JOURNAL OF ENDOUROLOGY
Volume 34, Number 5, May 2020

Pp. 541–549
DOI: 10.1089/end.2020.0342

Review Article

Urologic Surgery and COVID-19: How the Pandemic Is Changing the Way We Operate

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Abstract

The coronavirus disease 2019 (COVID-19) pandemic has had a global impact on all aspects of health care, including surgical procedures. For urologists, it has affected and will continue to influence how we approach the care of patients preoperatively, intraoperatively, and postoperatively. A risk-benefit assessment of each patient undergoing surgery should be performed during the COVID-19 pandemic based on the urgency of the surgery and the risk of viral illness and transmission. Patients with advanced age and comorbidities have a higher incidence of mortality. Routine preoperative testing and symptom screening is recommended to identify those with COVID-19. Adequate personal protective equipment (PPE) for the surgical team is essential to protect health care workers and ensure an adequate workforce. For COVID-19 positive or suspected patients, the use of N95 respirators is recommended if available. The anesthesia method chosen should attempt to minimize aerosolization of the virus. Negative pressure rooms are strongly preferred for intubation/extubation and other aerosolizing procedures for COVID-19 positive patients or when COVID status is unknown. Although transmission has not yet been shown during laparoscopic and robotic procedures, efforts should be made to minimize the risk of aerosolization. Ultra-low particulate air filters are recommended for use during minimally invasive procedures to decrease the risk of viral transmission. Thorough cleaning and sterilization should be performed postoperatively with adequate time allowed for the operating room air to be cycled after procedures. COVID-19 patients should be separated from noninfected patients at all levels of care, including recovery, to decrease the risk of infection. Future directions will be guided by outcomes and infection rates as social distancing guidelines are relaxed and more surgical procedures are reintroduced. Recommendations should be adapted to the local environment and will continue to evolve as more data become available, the shortage of testing and PPE is resolved, and a vaccine and therapeutics for COVID-19 are developed.

Keywords: coronavirus, COVID-19, surgery, urology, SARS-CoV-2, pandemic

Introduction

The first reported cases of coronavirus disease 2019 (COVID-19), which is caused by severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2), originated in Wuhan City, Hubei Province, China in December 2019. This respiratory disease spread outside of China, leading to outbreaks in Korea, Iran, Italy, and, eventually, the United States and the rest of the world. On March 11, 2020, the World Health Organization (WHO) declared the outbreak to be a pandemic. At the time of this writing, there are currently more than 1.3 million confirmed cases worldwide, with the total deaths numbering more than 74,000.[1] This pandemic is unlike anything that has been seen in recent history.

From a urologic surgery perspective, many questions arise regarding the immediate and long-term care of our patients. The goal of this article is to summarize some of the current information available on preoperative, intraoperative, and postoperative care. As we gain more knowledge about how the virus behaves, this body of literature will inevitably change.

Preoperative Care

Infection and mortality

The decision to operate has the potential to place the patient, health care workers, and other hospitalized patients at risk of infection with SARS-CoV-2 and therefore should be approached with careful thought and consideration. How long a patient remains infectious seems to correlate with the severity of the symptoms experienced. In a series of nine COVID-19 patients in Germany, all with mild symptoms,

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viral levels were low enough for infectious transmission to be effectively minimal by 10 days after symptom onset in all patients.[2] In another study among 191 hospitalized COVID-19 patients in China, the median duration of time of the virus being detectable in amounts to be infectious was 20 days.[3] For patients who did not survive, the virus was detectable at significant levels until they succumbed to the disease. The virus was found up to 37 days after symptom onset in the longest case in this patient cohort. In an article published in *Nature*, the infection rate of SARS-CoV-2 was shown to be higher than the seasonal flu based on current estimates.[4]

The question of when to return to work for health care professionals who have tested positive will impact care. The Centers for Disease Control and Prevention (CDC) offers guidelines, which separate decision making into testing-based and non-testing-based options.[5] For the testing-based approach, employees should return to work after the fever resolves without the use of medication, respiratory symptoms have improved, and two tests for COVID-19 collected ≥24 hours apart have resulted negative. The non-testing-based approach involves waiting at least 72 hours after resolution of fever without use of medications and with an improvement of respiratory symptoms. In addition, they recommend waiting 7 days after symptom onset for the non-testing-based approach. Lastly, the CDC advises asymptomatic health care professionals with confirmed COVID-19 cases to wait at least 10 days before returning to work.

