at risk for infection during aerosol generating procedures.

Institutional protocols for preoperative evaluation and testing should be followed. All patients who are scheduled for surgery should be screened for exposure to COVID-19, and for symptoms (ie, fever, cough, shortness of breath, muscle pain, sore throat, and/or new loss of taste or smell) within the prior two weeks; patients with symptoms should be referred for further evaluation. Some institutions are routinely performing COVID-19 testing before scheduling elective surgery, and some states have specific mandates or advisories for testing.

A joint statement from the American Society of Anesthesiologists (ASA) and the Anesthesia Patient Safety Foundation (APSF) recommends that in areas of high COVID-19 prevalence, testing for COVID-19 should be performed for all patients prior to non-emergency surgery, and that surgery should be delayed until the patient is no longer infectious and has recovered from COVID-19. Criteria for considering the patient no longer infectious are discussed separately. (See "Coronavirus

disease 2019 (COVID-19): Infection control in health care and home settings", section on 'Discontinuation of precautions'.)

INFECTION CONTROL FOR ANESTHESIA

Goals for infection control during anesthesia include prevention of transmission of infection to care providers, and prevention of contamination of the anesthesia machine and other anesthesia equipment. Infection control measures should be the **same** for patients with suspected or confirmed COVID-19.

Multiple United States and international organizations have published recommendations for infection control and the use of personal protective equipment (PPE) during anesthesia for patients with COVID-19. Precautions have been recommended by the Anesthesia Patient Safety Foundation (APSF) [3] and the American Society of Anesthesiologists (ASA) [4], which are based on guidance from the Centers for Disease Control and Prevention and (CDC) previous experience with other infectious agents (eg, severe acute respiratory syndrome [SARS-CoV] or Middle Eastern respiratory syndrome [MERS-CoV] viruses) [1-9,11,13,14,17-21]. They include meticulous hand hygiene, and the use of contact, droplet, and airborne precautions, depending partly on the risk of aerosolization of the virus (ie, during aerosol-generating procedures).

Hand hygiene and personal protective equipment

Hand hygiene — Perform meticulous hand hygiene (washing with soap and water or using alcohol based gel) before donning (putting on) PPE, after removing gloves, after every contact with the patient, and before touching anesthesia equipment.

PPE for care of patients who undergo aerosol-generating procedures — For patients with suspected or confirmed COVID-19 who undergo aerosol-generating procedures, including airway management for general anesthesia, appropriate PPE for health care workers includes use of N95 (picture 1) or other respirator (eg, a powered air-purifying respirator [PAPR]) that offers a higher level of protection, eye protection (goggles, face shield that covers the front and sides of the face, or full face PAPR), gloves, a water resistant gown, and shoe covers (figure 1). In addition, disposable operating room (OR) caps and beard covers should be worn so the clinician can avoid touching hair that may have been exposed to droplets. Any of the clinician's exposed skin is at risk for contamination with aerosols during intubation, particularly skin of the head and neck [22]. The neck and ears can be covered with a hood, or a towel around the neck with the ears covered with an OR cap, removed carefully to avoid contamination. Loose-fitting PAPRs provide high-level respiratory protection, and cover the face, hair and neck. They do not require fit testing and can be repeatedly disinfected and reused [23].

Some experts have recommended the use of airborne precautions (ie, N95 or higher respirator, or PAPR) if available for **all patients** who require airway management, since patients may be asymptomatic or minimally symptomatic, and COVID-19 may not be suspected [24-27].

Aerosol-generating procedures include many that involve anesthesia: tracheal intubation or extubation, bag mask ventilation, bronchoscopy and interventional pulmonology procedures, noninvasive ventilation, administration of high-flow oxygen or nebulized medications, tracheotomy, open suctioning of airways, upper endoscopy, transesophageal echocardiography [28,29], and colonoscopy. (See "Coronavirus disease 2019 (COVID-19): Infection control in health care and home settings", section on 'Aerosol-generating procedures/treatments'.)

