

Title: Urologic surgery and COVID-19: How the pandemic is changing the way we operate

Running Head: Urologic Surgery and COVID-19

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Abstract

The coronavirus disease 2019 (COVID-19) pandemic has had a global impact on all aspects of healthcare, including surgical procedures. For urologists, it has affected and will continue to influence how we approach the care of patients pre-operatively, intra-operatively, and post-operatively. 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 healthcare 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 post-operatively with adequate time allowed for the operating room air to be cycled after procedures. COVID-19 patients should be separated from non-infected 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 becomes available, the shortage of testing and PPE is resolved, and a vaccine and therapeutics for COVID-19 are developed.

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 over 1.3 million confirmed cases worldwide with total deaths numbering over 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 pre-operative, intra-operative, and post-operative 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, healthcare 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, 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 that 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 healthcare 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 seven 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 70-79. 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 over 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 Pre-operative 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 emergent cases.⁷ The American College of

Surgery offered guidelines on how to prioritize cases by describing the Elective Surgery Acuity Scale (ESAS).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 ($\geq cT2$), upper tract urothelial cancer ($\geq cT1$, 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 ($>T1$, grade 3). The panel also recommended transurethral resection for bladder tumors >2 cm. In a comprehensive review article, Puliatti et al 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 pre-operative counseling to telehealth when possible.¹¹

An important component of the preoperative evaluation for protecting patients and healthcare 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 to 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 to know for intraoperative care in protecting those in the operating room and for post-operative care in isolating the patient from other inpatients. Surgeons should also be aware that testing has its limitations. Yang et al found that nasopharyngeal and oropharyngeal testing has only a 60 to 70% sensitivity.¹⁴ Serologic testing has 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 pre-operative 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 prior to the OR.¹⁸

Intra-operative Care

Personal Protective Equipment

Adequate personal protective equipment in the operating room is necessary for ensuring the health of individual healthcare providers and maintaining an adequate workforce during the pandemic. In addition to the standard operating room personal protective equipment of a gown, gloves, mask, and eye protection, there is the question of whether an N95 respirator masks 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 pre-operative 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 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 two weeks. 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, 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 becomes available.

Scarcity of personal protective equipment, 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 either by 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 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 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 operating room 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 operating room. 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 operating room.²⁷

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 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 operating rooms are equipped with positive pressure ventilation systems to prevent contaminants from entering from outside the operating rooms to help decrease the incidence of surgical site infections. Thus, if logistically possible, the patient should be intubated in a negative pressure room prior to being transferred to the positive pressure operating room.

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 operating room, 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 (length of which depends on the specific OR) after intubation before starting the case until more data is 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 four 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 2-3 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 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 American Society of Anesthesiologists (ASA) states that laryngeal mask airway (LMA) may actually increase the risk of aerosolization of SARS-CoV-2 in the setting of high airway pressures and leakage around the mask.²⁸ Furthermore, monitored anesthesia care (MAC), 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 versus 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 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. Additionally, 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 to 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 if 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 healthcare workers, operating room 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 is 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 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[™] \square (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 the above systems. For example, with 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 above problem 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 for active smoke evacuation through a 0.1 micron 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 above products.

Post-operative Care

Disinfection of Operating Rooms

Appropriate disinfection of the operating room is vital to preventing transmission of the virus to future patients and healthcare workers. Dexter et al 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 non-contaminated items to facilitate proper decontamination and decrease risk of exposure. The 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 ultraviolet (UV-C) light. Finally, the surgical team should be allowed to work in another operating room 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 operating rooms 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 non-infected patients and healthcare workers continues beyond the time of the operation and thus post-operative precautions should be taken. The American Society of Anesthesiologists recommends that the surgical patient recovers in the operating room after extubation or be transported to an airborne infection isolation (AII) room.⁴⁵ Zheng et al 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 non-infected patients at all levels of care including recovery. Tables 1-3 outline recommendations for pre-, intra-, and post-

operative 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 becomes available, the shortage of testing and PPE is resolved, and a vaccine and therapeutics for COVID-19 are developed.

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Abbreviations Used

AAGL = American Association of Gynecologic Laparoscopists

ACS = American College of Surgeons

All = airborne infection isolation

AORN = Association of periOperative Registered Nurses

ASA = American Society of Anesthesiologists

CDC = Centers for Disease Control and Prevention

cm = centimeters

COVID-19 = coronavirus disease 2019

CT = computed tomography

EAU = European Association of Urology

ENT = ear, nose, and throat

ERUS = European Association of Urology Robotic Urology Section

ESAS = Elective Surgery Acuity Scale

FDA = United States Food and Drug Administration

IU = Indiana University

LMA = laryngeal mask airway

MAC = monitored anesthesia care

µm = micrometers

OR = operating room

PPE = personal protective equipment

RCS = Royal College of Surgeons

RNA = ribonucleic acid

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

WHO = World Health Organization

Table 1. Recommendations for pre-, intra-, and post-operative care. (These recommendations are subject to continued modification as evidence evolves during the COVID-19 pandemic.)

