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Reviews

Surgical Infection Society Guidance for Operative and Peri-Operative Care of Adult Patients Infected by the Severe Acute Respiratory Syndrome Coronavirus-2 (SARS-CoV-2)

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Abstract

Background: Severe acute respiratory syndrome coronavirus-2 (SARS-CoV-2)–associated viral infection (coronavirus disease 2019, COVID-19) is a virulent, contagious viral pandemic that is affecting populations worldwide. As with any airborne viral respiratory infection, surgical and non-surgical patients may be affected.
Methods: Review and synthesis of pertinent English-language literature pertaining to COVID-19 infection among adult patients.
Results: COVID-19 disease that requires hospitalization results in critical illness approximately 25% of the time and requires mechanical ventilation with positive airway pressure. Acute kidney injury, a marked hypercoagulable state, and sometimes myocarditis can be features of COVID-19 in addition to the characteristic severe acute lung injury. Even if not among the most seriously afflicted, older patients with medical comorbidities are both predisposed to infection and risk increased morbidity and mortality, however, all persons presenting for surgical intervention should be suspected of infection (and thus transmissibility) even if asymptomatic. Although most elective surgery has been curtailed by administrative or governmental fiat, patients will still need urgent or emergency operative intervention for time-sensitive disease processes such as malignant neoplasia or for true emergencies such as perforated viscus or traumatic injury. It is possible to provide safe surgical care for SARS-CoV-2–positive patients and minimize nosocomial transmission to healthcare workers.
Conclusions: This guidance will facilitate appropriate protection of patients and staff, and maintenance of infection control measures to assist surgical personnel and facilities to prepare for COVID-19–infected adult patients requiring urgent or emergent operative intervention and to provide optimal patient care.

Keywords: COVID-19; guidelines; pandemic; SARS-CoV-2; SIS; virus infection

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PERI-OPERATIVE PLANNING, crucial to the care of the adult surgical patient, is more complex during this current viral pandemic. Institutions are activating coronavirus disease 2019 (COVID-19)–specific protocols [1,2]. Lessons learned from other contagious illnesses such as multi-drug–resistant (MDR) tuberculosis or recent, smaller-scale viral pandemics such as influenza A (H1N1) and severe acute respiratory syndrome coronavirus (SARS-CoV) [3–6] can inform precautions that may need to be adapted to COVID-19 care. It is encouraging that prior educational efforts, particularly with respect to proper use of personal protective equipment (PPE) decreased transmission risk during the 2002–2003 SARS-CoV-1 outbreak [7]. Patient cohorting and containment of aerosols generated by high-risk procedures (e.g., endotracheal intubation, bronchoscopy, tracheostomy, and laparoscopic exhaust gases) will be crucial to minimize cross-contamination, and occupational and nosocomial COVID-19 disease.

Clinical Presentation of COVID-19

SARS-CoV-2 is spread predominantly through aerosolization, droplet particles, or respiratory secretions; human–human transmission has been confirmed. As with any viral respiratory illness, maintenance of appropriate distance (6 feet) between individuals takes primacy as a preventive measures [6]. It is clear that the elderly and infirm patients with chronic cardiopulmonary diseases are especially vulnerable [8], although numerous deaths have also been reported among patients age 50 years or younger without comorbid conditions. Data regarding pediatric patients remain scarce. As of this writing, more than 1.4 million infections are confirmed, although undoubtedly an underestimate of the true prevalence because of undertesting and dubious reporting from some jurisdictions. The mortality rate among reported cases is approximately 5.8%. Case numbers continue to increase, although the doubling time has lengthened presently to approximately six to seven days from a prior estimate of two to three days as infection regresses in some countries and social distancing is taken seriously by the general population.