Protective barriers — A wide variety of prototype devices have been created, designed to protect the anesthesiologist from droplet or aerosol contamination during intubation and extubation [30-33]. These devices consist of either clear acrylic boxes or plastic drapes (suspended from a frame or not), some with arm sheaths or gloves. Some also incorporate continuous suction to vent aerosols. Most prototypes have been evaluated with simulations using manikins to generate aerosols; none have been critically evaluated in human clinical studies or been US Food and Drug Administration (FDA) approved. Important concerns include ensuring adequate view of the patient's airway, appropriate ergonomics for intubation, extubation and mask ventilation, ease of construction, and ease of removal, particularly in emergency situations (eg, loss of the airway, patient vomiting).

PPE for care of patients who undergo low risk procedures — For care of patients with suspected or confirmed COVID-19 who do not undergo aerosol-generating procedures, the CDC and other organizations recommend that optimally, the same contact, droplet, and airborne precautions (including N95 or higher respirator, or PAPR) that are described above should be used. However, they recognize that N95 respirators and PAPR may not be available or may be in short supply, in which case the use of a surgical mask is an acceptable alternative. An N95 respirator or PAPR should be used by clinicians during low-risk procedures in any COVID-19 patient who is coughing (figure 1).

Donning and doffing PPE — Health care workers should pay special attention to the appropriate sequence of putting on (donning) and taking off (doffing) PPE to avoid contamination (figure 2 and figure 3). After removing gloves and other PPE, clinicians should avoid touching their own hair or face until they are able to perform fastidious hand hygiene. If possible, any exposed skin should be cleaned, including the neck and face, after doffing PPE. Donning and doffing should be monitored by a trained observer. Errors in removal of PPE are common, even in trained clinicians, and are associated with contamination of health care workers with pathogens [34,35]. (See

"Coronavirus disease 2019 (COVID-19): Infection control in health care and home settings", section on 'Patients with suspected or confirmed COVID-19'.)

Procedures for disposal of contaminated PPE and cleaning of reusable PPE should be established based on CDC and institutional guidelines.

INFECTION CONTROL DURING PATIENT TRANSPORT

Patients should wear a surgical mask whenever they are transported within a medical facility. Patients should ideally be transported directly to a procedure or operating room (OR), bypassing the holding area or pre-induction area. Some institutions use a portable tent system with HEPA filtration during transport for patients with COVID-19 [36,37]

For transporting intubated patients, a high-quality heat and moisture exchanging filter (HMEF) should be inserted between the self-inflating (Ambu) bag and the patient at all times. During transport, clinicians who contact the patient should not touch environmental surfaces such as elevator buttons; this should be done by a security officer or another helper.

Patients should recover from anesthesia in the OR or should be transported directly to an airborne infection isolation room for recovery, bypassing the post-anesthesia care unit (PACU).

PROTECTION OF ANESTHESIA EQUIPMENT

As a general rule, only necessary equipment should be in the operating room (OR) during aerosol-generating procedures in patients with COVID-19, to prevent unnecessary contamination and need for disinfection. Backup or emergency equipment should be kept immediately outside the OR and brought in as required by an assistant who is wearing appropriate PPE.

Preventing contamination — Preventing spread of infection via contamination of multiple components of the anesthesia machine (eg, breathing circuit, ventilator, surfaces) is critical, as noted in guidelines developed by the American Society of Anesthesiologists (ASA) and the Anesthesia Patient Safety Foundation (APSF; refer to the APSF's FAQ on anesthesia machine use, protection, and decontamination during the COVID-19 pandemic and the ASA Committee on Occupational Health's Coronavirus Information for Health Care Professionals (Clinical FAQs)) [4,38-40].

Surface contamination — Care must be taken to prevent contamination of the external parts of the anesthesia machine and other anesthesia equipment [1,40,41]. In some institutions, the anesthesia machine is covered with plastic (ie, a large plastic bag, used for storage in many

institutions) to reduce the bioburden, particularly on "high touch" surfaces (picture 2) [10,42]. Plastic covers are also available for the patient monitor, computer keyboard (picture 3), mouse, and touch screen, and for nondisposable equipment such as the videolaryngoscope monitor, and the ultrasound machine and monitor. However, the possibility of contamination of personnel, equipment, or the OR during removal and disposal of such protective drapes is unknown; concerns are similar to those incurred by improper removal of personal protective equipment (PPE). (See 'Donning and doffing PPE' above.)