Along with the chance of infection, the risk of death from COVID-19 should be weighed when deciding to operate. The worldwide mortality rate at the time of this writing is 5.6%.[1] However, this is among confirmed cases only and the actual rate is likely much lower. In a review of 44,672 COVID-19 patients in China, the overall mortality rate was found to be 2.3%.[6] In this study, age was significantly associated with increased mortality. For instance, mortality increased to 8.8% for patients between the ages of 70 and 79. For patients ≥80 years old, the mortality was 14.8%. Medical comorbidities were also associated with worse clinical outcomes among COVID-19 patients. Cancer as a diagnosis increased mortality to 5.6%, diabetes to 7.3%, chronic respiratory issues to 6.3%, hypertension to 6%, and cardiovascular disease to 10.5%. Of the more than 44,000 patients, 81% of cases were mild (defined as presence of fever or cough), 14% were severe (as defined by dyspnea or hypoxia requiring supplemental oxygen), and 5% of cases were critical (as defined by respiratory failure, shock, or multiorgan failure). If a patient reached a critical state, the fatality rate was 49%.

Triaging patients and preoperative evaluation

To respond to and prepare for the surge of COVID-19 cases during the pandemic, hospitals around the world, including urology departments, have canceled elective procedures and prioritized only high-risk and emergency cases.[7] The American College of Surgery offered guidelines on how to prioritize cases by describing the Elective Surgery Acuity Scale.[8] This system divides the procedures into three tiers, with the third tier being the highest priority cases. They recommend that only cancer and high acuity cases be performed. A panel of urologists in Italy gave similar recommendations.[9] In addition to emergency procedures, they strongly recommended continuing to operate on kidney cancer ($\geq cT_2$), upper tract urothelial cancer ($\geq cT_1$, high grade), muscle invasive bladder cancer and refractory carcinoma *in situ*, prostate cancer (high risk and not a radiation candidate), testis cancer, and penile cancer ($>T_1$, grade 3). The panel also recommended transurethral resection for bladder tumors >2 cm. In a comprehensive review article, Puliatti and colleagues offered similar recommendations to prioritize emergency cases and high-risk cancer procedures.[10]

Selection of cases in a given region will be driven by the total number of cases, the projection of number of hospitalized patients during the surge, and the hospital and intensive care capacity. As the number of open hospital beds, ventilators, and personal protective equipment (PPE) decreases, postponing all but emergency and urgent surgeries becomes life-saving. Since the start of the pandemic, many have transitioned preoperative counseling to telehealth when possible.[11]

An important component of the preoperative evaluation for protecting patients and health care workers is testing for SARS-CoV-2. Most recommendations, such as those from the CDC, only recommend testing patients with symptoms.[12] However, a significant proportion of COVID-19 patients are asymptomatic. A group at the University of Oxford reviewed 21 studies on the subject and found that anywhere between 5% and 80% of COVID-19 positive patients may be asymptomatic depending on the population studied.[13] Knowledge of the patient being positive for the disease is important for intraoperative care in protecting those in the operating room (OR) and for postoperative care in isolating the patient from other inpatients. Surgeons should also be aware that testing has its limitations. Yang and colleagues found that nasopharyngeal and oropharyngeal testing has only a 60% to 70% sensitivity.[14] Serologic testing has a higher sensitivity at 80% to 100% for most tests.[15] Reinfections among previously infected patients are also a possibility, although it is too early to be determined conclusively. We recommend testing all patients during and soon after the pandemic preoperatively for COVID-19 if the testing capacity is present. It is essential to know the specificity and sensitivity of the specific test that is being used at an institution when making decisions regarding anesthesia, surgery, and the use of appropriate PPE. During the pandemic, all patients could be considered to be potentially infected with the virus given the possibility of a false negative test.

Knowledge of the patient's medications specifically for COVID-19 is also potentially impactful information. Hydroxychloroquine, which is now being used for treatment (and in some cases prophylaxis after exposure), has potential cardiac side effects, including cardiomyopathy and prolongation of the QT interval.[16] Remdesivir, an RNA synthesis inhibitor, is currently being studied as a potential treatment.[17] The safety and efficacy of this medication in this capacity has yet to be established.