Characteristic features have been described as the disease progresses through several stages. COVID-19 is mediated by binding of viral ''spike proteins'' to human angiotensin-converting enzyme 2 (hACE2) coreceptors concentrated in the lungs, but also expressed by brain, heart, kidneys, and the gastrointestinal tract [9]. Predominant initial symptoms are cough, headache, and a fever in the initial stage, which is characterized by progressive lung inflammation [10]. However, atypical symptoms that may drive surgical consultation are being reported increasingly. Abdominal pain, nausea, and diarrhea are among the most common atypical COVID-19 manifestations, most notably affecting younger patients, and may precipitate surgical consultation. In the early stage of the disease, a helper T cell (T_H)1-mediated innate immune response produces lung inflammation and edema reminiscent of vasculitis as T_H1 lymphocytes traffic to the lungs [11], often causing lymphopenia. If infection progresses, acute respiratory distress syndrome develops at a median of eight days after symptom onset, at which time critical care becomes necessary. Acute respiratory distress syndrome (ARDS) is often accompanied by shock, acute kidney injury, and marked hypercoagulability that requires aggressive anticoagulant prophylaxis against frequent vascular catheter occlusion and venous thromboembolic complications, as well as myocarditis that may impede cardiac performance [12]. Critical illness-related corticoadrenal insufficiency (CIRCI) has been observed. Surgical emergencies such as trauma, major thermal injuries, perforated viscus, and vascular thrombosis or occlusion will still present requiring operative intervention As hospitals fill to overflowing with patients with COVID-19 infection and the prevalence increases in the community, it is inevitable that patients with COVID-19 will need operations.

Patient Environment

Routes of viral transmission include respiratory droplets, aerosolization, direct contact including with inanimate objects, fomites, and potentially the fecal–oral route [13]. If possible, patients with COVID-19 infection should be maintained in a negative-pressure room insofar as possible, including operating rooms (ORs) dedicated to their care. Windows must not be opened, and doors must stay closed as much as possible, limiting traffic to essential patient care tasks. It is clear that the number of hospital negative-pressure rooms will be vastly outnumbered by patient needs, rendering cohorting COVID patients as an evolving priority. Any clinician entering the room of a patient with COVID-19 requires appropriate PPE, including a respirator or N95 mask covered by a face shield for aerosol-generating procedures, or a powered air-purifying respirator (PAPR) depending on fit-testing and facial hair. The surgical team should be limited to only essential providers, and the number of times that members of the surgical team enter the room of a COVID-19 patient while still maintaining the standard of care should also be limited. Furthermore, ''pre-rounding'' to prepare for rounds must be restricted [14]. Functional work rounds may provide excellent patient care coupled with focused education [15] all while reducing the number of required room entries. These measures are intended to protect surgical team members and to preserve supplies of scarce PPE. Wound-care supplies, if stocked within the room, should not be removed to use for any other patient.

Peri-Operative Considerations for COVID-19 Patients

The plan of execution for a COVID-19 patient requiring an operation must incorporate three essential elements: limit foot traffic and OR personnel; locate the designated OR and supplies to minimize risk to staff; and communicate the plan to personnel (Table 1). Appropriate clinician and patient PPE must be maintained at all times while the patient is being transported throughout the facility [16]. Disposable OR attire such as surgical caps and masks should be in an accessible area in the operating suite. Given the current shortage of PPE crucial to the surgical mission [17], it is advised that these supplies be centralized and access be monitored and limited to essential use.

Many institutions have designated specific negative-pressure ORs for COVID-19 patients who need surgery, but not all institutions are capable of providing negative-pressure ORs. Facilities that lack negative-pressure ORs may also consider equipping a dedicated room with a high-efficiency particulate air filter (HEPA). Although testing of all pre-operative patients is desirable, limited test kit availability or

Table 1. Organization of Operating Room Flow

1. Limit unnecessary personnel within and throughout the OR.
2. Restrict movement (e.g., ambulation, intra-hospital transport) of non- COVID-19 patients to minimize potential contact with COVID-19 patients.
3. Separate ORs geographically; OR supplies and PPE should be designated for COVID-19 patient care only.
4. Assign a dedicated infection control person trained to supervise appropriate donning and doffing of PPE for any OR personnel who will be in the room of the COVID-19 patient.
5. Assign an area for containment and disposal of OR attire including scrubs after an operation on a COVID-19 patient.
6. Clearly display the plan and map for personnel to reference.