Contamination of the internal components of the anesthesia machine — The anesthesia machine breathing circuit and its connection to the gas analyzer should be protected from becoming a vector of infection for subsequent patients via the anesthesia machine. The breathing circuit should contain two filters rated for viral filtration efficiency (VFE) (figure 4). Filters with the highest VFE are recommended.

- In adults, in whom the tidal volume is greater than 300 ml, one filter is placed at the airway. The gas sampling line should be connected on the side of the filter away from the patient (figure 4). A second filter is placed on the expiratory limb of the breathing circuit where it connects to the anesthesia machine. Thus, filtering is accomplished for the patient, the gas sampling line and the breathing circuit; the patient inhales gas that is filtered once, and exhales gas that is filtered once before entering the gas analyzer sampling system and twice before entering the anesthesia machine.

- In children less than 20 kg, one filter should be placed on the expiratory limb of the breathing circuit, but a standard size filter should not be added at the patient end of the breathing circuit because of added dead space [43]. For these patients, a filter with a smaller internal volume may be used, or the filter can be omitted. If the airway filter is omitted, a filter should be placed on the inspiratory limb and separate 0.2 micron filter should be added to the gas analyzer sampling line.

There are three types of breathing circuit filters: mechanical filters, electrostatic filters, and heat and moisture exchange filters (HMEFs) (picture 4) [44,45].

- Pleated mechanical filters contain a sheet of thick hydrophobic filter material that is pleated to increase the surface area and decrease resistance to flow. They have small channels and depth that traps particles, and typically have a VFE greater than 99.99 percent. Their VFE is not degraded by exposure to humidity, and may also provide some heat and moisture exchange when placed at the airway. Most pleated filters have an internal volume of around 80 mL, and a minimum tidal volume requirement of 300 mL because of dead space ventilation.

- Electrostatic filters contain a thinner sheet of filter material that is less tightly woven, so that the resistance to flow is less for a given surface area. Electrostatic filters are so named because they have an electrostatic charge that helps to attract and trap particles. The VFE of an electrostatic filter is generally less than or equal to 99.99 percent, and this tends to decline as the filter becomes wet (eg, when exposed to high humidity) [46].

- HMEFs combine a heat and humidity exchanger and a filter (typically electrostatic-type) in one unit; thus, these are ideal for use in the breathing circuit after the Y-piece connector to provide both filtration and heat and humidity conservation.

Heat and humidity exchange (HME) devices without filters only provide heat and humidity exchange. These devices do **not** remove viral particles, and do **not** protect the anesthesia machine.

Membrane filters are different from the mechanical and electrostatic filters typically used in breathing circuits. In anesthesia, hydrophilic membrane filters are often used to filter liquids, such as epidural infusions. These are sieve filters, typically with a 0.2 or 0.22 micron pore size, which means that they will not allow any particle larger than the rated size to pass (as opposed to mechanical and electrostatic woven filters that allow a very small percentage of larger particles to pass). Hydrophobic membrane filters are in most gas analyzer water traps to prevent liquid and particles from entering the gas analyzer chamber. They may also trap viruses in the gas stream, because all filters are more efficient at trapping particles in a gas medium than in a liquid medium. A 0.2 or 0.22 micron epidural filter can be added to the gas analyzer sampling line to provide additional filtration.

Decontamination — The anesthesia machine and reusable equipment, meticulous routine cleaning should be performed according to manufacturer's recommendations [4,39]. Disposables, including the anesthesia breathing circuit, reservoir bag, mask, forced air warming blanket, and any other disposable equipment should be bagged for disposal as contaminated waste [40].

The gas sampling tubing should be changed after use in a COVID-19 positive patient. However, the water trap that receives the gas sampling line does not need to be replaced between COVID-19 positive patients if appropriately placed high-quality HMEF filters were used as directed (figure 4) (see 'Preventing contamination' above). Similarly, there is no evidence that the soda lime carbon dioxide (CO_2) absorber needs to be changed between COVID-19 positive patient cases (over and above normal depletion) since it is protected by the filters in the breathing circuit and is highly alkaline and likely viricidal.