Currently, there is no anesthesia preoperative risk stratification specifically for COVID-19 of which we are aware. This is something that may develop as the pandemic improves and more surgical cases are performed. The Royal College of Surgeons recommends preoperative chest imaging with a chest X-ray or CT, especially if the patient has respiratory symptoms and is unable to be tested for COVID-19 before the OR.[18]

Intraoperative Care

Personal protective equipment

Adequate PPE in the OR is necessary for ensuring the health of individual health care providers and maintaining an adequate workforce during the pandemic. In addition to the standard OR PPE of a gown, gloves, mask, and eye protection, there is the question of whether an N95 respirator mask should be used for surgeons. Organizations vary in the recommendations regarding the use of N95 masks. The American Association of Gynecologic Laparoscopists (AAGL) endorses the use of either a standard surgical mask or N95 depending on the clinical situation.[19] The Royal College of Surgeons recommends using an N95 respirator mask during procedures that have the potential to aerosolize the virus.[18] A task force assembled at Stanford University recommends wearing an N95 mask in the setting of a preoperative positive test for COVID-19.[20] They also recommended using a face shield along with the N95 mask to prevent droplets from accumulating, which could extend the use of each mask. Recommendations from the First Affiliated Hospital in China are to wear an N95 mask for all surgical cases.[21] The CDC also recommends wearing an N95 respirator when operating.[22] A randomized controlled trial between N95 and standard surgical masks in preventing influenza has been performed and found no difference.[23] However, this was in the outpatient setting where there is less risk for aerosolization of the virus.

In view of the scarcity of N95 masks and the lack of good evidence to confirm transmission of the SARS-CoV-2 during laparoscopy and robotic surgery, Indiana University (IU) Health at this time is recommending preoperative testing to determine which patients are at highest risk for transmission. If a patient is symptomatic or tests positive for COVID-19, the surgery should be postponed for at least 4–6 weeks with retesting being an option. If postponement is not possible, N95 masks are recommended for the surgical staff if aerosol-generating procedures on the respiratory tract are being performed (i.e., intubation/extubation, bronchoscopy, ear, nose, and throat [ENT], oral and maxillofacial surgery, and thoracic surgeries). Standard surgical masks are recommended for COVID-19 negative patients. This recommendation as well as all recommendations related to this pandemic are subject to change as more data become available.

Scarcity of PPE, such as N95 masks, has led to strategies to reuse the items to extend their use. If choosing to reuse the N95 mask, the CDC recommends using a face shield over the mask to avoid contamination, washing your hands after handling the mask, not touching the inside of the mask, and storing it by either hanging or placing inside a paper bag.[24] The CDC recommends discarding masks following aerosol-generating procedures, contamination with any body fluids, and close contact with infected patients. The United States Food and Drug Administration (FDA) has approved three methods of sterilizing N95 masks during the pandemic by using vaporized hydrogen peroxide.[25] The Battelle Decontamination System can be used a maximum of 20 times to reuse a single N95 mask as long as it is not visibly soiled. The Steris Sterilization System can be used up to 10 times. The Sterrad Sterilization System can be used up to two times. Ultraviolet C (UV-C) light treatment has also been used.[24] In our hospital, the current plan is to re-process them up to three times. Decontamination of masks at home is not recommended.

Workflow

The workflow in the OR has changed and will evolve as the pandemic continues. Drs. Brindle and Gawande offer surgical guidelines to follow during the pandemic.[26] Among these, they recommend creating a dedicated COVID-19 operating space. No unnecessary materials should be brought into the OR. Entering and exiting the room should be kept to a minimum. Similarly, a colorectal surgery group in Italy described their experience and recommended precautions including minimizing personnel and traffic into and out of the OR.[27]

The OR practices surrounding intubation and extubation remain an area of concern as these are high-risk instances in patient care when the virus is aerosolized. The American Society of Anesthesiologists (ASA) recommends that the areas in which aerosolization occurs be equipped with negative pressure ventilation to prevent transmission to hospital staff.[28] They also recommend having the fewest necessary staff present during intubation and/or aerosolizing procedures, especially if the intubation cannot be done in a negative pressure room. Most ORs are equipped with positive pressure ventilation systems to prevent contaminants from entering from outside the ORs to help decrease the incidence of surgical site infections. Thus, if logistically possible, the patient should be intubated in a negative pressure room before being transferred to the positive pressure OR.