OR = operating room; COVID-19 = coronavirus disease 2019; PPE = personal protective equipment.

the need to take the patient to the OR immediately may preclude having results pre-operatively. Thus the dedication of one (or more) ORs for persons under investigation (PUI), or planning to close the OR for deep cleaning after a PUI is found post-operatively to harbor SARS-CoV-2, will minimize the risk of viral transmission [1,2]. The COVID-19 OR should have a separate entry point. It is crucial that any anesthesia equipment including the ventilator must be designated exclusively for the COVID-19 OR. All staff and appropriate administration should be aware of the COVID-19 OR patient and staff flow (Table 2).

A supply of PPE, including N95 masks or PAPR [16] should be available to the operating team immediately to minimize delays when operating upon unstable patients. Pre-operative checklists minimize the risks of error or adverse events; it is recommended that COVID-19–specific components be added. This may include a buddy system to check for proper fit of PPE as well as safe donning and doffing, a review of specific high-risk exposure points anticipated during the case, and the plan for extubation and transition to the next level of care. During the operation, the use of telephonic or other electronic tools to communicate between team members inside and outside the OR is essential to minimize unnecessary door opening and foot traffic [18]. This will minimize the number of individuals who are potentially exposed, unnecessary consumption of PPE and, in cases of negative-pressure rooms, disruption of the pressure gradient [18,19]. The use of a runner stationed immediately outside the door of the OR can facilitate coordinated delivery of needed equipment or specimen processing. Any piece of equipment left unused at case end should be considered contaminated and treated or disposed of as such. Coughing or forced expectoration after endotracheal extubation poses considerable risk to all personnel. If the patient is to be extubated at the end of the case, all non-airway personnel must leave the OR prior to extubation. After extubation, the patient should recover fully in the OR to minimize risk of aerosolization in the post-anesthesia care unit or intensive care unit (ICU).

If the patient remains intubated and needs to be transported to the ICU, several crucial steps at end-operation require consideration. A dedicated COVID-19 transport ventilator should be maintained. If not possible prior to surgery, then post-operatively the ventilator must not be re-deployed until thoroughly decontaminated. Considerable risk of aerosolization of virus exists when switching from the anesthesia ventilator to the transport ventilator. Prior to the transition, gas flow is interrupted expeditiously, and the endotracheal tube is occluded briefly. All individuals involved in both transport and acceptance of the patient in the ICU should wear full PPE and, if possible based on availability, a PAPR. The transport route must be cleared of impediments in advance to ensure smooth transit while minimizing incidental contact. Upon arrival to the ICU, the endotracheal tube occlusion maneuver should be repeated when exchanging from the transport ventilator to the ICU ventilator (Table 3).

Table 2. COVID-19 Operating Room Precautions to Minimize Unnecessary Contact and Delay in Transport

1. Inform the OR staff that a COVID-19 patient is coming to the OR as soon as the indication for immediate surgery is established.
2. Use electronic records and communication between anesthesia and surgery clinicians prior to patient arrival to minimize the time in a pre-operative holding area.
3. Clear the route of any patients and non-essential personnel through which the COVID-19 patient will be transported.
4. If PPE is securely stored, ensure that PPE is immediately available for all operating team members to minimize time in the pre-operative area.
5. Prepare the post-operative destination plan of disposition as soon as possible, whether the destination is the post-anesthesia care unit or directly back to a negative-pressure room or the ICU.

OR = operating room; COVID-19 = coronavirus disease 2019; PPE = personal protective equipment; ICU = intensive care unit.

Table 3. Peri-Operative Considerations

1. All personnel involved must have appropriate PPE including N95 masks or PAPR. Have extra PPE equipment readily available.
2. Use a dedicated negative-pressure OR if possible.
3. Limit the number of people in the OR to essential personnel only.
4. Pre-operative ''time out'' must include COVID-19–specific information in the checklist.
5. Use telephonic or other electronic tools to facilitate communication from inside to outside the OR to minimize door opening and foot traffic.
6. Consider using a topical local anesthetic to minimize aerosolization from coughing during airway manipulation.
7. For extubated patients, consider recovering the patient fully in the OR for up to 1 h prior to transport to the next level of care.
8. For patients remaining intubated, a dedicated COVID-19 transport ventilator should be used.
9. When switching between anesthesia and transport ventilators the endotracheal tube should be temporarily occluded to minimize risk of aerosolization.