The internal components of the anesthesia machine and breathing system do not need "terminal cleaning" if appropriately selected and placed high-quality filters were used as directed (see 'Preventing contamination' above). In the event of overt or suspected contamination of the internal components of the anesthesia machine (eg, failure to use filters, incorrectly placed filters, or spillage

of pulmonary edema fluid into the circuit), the specific manufacturer's recommendations will need to be followed. Some models of anesthesia machines require a prolonged period of decontamination. Links to manufacturer specific recommendations can be found here.

After the patient has left the OR, the room should remain closed until there have been enough air exchanges to remove aerosolized pathogens, which may be determined on an institutional level. The OR should then undergo deep terminal cleaning, following Centers for Disease Control guidelines. Many hospitals have implemented enhanced environmental cleaning and disinfection protocols for rooms in which COVID-19 patients have received care, including the use of UV-C light [40] and/or hydrogen peroxide vapor. (See "Coronavirus disease 2019 (COVID-19): Infection control in health care and home settings", section on 'Environmental disinfection'.)

For further information on cleaning of anesthesia equipment, refer to guidance from the APSF and ASA.

MANAGEMENT OF ANESTHESIA

Principles and practice of preanesthesia assessment and anesthetic management are discussed in multiple other UpToDate topics. Issues specific to patients with COVID-19 are discussed here.

Most of the following discussion is applicable to anesthesia for children as well as adults. Issues specific to children are discussed separately. (See "Airway management for pediatric anesthesia", section on 'Airway management for patients with COVID-19'.)

Choice of anesthetic technique — The choice of anesthetic technique (ie, general anesthesia [GA], regional anesthesia, monitored anesthesia care) should be based on patient factors and the planned procedure. Important considerations include the following: (See "Overview of peripheral nerve blocks", section on 'Patients with suspected or confirmed COVID-19' and "Overview of neuraxial anesthesia", section on 'Patients with suspected or confirmed COVID-19'.)

- Regional anesthesia (neuraxial anesthesia, peripheral nerve block) is not contraindicated in patients with COVID-19. The use of regional anesthesia may avoid the need for general anesthesia, airway management, and the associated risk of aerosolization of airway secretions. Many COVID-19 patients are anticoagulated, which may affect the timing of or decision to use neuraxial anesthesia or deep peripheral nerve blocks. (See "Neuraxial anesthesia/analgesia techniques in the patient receiving anticoagulant or antiplatelet medication" and "Coronavirus disease 2019 (COVID-19): Hypercoagulability".)

- Unplanned conversion from regional anesthesia to GA should be avoided if at all possible. The decision to perform surgery with regional anesthesia alone should be considered carefully and

discussed with the surgeon, including whether conversion to GA might be required.

- Patients who do not receive GA should wear a surgical mask at all times, including throughout the procedure. If supplemental oxygen is required, the oxygen face mask should be placed over the surgical mask, or nasal prongs can be placed under a face mask.

- If supplemental oxygen is required during regional anesthesia or MAC, the lowest flows possible to maintain oxygenation should be used.

General anesthesia

Induction — Perform a rapid sequence induction and intubation, modified as necessary for patient factors. (See "Rapid sequence induction and intubation (RSII) for anesthesia".)

- For critically ill patients, if necessary, administer intravenous fluid and/or vasopressors in anticipation of induction of anesthesia, and consider using ketamine, etomidate, or a combination of ketamine and propofol for induction of anesthesia, rather than propofol alone. Anticipate that critically ill patients with COVID-19 may become even more hypoxemic and hypotensive after induction and during intubation. In a review of 202 critically ill COVID-19 patients who were intubated emergently, hypoxemia occurred in 74 percent of patients, hypotension occurred in 18 percent, and four patients had cardiac arrest [47]. Almost all of these patients were induced with propofol using a modified rapid sequence induction, and were intubated with a videolaryngoscope. Most patients had hypoxemia, hypotension, and tachycardia prior to induction of anesthesia.

- If a modified rapid sequence induction with mask ventilation is felt to be necessary, use low pressure, small volume breaths, maintaining a tight mask seal. Some guidelines recommend use of two person ventilation, with one person holding the mask on each side of the face to minimize air leak around the mask.

Airway management

Choice of airway device — Endotracheal intubation should be used to manage the airway during general anesthesia, rather than a supraglottic airway, to most effectively seal the airway and prevent viral spread.