Another question is whether there should be a period of time after intubation or extubation during which non-essential personnel should remain outside of the room, especially if the intubation/extubation is not able to take place in a negative pressure room. These time estimates are based on the number of air changes within the room per hour.[29] The number of air changes per hour depends on the specific OR, and the faster the air is turned over in the room, the quicker the particles are removed. For example, if a room has an air turnover rate of roughly 20 times per hour, 99% of particles are removed after 14 minutes. Although there is a lack of evidence at this time, it seems reasonable to wait a period of time (the length of which depends on the specific OR) after intubation before starting the case until more data are available, especially in a positive pressure setting.

Endoscopy

Thus far, most analyses of urine specimens for SARS-CoV-2 have been negative.[2,30,31] One study in China found SARS-CoV-2 RNA in the urine of 4 COVID-19 patients requiring hospitalization out of a total of 58 patients in the cohort.[32] In addition to urine, the virus RNA has been found in blood specimens.[33] However, blood from COVID-19 positive patients has been reported to be transfused unknowingly in seven patients, and none of the recipients developed symptoms.[34] Three of the recipients were tested 2 to 3 weeks after the donation and were found to be COVID-19 negative. Out of caution, care should still be taken to minimize trauma during cystoscopy and ureteroscopy. To decrease the risk of contamination of equipment, disposable ureteroscopes may be used more frequently depending on outcomes as we move forward during the COVID-19 pandemic.

Another factor to consider for endoscopy is whether to place a stent or nephrostomy tube for emergent cases, such as an obstructing stone in the setting of infection. According to

Table 1. Recommendations for Pre-, Intra-, and Postoperative Care

Preoperative
Postpone elective procedures until the surge of the pandemic has passed.
Unless emergent, consider SARS-CoV-2 testing and chest imaging for all patients who need a procedure.
Ideally perform testing within 48 hours of the procedure.
Avoid operating on COVID-19 positive patients if possible.
Use telehealth to perform preoperative counseling and communication when possible.
Preoperative counseling should include the risk of contracting the disease during or after the procedure for COVID-19 negative patients.
Intraoperative
If able, choose the anesthesia method that minimizes risk of aerosolization of the virus.
If intubation is required for a COVID-19 positive patient, perform the intubation and extubation in a negative pressure room if available.
If a negative pressure room for intubation/extubation is not available, have team members except the anesthesia provider and assistant wait outside the room until 99% of the room's air has been exchanged (15 to 30 minutes for most ORs).
Anesthesia team to use enhanced PPE, including N95 masks or PAPR.
Include as few members as possible on the surgical team to minimize virus transmission.
For the surgical team, in COVID-19 positive patients, those with unknown COVID-19 status, and symptomatic patients, N95 mask recommended in addition to standard PPE.
Consider using a face shield or standard surgical mask on top of the N95 to extend the use of the N95 if resources are scarce.
Have only equipment essential for the surgery in the room to minimize contamination.
Avoid entering and exiting the room as much as possible.
Have a person outside the room to obtain needed equipment.
Choose a surgical approach with consideration of aerosolization of the virus, time in the hospital, blood loss, cancer control, operative time, and surgeon familiarity with the procedure.
Regardless of the approach chosen, minimize aerosolization of the virus (Table 2).
Avoid leaving a surgical drain if possible.
Use disposable equipment when possible.
Postoperative
For COVID-19 positive patients, recover the patient in the OR if possible.
Create a separate COVID-19 area within the hospital to avoid transmission to noninfected patients.
Perform appropriate sterilization and/or disposal of equipment and instruments.
Allow adequate time for thorough OR cleaning.
Avoid family visits.

These recommendations are subject to continued modification as evidence evolves during the COVID-19 pandemic.
COVID-19 = coronavirus disease 2019; OR = operating room; PAPR = Powered Air-Purifying Respirator; PPE = personal protective equipment; SARS-CoV-2 = severe acute respiratory syndrome coronavirus 2.

the Anesthesia Patient Safety Foundation, during procedures that require general anesthesia, the highest risk of aerosolization of the virus is during intubation and extubation.[35] For this reason, a stent placed under sedation without intubation or the placement of a nephrostomy tube may be safer than a stent placed in an intubated patient. However, this remains an area of debate. The ASA states that laryngeal mask airway may actually increase the risk of aerosolization of SARS-CoV-2 in the setting of high airway pressures and leakage around the mask.[28] Further, monitored anesthesia care, although it avoids intubation and extubation, could potentially require the anesthesia provider to be closer to the patient's airway and be a potentially greater risk if there is any issue requiring manual bagging or unplanned intubation. The society admits this is only expert opinion because there are a lack of studies, but it still remains a valid concern. Adequate neuromuscular blockade during procedures may also help avoid coughing and aerosolization of the virus.