PPE = personal protective equipment; PAPR = powered air-purifying respirators; OR = operating room; ICU = intensive care unit; COVID-19 = coronavirus disease 2019.

Table 4. Safe and Appropriate Removal of PPE in the Correct Sequence

1. At no time touch the outside of PPE items. All PPE should be considered contaminated.
   Gloves
   Grasp outside of glove with opposite gloved hand and peel off.
   Hold removed glove in gloved hand.
   Slide fingers of ungloved hand under remaining glove at wrist.
   Peel second glove off over first glove and discard into trash receptacle.
2. Goggles or face shield
   Grasp the headband or earpieces and pull forward carefully, avoiding contact with any potential splashed materials on the front of the googles or face shield
   Place the googles or face shield into a designated waste container.
   Do not re-use the goggles or face shield if visibly soiled or until decontaminated
3. Gown
   Unfasten ties. If tied at the back, have someone else, attired appropriately, undo the ties.
   Pull the gown away from neck and shoulders making sure to touch only the inside of gown.
   Turn the gown inside out, fold or roll into a bundle, and discard. Place—do not throw—the gown into the disposal unit.
4. Mask or respirator
   Grasp bottom ties or elastic band, then grab the upper ties or band and remove without touching or contaminating the face.

PPE = personal protective equipment.

Removal of Surgical Attire after the Operation

Appropriate techniques for wearing and removing surgical attire and PPE have been established for both surgical and non-surgical staff caring for COVID-19 patients (Table 4). Although OR staff are well trained in donning and doffing attire [20], presumed lack of risk must not engender complacency, and providers new to special airborne PPE will be inexperienced at first. Moreover, PPE can be rendered ineffective by inappropriate application, placing themselves and others at risk.

The technique for surgical gowning and gloving is unchanged for COVID-19 patients but must be painstaking to avoid the splashing of body fluid, particularly if a gown and glove change is required once the case is underway. Universal double-gloving is strongly recommended. Great care must be taken to avoid any breach of gown or gloves throughout the operation. Either a N95 mask beneath a surgical mask, with appropriate eve protection (e.g., face shield) or PAPR with eye protection is mandatory for high-risk patients (Table 3), and advisable for all operations performed in a COVID-19–designated OR. Doffing is the procedure associated with the highest risk of self-contamination and should be supervised closely.

SARS-CoV-2 can persist for hours to days on inanimate surfaces, but it is not certain whether this applies to clothing, including OR attire. Despite being worn under a waterproof surgical gown, it is advised to treat all OR attire, including surgical scrubs as though contaminated. An area must be designated, as close to the designated OR as possible, for disposal of surgical attire [20]. Surgical providers should not speak to family (if allowed to be present in a waiting area) after a COVID-19 case until after personal hygiene has been completed and after changing into fresh attire; families should be advised pre-operatively that these safety precautions may engender delay.

High-Risk Interventions and COVID-19 Patients

Surgical care for the COVID-19 patient who requires an operation should proceed as indicated, including, if possible, the use of a negative-pressure OR, use of appropriate PPE, and management of OR and surgical team personnel (Fig. 1). Several procedures pose a heightened risk to healthcare workers (HCWs) (Table 5). This guidance will address four specific situations for which surgical personnel need to pay particular attention: intubation, tracheostomy, endoscopy (especially bronchoscopy), and laparoscopy.