Endotracheal intubation — Endotracheal intubation and extubation are aerosol-generating procedures that increase the risk of transmission of infection [30,48]. Endotracheal intubation is especially hazardous because the clinician is close to the patient's airway before, during, and after the procedure, and performs associated interventions that create respiratory aerosols, such as

mask ventilation [23,49]. Thus, high-level personal protective equipment (PPE) is necessary, as noted above. (See 'PPE for care of patients who undergo aerosol-generating procedures' above.)

Goals for airway management are to secure the airway rapidly, on the first attempt, and to reduce or eliminate aerosolization of respiratory secretions. Important considerations during airway management, based on expert opinion and what is known about viral transmission, include the following [6-8,20,21,50,51]:

- Create a plan for airway management, with backup contingencies. Many guidelines suggest creating a COVID-19 intubation checklist, and performing COVID-19 intubation simulations. (See "Safety in the operating room", section on 'General approaches to risk reduction'.)
- When possible, intubate in a negative pressure operating room (OR). Most ORs use positive pressure air flow.
- Use double gloves during intubation; use one of the outer gloves to sheath the used laryngoscope.
- Use disposable airway equipment whenever possible.
- Minimize the number of persons in the OR during intubation; usually limit personnel to one intubator and one other assistant skilled in airway management. Follow institutional protocols for the length of time before other personnel can return to the OR after intubation. That interval may be based on the frequency of air exchanges in the OR, will vary with the size of the OR and other factors, and should be set by institutional policy [52,53]. The required waiting period will often be between 15 and 30 minutes.
- Optimize patient positioning for preoxygenation and airway management, with head elevated. Hypoxemic patients who require emergency intubation may not tolerate lying flat.
- For critically ill patients, expect that hypoxemia will often occur during intubation. For this reason, we preoxygenate with 100 percent oxygen for five minutes if possible based on hemodynamic or other clinical factors, with a tight fitting face mask, or with the existing method of oxygen therapy (eg, high flow nasal oxygen with a surgical mask over the patient's mouth) [47].
- The most experienced anesthesia clinician should perform intubation.
- Perform rapid sequence induction and intubation to minimize the need for ventilation and thereby prevent aerosol spread of respiratory secretions (see "Rapid sequence induction and intubation (RSII) for anesthesia"). If face mask ventilation is required to prevent desaturation

while waiting for neuromuscular blockade, use low volume, low pressure breaths. Use cricoid pressure only for aspiration concerns.

- Use whatever type of laryngoscope the clinician finds most comfortable and is likely to achieve intubation most rapidly. Videolaryngoscopy is typically preferred since this may increase the likelihood of first pass success in patients with a difficult airway [54], and also allows the clinician to remain farther from the patient's oropharynx during intubation [55].

- If rescue ventilation is required, use a supraglottic airway (SGA), rather than ventilation by mask, to better seal the airway and allow intubation through the device if necessary. If mask ventilation is required, use two hands with a two-person technique, with low pressures and small tidal volumes. There are reports of placing wet gauze or towels around the airway and/or nose may be helpful in reducing leaks during mask ventilation [7] or with the use of an SGA.

- Once the endotracheal tube is placed in the trachea at the proper depth, inflate the cuff before connecting the breathing circuit. After giving a breath, make sure there is no leak around the cuff.

- For confirmation of proper endotracheal tube placement, use end-tidal carbon dioxide ($EtCO_2$) and pay particular attention to proper tube depth during videolaryngoscopy. Avoid auscultation with a conventional stethoscope, since this requires bringing the clinicians face closer than necessary to the patient's face. Auscultation provides little additional information if videolaryngoscopy was used, and for patients in the intensive care unit, a chest radiograph will be used to confirm proper depth.

- For any circuit disconnects (eg, transport, expiratory limb filter change), leave the viral filter on the ETT at all times if possible. As an alternative if a viral filter is not in place at the airway, for patients who are not breathing spontaneously, pause the ventilator and clamp the ETT before a disconnect (picture 5).

- Use a closed suction system as necessary for tracheal suction, or for oral suction prior to extubation.

- Place all used airway equipment into a double zip-locked plastic bag for subsequent removal for decontamination. One suggestion is to place a wire basket lined with such a zip-locked bag on an IV pole close to the provider [40].

- After induction of anesthesia, wipe down all equipment and surfaces with anti-viral disinfection wipes [40].