Laparoscopy and robotics vs *open surgery*

The potential for aerosolization of SARS-CoV-2 has led organizations such as the Society of American Gastrointestinal and Endoscopic Surgeons (SAGES) to recommend

Table 2. Techniques to Decrease the Potential Risk of Aerosolization of Severe Acute Respiratory Syndrome Coronavirus 2 During Laparoscopic or Robotic Procedures

Use an insufflation system with an ultra-low particulate air filter.
Use the lowest insufflation pressure possible to complete the procedure.
Avoid air leaks during instrument changes, introduction of material into the peritoneal cavity, and around port sites.
Use the least duration of cautery and at the lowest possible setting without compromising surgical outcomes.
Use a filter for desufflation of pneumoperitoneum and desufflate before ports are removed.
Avoid using a two-way circuit for pneumoperitoneum if possible.
Use suction liberally to avoid smoke accumulation.
Avoid hand-assisted approaches if possible.
Use a smoke evacuator if available.

These recommendations are subject to continued modification as evidence evolves during the COVID-19 pandemic.

Table 3. Summary of Recommendations from Surgical Organizations

	Preoperative testing for SARS-Cov-2	*MIS* vs *open surgery*	*PPE*	*Intra-op personnel*	*Other recommended equipment*	*Extubation, post-op convalescence*	*Telemedicine*	*Level of evidence*
ACS	Recommend COVID-19 testing when possible	Consider avoiding laparoscopy	Use N95 respirators when operating if available.	Minimum number of personnel suggested	Closed filtration system during laparoscopy and for evacuation of the pneumoperitoneum. Use a smoke evacuator.	Minimum number of personnel	Utilize when possible	Expert opinion
RCS	Recommend testing all urgent patients and using history, testing, and X-rays to aid in decisions	Consider laparoscopy only if clinical benefit to the patient exceeds the risk of viral transmission	Filtering mask (N95 or greater) required for aerosolization procedures; standard surgical mask for all other non-aerosol-producing OR procedures.	Minimum number of staff in OR. Team changes recommended for prolonged procedures	Smoke evacuation devices, laparoscopic filters.	Staff immediately present should be at a minimum	Encourage use of virtual clinics	Expert opinion
SAGES	Test all patients if possible	Minimal risk of transmission during laparoscopy	N95 and face shield for surgical procedures and endoscopy	Essential personnel present	Negative pressure room for intubation, electrocautery on lowest settings, smoke evacuator, and laparoscopic filters		Telemedicine should be used when possible	Expert opinion
ERUS	Test all patients if possible	Perform laparoscopy with caution due to the increased risk of aerosolization	Recommend a respirator mask for the surgeon; possibly wearing a sealed visor mask for the console surgeon	Minimum number of OR staff	Operate at lowest pressure possible. Avoid two-way pneumoperitoneum insufflators to prevent pathogen colonization.			Expert opinion
AAGL	Test symptomatic patients. If the testing becomes more available, then screen all patients	Proceed with caution with laparoscopy due to theoretical risk	Standard surgical or N95 masks depending on the clinical situation	Minimal personnel present	Laparoscopic filters, smoke evacuators			Expert opinion
IU Health	Test all patients within 72 hours of elective procedures	Perform laparoscopy and robotics when indicated	In COVID-19 positive or COVID-19 status unknown patients: if patient intubated in separate room or surgery >15 to 30 minutes after intubation, then enhanced droplet (surgical mask); if surgery <15 to 30 minutes after intubation AND in same room as intubation, then enhanced airborne (N95); N95 masks for all aerosol-generating procedures related to the respiratory tract	Minimal personnel present	Smoke evacuation devices and laparoscopic filters.	Negative pressure room is preferred for: (1) intubations/ extubations and high-risk procedures for COVID-confirmed patients; (2) intubations/ extubations and high-risk procedures for COVID-suspected (test pending) emergent cases	Utilize when possible	Expert opinion

AAGL = American Association of Gynecologic Laparoscopists; ACS = American College of Surgeons; EAU = European Association of Urology; ERUS = European Association of Urology Robotic Urology Section; IU = Indiana University; MIS = minimally invasive surgery; SAGES = Society of American Gastrointestinal and Endoscopic Surgeons; RCS = Royal College of Surgeons.