Endotracheal intubation

Experience from the prior SARS-CoV epidemic demonstrates that coronavirus can be disseminated via airway-related, aerosol-generating interventions such as non-invasive positive-pressure ventilation (NIPPV), endotracheal intubation [21,22]

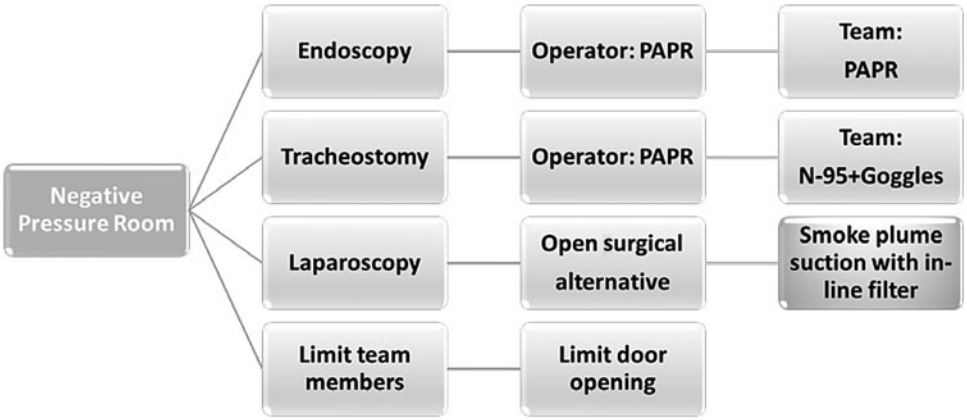

FIG. 1. Aerosolizing procedures: ICU/OR safety recommendations for COVID-19–positive patients. ICU = intensive care unit; OR = operating room; COVID-19 = coronavirus disease 2019; PAPR = powered air-purifying respirator.

Table 5. High-Risk Procedures for Aerosolization and Potential Viral Particle Transmission

Bronchoscopy
Endotracheal intubation
Laparoscopy, including diagnostic laparoscopy
Open lung surgery
Percutaneous endoscopic gastrostomy
Esophagogastroduodenoscopy
Colonoscopy
Tracheal surgery, including tracheostomy and percutaneous tracheostomy

or bronchoscopy. Awake intubation should be avoided unless absolutely necessary [23]. Rapid-sequence intubation minimizes (and ideally obviates) the need for aerosol-generating bag-mask ventilation (if used, the device must be equipped with a suitable in-line filter). Several aspects of physiology make intubation of COVID-19 patients especially challenging [24]. First, most critically ill patients are elderly with multiple comorbidities, thus physiologic reserve may be limited. Second, COVID-19 patients requiring intubation are likely to have ARDS with ventilation-perfusion mismatching and marginal oxygenation. Third, myocarditis may degrade cardiovascular elasticity and end-organ perfusion. The airway team must be ready to intervene immediately for hypoxemia or cardiovascular collapse associated with the use of facilitating agents (e.g., propofol, depolarizing agents).

Rapid-sequence intubation with the use of a topical local anesthetic [25] will minimize airway irritation and minimize coughing and secretions. Video laryngoscopy is beneficial to facilitate smooth intubation and takes the airway manager's face out of direct alignment with the opened patient airway. After intubation, equipment including the laryngoscope should be disposed of or cleaned thoroughly and separately from equipment from non-COVID-19 patients. A ''difficult airway'' cart should be available in case advanced airway techniques become necessary, including establishing a surgical airway. Several novel barrier devices ranging from complex boxes to low-tech clear plastic sheeting also helps limit aerosolization around airway control procedures.

Tracheostomy

Data from other respiratory outbreaks suggest that a large proportion of intubated COVID-19 patients will develop ARDS and require long-term mechanical ventilation [26]. By inference, approximately 25% of critically ill, intubated COVID-19 patients may require tracheostomy, the epitome of high-risk procedures. A negative-pressure room may minimize viral particle dissemination but does not decrease the risk to the operating team, who will be well within six feet of an open airway. Any airway manipulation, including tracheostomy, should be undertaken by experienced practitioners so as to expedite the procedure. Open tracheostomy may carry lower risk of aerosolization than the percutaneous technique. Being done at the bedside will obviate the risk of patient transport [27]. However, the OR is a more controlled environment with experienced personnel, especially as novel and non-traditional ICUs are pressed into service. Cleaning of the OR post-procedure should also systematized to reduce variations in decontamination procedure efficacy. Several centers have developed tracheostomy-specific teams as further risk mitigation.