Airway management for children with COVID-19 is discussed separately. (See "Airway management for pediatric anesthesia", section on 'Airway management for patients with COVID-19'.)

Tracheal extubation — Extubation is as high risk for aerosolization of respiratory secretions as intubation; similar precautions should be followed.

- Similar to endotracheal intubation, non-anesthesia personnel should leave the room during extubation, and should allow a number of air exchanges before reentry into a positive pressure room. (See 'Endotracheal intubation' above.)
- Administer prophylaxis for postoperative nausea and vomiting.
- Some experts suggest prophylaxis for coughing before extubation [5]. Options include IV, topical, or intracuff lidocaine, low dose opioids, and dexmedetomidine. (See "Extubation following anesthesia", section on 'Minimizing physiologic response to extubation'.)
- Several techniques can be used to prevent spread of secretions during extubation. The easiest of these is to secure a surgical mask over the patient while the endotracheal tube is still in place. Some experts suggest placing wet gauze over the patients mouth and nose just prior to extubation if the patient starts to cough [7,19], and/or covering the patient's face with a clear plastic drape or with the warming blanket if one is used. Any such device must be removed carefully and treated as biohazard.
- After extubation, place a surgical mask over the patient's airway. Apply a plastic mask for supplemental oxygen over the surgical mask, or nasal prongs under the surgical mask.

Management of the difficult airway — The basic principles for management of the difficult airway apply to patients with COVID-19. (See "Management of the difficult airway for general anesthesia in adults".)

However, awake fiberoptic intubation should in general be avoided unless absolutely necessary, since there is a higher risk of coughing and subsequent aerosol generation with this technique. If awake intubation is performed, meticulous airway anesthesia should be achieved, using topical local anesthetic ointment or gel, and/or nerve blocks. Nebulized local anesthetic should be avoided. Transtracheal injection of local anesthetic should also be avoided, as it is likely to generate a cough. Topical anesthesia should be tested prior to attempts at intubation. (See "Flexible scope intubation for anesthesia", section on 'Airway anesthesia'.)

Sedation should be administered sparingly during awake intubation, and titrated to effect, to minimize the need for supplemental oxygen or airway manipulation.

It is best practice to leave the emergency airway cart immediately outside the OR to minimize unnecessary contamination, with requested equipment brought in by an assistant who is wearing appropriate PPE.

OFF-SITE ENDOTRACHEAL INTUBATION

Considerations for emergency endotracheal intubation in locations outside the operating room (OR) are similar to those noted above, as summarized in the table (table 1) (see 'Airway management' above). Additional considerations include prepackaging, advance preparation of necessary equipment, and use of a COVID-19 modified intubation checklist (figure 5).

Importantly, PPE should be donned using proper technique and supervision, even in the most emergency clinical circumstances. Even small lapses in proper use of PPE increase the risk of transmission of infection to clinicians, particularly during emergency intubation and advanced cardiac life support (ACLS) scenarios [6].

Considerations for performing cardiopulmonary resuscitation in patients with COVID-19 are discussed separately. (See "Advanced cardiac life support (ACLS) in adults", section on 'Resuscitation of patients with COVID-19'.)

SOCIETY GUIDELINE LINKS

Links to society and government-sponsored guidelines from selected countries and regions around the world are provided separately. (See "Society guideline links: Coronavirus disease 2019 (COVID-19) – International and government guidelines for general care" and "Society guideline links: Coronavirus disease 2019 (COVID-19) – Guidelines for specialty care" and "Society guideline links: Coronavirus disease 2019 (COVID-19) – Resources for patients".)

SUMMARY AND RECOMMENDATIONS

- Frequent hand hygiene and proper donning and doffing of personal protective equipment (PPE) are essential to preventing transmission of coronavirus disease 2019 (COVID-19) to health care workers (figure 3 and figure 2). (See 'Hand hygiene and personal protective equipment' above.)
- Aerosol-generating procedures increase the risk of transmission of COVID-19 to health care workers. Aerosol-generating procedures include tracheal intubation or extubation, bag mask

ventilation, bronchoscopy and interventional pulmonology procedures, noninvasive ventilation, administration of high-flow oxygen or nebulized medications, tracheotomy, open suctioning of airways, upper endoscopy, and colonoscopy. (See 'PPE for care of patients who undergo aerosol-generating procedures' above.)