Source: Pryor,[36] Society of American Gastrointestinal and Endoscopic Surgeons,[42] American College of Surgeons,[47] American Association of Gynecologic Laparoscopists,[48] Royal College of Surgeons,[49] and Mottrie.[50]

precautions regarding laparoscopic and open surgery.[36] They recommend minimizing energy use from electrocautery devices to avoid collection of surgical smoke. They recommend using insufflation systems with ultra-low particulate air (ULPA) filters. In addition, SAGES recommends against using two-way pneumoperitoneum insufflators to prevent the pathogens from collecting in the circuit and possibly infecting future patients. Although there have been no reported infections from surgical smoke, it remains a concern as there is a lack of direct evidence. The current recommendations are based on prior research of other viruses that have been detected in surgical smoke, including human immunodeficiency virus and papillomavirus.[37,38] A recent study in China found that smoke concentration is higher during laparoscopic cases compared with open cases,[39] which makes minimally invasive laparoscopic and robotic surgery particularly vulnerable to possible aerosolization of the virus, if present. In addition to blood, SARS-CoV-2 RNA has been found in stool samples.[31,40] It is unknown whether the virus is present in peritoneal fluid.

Despite the lack of evidence of transmission of the virus to health care workers during laparoscopy, steps are advised to reduce the risk of aerosolization during release of pneumoperitoneum and diathermy until more information is available. Maneuvers that can help for minimally invasive surgery are frequent suctioning of smoke in the pneumoperitoneum, avoidance of air leaks around ports and during instrument transfers, and care in removing ports, especially when pneumoperitoneum is still established. Other techniques to consider include using balloon ports or trocars that can be secured to avoid pneumoperitoneum leaking at the port sites.

Ultimately, the choice of procedure should not compromise the patient outcomes and laparoscopy and robotics must be used when indicated. The surgeon should carefully weigh the pros and cons of each approach. In addition to reducing exposure to patient and health care workers, OR time, blood loss, length of hospital stay, and risk of short- and long-term complications should be considered.

Filters

Although there have been no reported transmissions via surgical smoke, out of caution and until more data are obtained, the use of smoke evacuators and surgical laparoscopic systems that have appropriate filters for the virus should be considered. The size of SARS-CoV-2 virus is 0.06 to 0.14 μm.[41] The ULPA filters are capable of filtering virus particles of this size and are therefore recommended. According to SAGES, the UHI-4 insufflation system (Olympus, Tokyo, Japan) does not have a ULPA filter, but there are other insufflation systems and smoke evacuators that do utilize them: AirSeal® (ConMed, Utica, NY), SeeClear® (CooperSurgical, Trumbull, CT), Megadyne™ (Ethicon, Somerville, NJ), RapidVac™ (Medtronic, Minneapolis, MN), Pneumoclear™ (Stryker, Kalamazoo, MI), Nebulae™ (Northgate Technologies, Elgin, IL), and S-PILOT™ (Karl Storz, Tuttlingen, Germany).[42]

There may be concerns with two-way insufflation with regard to the systems mentioned earlier. For example, AirSeal, which is designed to keep the pneumoperitoneum at a constant pressure, uses a two-way system in which all of the circulating air may not be filtered through the ULPA filter.[42] However, the problem just cited can be remedied by using the device in smoke evacuation mode. In this mode, the tubes are set to two standard trocars in a closed loop configuration. One connection is for insufflation, and the other is for active smoke evacuation through a 0.1 μm ULPA filter. In addition to ConMed, most other companies have described similar solutions to avoiding the issues with two-way insufflation. You should contact the representative of the system at your institution to determine the best settings to prevent transmission/aerosolization. We do not specifically endorse any of the products just mentioned.