The timing of tracheostomy for COVID patients is controversial. Most recommendations suggest waiting for stable oxygenation and ventilation after the acute phase of illness has resolved. Others have suggested waiting for at least three weeks from initial airway control. At present there is no clinical trial data to inform best practice regarding timing. Waiting for negative follow-up testing may be ideal but remains challenging until testing becomes more widely available and accuracy improves. Treating every patient as if COVID-19–positive is safest to presume during this pandemic.

Endoscopy

Endoscopic procedures such as esophagogastroduodenoscopy (EGD), percutaneous endoscopic gastrostomy, or colonoscopy insufflate gas into the gastrointestinal tract to improve navigation and visualization; egress of gas also must occur. Because there is no effective means to trap such gas, it is reasonable to avoid such techniques absent any alternative, and to forgo such procedures if the patient is unlikely to survive. For those who require endoscopy, all team members should wear full PPE including goggles, with the endoscopist protected by a PAPR if feasible. Similar to tracheostomy, these procedures are performed ideally in a negative-pressure room. Percutaneous endoscopic gastrostomy (PEG) should be avoided specifically because high-volume insufflation is necessary to dilate the stomach and appose it to the anterior abdominal wall. Bronchoscopy should especially be avoided because it combines high risk of aerosolization with periodic gas insufflation and saline irrigation and aspiration, a ''perfect storm'' for risk of dissemination. Bronchoscopy should also be avoided in favor of ultrasound guidance for percutaneous tracheostomy.

Laparoscopy

Laparoscopy insufflates a large volume of pressurized gas into a confined space. After initial abdominal insufflation, each additional port insertion invariably vents gas, as does every instrument exchange. However, the ports make it possible to capture the egress of gas, except when in active use. Estimated risk of transmission of viral particles during laparoscopy is currently inferred from other viral illness [28,29]. The SARS-CoV-2 virus has been identified in enteric epithelium and feces. Thus, the abdominal cavity during laparoscopy must be considered contaminated, and insufflated gas must be evacuated safely at the end of the case. Simple withdrawal of laparoscopic ports at the end of the case and allowance of pneumoperitoneum to escape into the general room environment is to be scrupulously avoided. As the abdomen is decompressed at the conclusion of the case, the evacuated smoke and pneumoperitoneum should be captured by an exhaust filtration collection system (see below).

The risk of potential SARS-CoV-2 exposure needs to be considered when making the choice between open versus laparoscopic technique for procedures amenable to both. On balance, surgeons may consider avoiding laparoscopy in

patients with known COVID-19 disease, instead performing open surgery to reduce aerosolization. Whereas certain procedures that are performed in an open fashion create longer incisions, more post-operative pain, and have a longer recovery, protection of patients, HCWs, and the hospital environment is essential to enable optimal care for all patients, regardless of SARS-CoV-2 status.

Surgical smoke evacuation

Numerous devices used during operations create a gaseous suspension of incinerated tissue microparticles, combustion products, and carbon dioxide, or ''smoke,'' which carries with it the risk of aerosolizing transmissible diseases. These devices include electrocautery, the ultrasonic harmonic scalpel, and lasers used for tissue ablation. Use of bipolar electrocautery may generate less smoke than either monopolar cautery or the harmonic scalpel. Although case reports of actual transmission of infections are sparse, concern is great, especially with the prominent respiratory transmission characteristic of SARS-CoV-2. Care must be exercised to ensure proper smoke collection and evacuation. The Association of Operating Room Nurses [30] and the National Institute of Occupational Safety and Health [31] both recommend smoke evacuators and filtration systems be used when operating on a patient with actual or potential airborne-transmissible disease. The National Institute of Occupational Safety and Health recommends the use of a smoke evacuation system with a capture velocity of 100–150 ft/min and a nozzle inlet that is kept within two inches of the generation point of smoke. During laparoscopy, it is commonplace to clear the field of vision by merely venting one of the ports, allowing the smoke to escape into the OR environment, with no effort made to capture or contain the disseminated smoke. This practice is clearly to be avoided. A controlled suction or filter device or smoke evacuator should be attached to the suction/aspirator device to capture the smoke from the abdominal cavity before egress.