- For patients with confirmed or suspected COVID-19 who undergo aerosol-generating procedures, clinicians involved in their care should use personal protective equipment (PPE) appropriate for contact, aerosol, and airborne precautions (figure 1). This includes:
  - Use of N95 (picture 1) or other respirator (eg, a powered air-purifying respirator [PAPR]) that offers a higher level of protection,
  - Eye protection (goggles, face shield that covers the front and sides of the face, or full face PAPR),
  - Gloves (double gloves for intubation).
  - Water resistant gown.

  In addition, a disposable hair cover cap, beard cover, and shoe covers should be used. (See 'PPE for care of patients who undergo aerosol-generating procedures' above.)

- For patients who undergo non-aerosol-generating procedures, the same level of protection should be used as for aerosol-generating procedures if it is available. If N95 or higher respirators or PAPRs are not available, a surgical mask is an acceptable alternative. (See 'PPE for care of patients who undergo low risk procedures' above.)

- Patients should wear a surgical mask during transport, and should be transported directly to and from the operating room (OR), bypassing the holding area and preinduction area and the postanesthesia care unit (PACU). For intubated patients, a high quality viral filter should be placed between the endotracheal tube and the self-inflating (Ambu) bag used for ventilation (picture 6). (See 'Infection control during patient transport' above.)

- The anesthesia machine and other equipment should be protected from viral contamination, using plastic covers, and high quality viral filters in line in the breathing circuit. Filters should be placed at the end of the endotracheal tube connector, and on the expiratory limb of the breathing circuit where it connects to the anesthesia machine (figure 4). The gas sampling tubing should be connected on the machine side of the filter connected to the endotracheal tube. (See 'Preventing contamination' above.)

- The choice of anesthetic technique should be based on patient factors and the planned procedure. Regional anesthesia is not contraindicated by COVID-19. (See 'Choice of anesthetic technique' above.)

- For general anesthesia, a rapid sequence induction and intubation should be performed, modified for patient factors. (See 'Induction' above.)
- Goals for endotracheal intubation are to secure the airway rapidly, on the first attempt, and to reduce or eliminate aerosolization of respiratory secretions. Key considerations during intubation include the following (see 'Endotracheal intubation' above):
  - Minimize the number of persons in the room during intubation.
  - Preoxygenate and position the patient optimally for intubation.
  - Have the most experienced clinician perform the intubation.
  - Use double gloves for intubation.
  - Use whatever type of laryngoscope the clinician finds most comfortable and is likely to achieve intubation most rapidly. Videolaryngoscopy is typically preferred.
  - If rescue ventilation is required, use a supraglottic airway. If mask ventilation is required, use low pressure, low tidal volumes with a two person, two hand technique.
  - Use end-tidal carbon dioxide (CO_2) and proper tube depth during videolaryngoscopy to confirm endotracheal tube placement, rather than bilateral breath sounds.
  - Immediately dispose of contaminated equipment.
  - For mechanically ventilated patients who are not breathing spontaneously, leave the filter on the ETT or pause the ventilator and clamp the endotracheal tube for all breathing circuit disconnects.
- Extubation is as high risk for aerosolization of respiratory secretions as intubation; similar precautions should be followed. Key considerations during extubation include the following (see 'Tracheal extubation' above):
  - Minimize the number of persons in the room during extubation.
  - Administer prophylaxis for nausea and vomiting.
  - Consider administration of medication (eg, lidocaine, low dose opioid, dexmedetomidine) to reduce cough during emergence and extubation.
  - Place wet gauze, a clear plastic drape, or the warming blanket over the patient's face during extubation.

- After extubation, place a surgical mask over the patient's airway; apply a plastic mask for supplemental oxygen over the surgical mask, or nasal prong oxygen under the mask.

- The basic principles for management of the difficult airway apply to patients with COVID-19. However, awake fiberoptic intubation should generally be avoided if possible. (See 'Management of the difficult airway' above.)

- Considerations for anesthesiologists and other skilled clinicians called to perform endotracheal intubation in locations outside the OR are summarized in a table (table 1). (See 'Off-site endotracheal intubation' above.)

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