Pre-operative

- Postpone elective procedures until the surge of the pandemic has passed.
- Unless emergent, consider SARS-CoV-2 testing and chest imaging for all patients that 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.

Intra-operative

- 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 isn't available, have team members except the anesthesia provider and assistant wait outside the room until 99% of the room's air has been exchanged (15-30 minutes for most ORs).
 - Anesthesia team to use enhanced PPE including N95 masks or Powered Air-Purifying Respirator (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.
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- 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 (see Table 2).
 - Avoid leaving a surgical drain if able.
 - Use disposable equipment when possible.

Post-operative

- For COVID-19 positive patients, recover the patient in the operating room if possible.
- Create a separate COVID-19 area within the hospital to avoid transmission to non-infected patients.
- Perform appropriate sterilization and/or disposal of equipment and instruments.
- Allow adequate time for thorough operating room cleaning.
- Avoid family visits.

SARS-CoV-2 = severe acute respiratory syndrome coronavirus 2, COVID-19 = coronavirus disease 2019, OR = operating room, PPE = personal protective equipment

Table 2. Techniques to decrease the potential risk of aerosolization of SARS-CoV-2 during laparoscopic or robotic procedures. (These recommendations are subject to continued modification as evidence evolves during the COVID-19 pandemic.)

Recommendations for minimizing aerosolization of SARS-CoV-2

- 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.

SARS-CoV-2 = severe acute respiratory syndrome coronavirus 2, COVID-19 = coronavirus disease 2019

Table 3. Summary of recommendations from surgical organizations.^{36,42,47,48,49,50}

	Preoperative Testing for SARS-Cov-2	Minimally Invasive Surgery (MIS) vs. Open Surgery	Personal Protective Equipment	Intra-op Personnel	Other Recommended Equipment	Extubation, post-op convalescence	Telemedicine	Level of Evidence
American College of Surgeons (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 pneumoperitoneu	Minimum number of personnel	Utilize when possible	Expert opinion

					m. Use a smoke evacuato r.			
Royal College of Surgeons (RCS)	Recom mend testing all urgent patient s and using history , testing , and xrays to aid in	Consider laparoscopy only if clinical benefit to the patient exceeds the risk of viral transmission.	Filtering mask (N95 or greater) required for aerosoliza tion procedure s Standard surgical mask for all other	Minim um numb er of staff in OR. Team chang es recom mend ed for prolon ged proce	Smoke evacuatio n devices, laparosco pic filters	Staff imme diately presen t should be at a minim um.	Encourage use of virtual clinics	Expert opinion

	decision		non-aerosol producing OR procedures.					
Society of American Gastrointestinal and Endoscopic Surgeons (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, laparosc		Telemedicine should be used when possible	Expert opinion

					pic filters			
EAU Robotic Urology Section (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
American Association of Gynecologic	Test symptomatic	Proceed with caution with laparoscopy due to theoretical risk	Standard surgical or N95	Minimal personal	Laparoscopic filters,			Expert opinion

<p>Laparoscopists (AAGL)</p>	<p>patients. If the testing becomes more available, then screen all patients.</p>		<p>masks depending on the clinical situation</p>	<p>personnel present</p>	<p>smoke evacuators</p>			
<p>Indiana University (IU) Health</p>	<p>Test all patients within 72 hours of</p>	<p>Perform laparoscopy and robotics when indicated</p>	<p>In COVID 19 positive or COVID 19 status unknown</p>	<p>Minimal personnel present</p>	<p>Smoke evacuation devices and laparoscopic filters</p>	<p>Negative pressure room is</p>	<p>Utilize when possible</p>	<p>Expert opinion</p>

	<p>elective procedures</p>		<p>patients</p> <ul style="list-style-type: none"> • If patient intubated in separate room or surgery > 15-30 mins after intubation then enhanced droplet (surgical mask) • If surgery < 15-30 			<p>preferred for:</p> <ol style="list-style-type: none"> 1. Intubations/extubations and high risk procedures for COVID - confirmed patient 		
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			mins after intubation AND in same room as intubation then enhanced airborne (N95) • N95 masks for all aerosol generatin g procedure s related to the respirator			ts 2. Intuba tions/ extuba tions and high risk proced ures for COVID - suspec ted (test pendin g)		
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