Postoperative Care

Disinfection of ORs

Appropriate disinfection of the OR is vital to preventing transmission of the virus to future patients and health care workers. Dexter and colleagues describe detailed recommendations for decontamination during and after OR procedures during the COVID-19 pandemic.[43] They suggest frequent and thorough handwashing by all members of the surgical team. Exposed equipment, instruments, and trash should be separated from noncontaminated items to facilitate proper decontamination and decrease risk of exposure. The

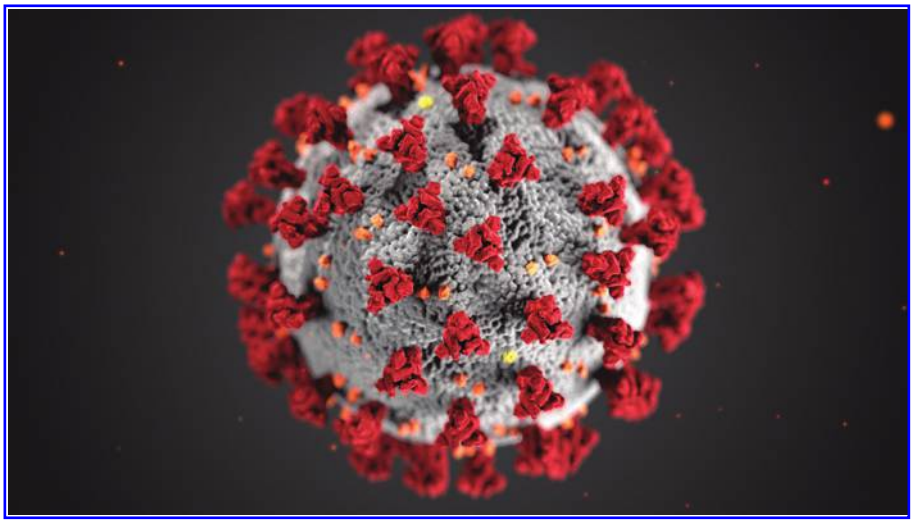

FIG. 1. Illustration of the morphology of a coronavirus. Photo credit: Alissa Eckert, MS and Dan Higgins, MAMS ID #: 23311. Public Health Image Library. Centers for Disease Control and Prevention.

area around the patient and anesthesia work team should be wiped down with a cloth containing alcohol and a quaternary ammonium solution. They also recommend the room be disinfected with UV-C light. Finally, the surgical team should be allowed to work in another OR for the following case to allow time for the first room to be deep cleaned.

The Association of periOperative Registered Nurses (AORN) states that standard hospital grade disinfectants that are registered by the Environmental Protection Agency are adequate for cleaning ORs during the COVID-19 pandemic.[44] There should be sufficient time between cases to allow for cleaning and to allow for sufficient air exchanges in the room to decrease the amount of virus to an acceptable level before the next procedure. Consideration should also be given to cleaning the robotic console in between cases for robotic surgeons, as this is a potential mode of transmission.

Patient recovery

The risk of transmission of SARS-CoV-2 to noninfected patients and health care workers continues beyond the time of the operation, and, thus postoperative precautions should be taken. The ASA recommends that the surgical patient recovers in the OR after extubation or be transported to an airborne infection isolation room.[45] Zheng and colleagues described their experience performing surgery in China and Italy during the beginning of the pandemic.[46] For containment, they also recommend separation of COVID-19 patients from noninfected patients at all levels of care, including recovery. Tables 1 to 3 outline recommendations for pre-, intra-, and postoperative care, techniques to decrease the risk of aerosolization, and a summary of current recommendations from surgical organizations.

Conclusions

A risk-benefit assessment of every urologic patient undergoing surgery should be performed during the COVID-19 pandemic based on the urgency of the surgery and the risk of the viral illness and transmission. Minimally invasive surgery, including laparoscopy and robotic surgery, should be performed when indicated with attention to minimizing potential aerosolization. Routine preoperative testing for COVID-19 and adequate protective equipment for the surgical team is essential. Future directions will be guided by outcomes and patient infection rates as social distancing guidelines are relaxed and more surgical procedures are reintroduced. Recommendations should be adapted to the local environment and will continue to evolve as more data become available, the shortage of testing and PPE is resolved, and a vaccine and therapeutics for COVID-19 are developed.

Acknowledgment

Gratitude is extended to Margaret S. Pearle, MD, PhD, for reviewing this article.

Author Disclosure Statement

There are no conflicts of interest to disclose.

Funding Information

There was no funding received for this article.

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Abbreviations Used

ASA = American Society of Anesthesiologists
CDC = Centers for Disease Control and Prevention
COVID-19 = coronavirus disease 2019
CT = computed tomography
OR = operating room
PPE = personal protective equipment
SAGES = Society of American Gastrointestinal and Endoscopic Surgeons
SARS-CoV-2 = severe acute respiratory syndrome coronavirus 2
ULPA = ultra-low particulate air
UV-C = ultraviolet C

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