Cleaning the OR

Complete cleaning of the OR is crucial after operating on a patient with COVID-19 infection, or if a patient is considered a PUI. A systematic, coordinated plan and approach, using a checklist, minimizes errors or omissions, and keeps all personnel as safe as possible [32]. Cleaning supplies designated for the COVID-19 OR should be segregated from other supplies used for other ORs. U.S. Environmental Protection Administration-registered hospital detergents or disinfectants are suitable for room cleaning and disinfection. Human coronaviruses can persist on uncleaned surfaces for up to nine days. However, viruses can be eliminated with disinfectants containing 70% ethanol, 0.1% sodium hypochlorite, or 0.5% hydrogen peroxide [33]. Agents such as benzalkonium chloride and chlorhexidine digluconate are less effective. Disposable equipment or filters must be discarded and never cleaned or disinfected. Non-disposable equipment should be double-bagged in red biohazard bags for transport for centralized cleaning. Personnel involved in the cleaning process must wear full PPE similar to that worn in the OR, and be well trained in the procedures and techniques specific to a COVID-19–positive room [34]. Ultimately, personnel must recognize that risk extends beyond the operation until cleaned items are suitable for reuse. The time for proper decontamination of an OR ranges up to three hours between ending of cleaning and permitting non-protected individuals into an unoccupied room, depending on the filtration rate [35]. Disposable equipment should be used as much as possible. Ultimately, personnel need to remember that the end of the case does not mean the end of the risk. Simulation-based training may be invaluable in preparing workers for COVID-19 contaminated OR management.

Potential Exposure of a Provider

Transmission of viral infection to HCWs is a real risk. Experience in both China and Italy documents that approximately 4% of hospitalized COVID-19 patients are HCWs. During the 2002–2003 SARS outbreak HCWs comprised approximately 20% of all infected individuals globally [36]. SARS-CoV-2 appears to be even more virulent and contagious resulting in higher rates of HCW infections. As such, in conjunction with the latest American Heart Association Advanced Cardiovascular Life Support guidelines, hospitals have mandated that even responders to a cardiac arrest must don full PPE including a face shield before entering the room. In the event that an HCW without appropriate PPE is exposed to a patient with COVID-19, self-isolation with monitoring of symptoms is still advised. If the HCW remains asymptomatic, there is no need for hospitalization especially as the hospital resources become stressed; home quarantine is instead recommended. Drawing from the experience with other outbreaks of airborne viral infections, including the seasonal influenza virus infection [6], it is known that asymptomatic persons shed viral particles and may be a source of transmission to patients. The duration of isolation is both time- and symptom-based. Given that no test is perfect, any clinician with unprotected exposure to a COVID-19 patient and who demonstrates symptoms should refrain from direct patient care until complete symptom resolution.

Presenteeism is a substantial risk for potential HCW-to-patient transmission. Surgical clinicians bring experience and abilities that may be valuable to other direct or non-direct patient care areas during this crisis. Hospital administrators are implementing enhanced communications technologies that make it possible for HCWs, whether exposed to or recovered from COVID-19, or has time available because elective surgeries have been suspended, to provide crucial support via remote access, tele-health to render consultation or outpatient care, as well as inpatient tele-critical care.

Conclusions

The SARS-CoV-2–COVID-19 pandemic is a health crisis of global impact and magnitude. Sometimes unavoidable high-risk procedures or operations (those that generate aerosols) place HCWs at increased risk for patient-to-HCW viral transmission. Risk mitigation includes social distancing while at work, frequent hand washing, and appropriate use of PPE such as N-95 masks, goggles, and ideally, PAPRs if available, in especially high-risk circumstances. We offer recommendations to reduce the potential of aerosolized viral particle transmission to HCWs during common, indicated high-risk urgent or emergent surgical procedures performed on known or presumed adult COVID-19 patients, in the ICU

or in the OR. Knowledge of SARS-CoV-2 and COVID-19 is changing rapidly, and guidance is based on current information, however limited. Accordingly, local protocols should be updated and shared frequently. This guidance spans all stages of surgical patient care, from systems preparation to post-operative recovery, and ideally will help to optimize patient care and protect HCWs as well as the hospital environment.

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