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## Special Article

# Advantages of, and Adaptations to, Enhanced Recovery Protocols for Perioperative Care during the COVID-19 Pandemic

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**ABSTRACT Objective:** This review formulates the rationale for using enhanced recovery protocols (ERPs) to standardize and optimize perioperative care during this high-risk time to minimize poor outcomes owing to provider, patient, and system vulnerabilities.

**Data Sources:** n/a

**Methods of Study Selection:** A literature review using key Medical Subject Headings terms was performed—according to methods described by the Cochrane Collaboration and Preferred Reporting Items for Systematic Reviews and Meta-Analyses guidelines—on studies that described enhanced recovery and coronavirus disease (COVID-19).

**Tabulation, Integration, and Results:** Modifications to our existing ERPs related to the COVID-19 pandemic should include new accommodations for patient education, preoperative COVID-19 testing, prehabilitation, and intraoperative infection as well as thromboembolism risk reduction.

**Conclusion:** ERPs are evidence-based, best practice guidelines applied across the perioperative continuum to mitigate surgical stress, decrease complications, and accelerate recovery. These benefits are part of the high-value–care equation needed to solve the clinical, operational, and financial challenges of the current COVID-19 pandemic. The factors driving outcomes on ERPs, such as the provision of minimally invasive surgery, warrant careful consideration. Tracking patient outcomes and improving care in response to outcomes data are key to the success of clinical care protocols such as ERPs. Numerous emerging clinical registries and reporting systems have been activated to provide outcomes data on the impact of COVID-19. This will inform and change surgical practice as well as provide opportunity to learn if the advantages that surgeons, patients, and the healthcare system might gain from using ERPs during a pandemic are meaningful. *Journal of Minimally Invasive Gynecology* (2021) 28, 481–489. © 2021 Published by Elsevier Inc. on behalf of AAGL.

**Keywords:** Coronavirus; Enhanced recovery after surgery; ERAS; Gynecologic surgery; SARS-CoV-2

The coronavirus disease (COVID-19) was first identified outside China on January 13, 2020, declared a “Public Health Emergency of International Concern” by the World Health Organization on January 30, 2020, and declared a pandemic on March 11, 2020. The COVID-19 pandemic has since been described as the worst medical crisis of the 21st century. It has had a ripple effect on all aspects of healthcare, with many unique and unresolved problems complicating surgical practice. As the surgical workforce strives to resume elective surgery and to continue

high-acuity operations after the initial 6- to 8-week shutdown, we must work together to sustain and even redefine high-quality and safe patient care. Resource use has become a pressing if not moral issue, making expeditious and uncomplicated recovery from surgery more important than ever. Prepandemic, there was increasing uptake of enhanced recovery protocols (ERPs) to achieve this goal for patients undergoing gynecologic surgery, with the Agency for Healthcare Research and Quality Safety Program and the American Association of Gynecologic Laparoscopists leading the charge. This review formulates the rationale for using ERPs to standardize and optimize perioperative care during this high-risk time to minimize poor outcomes owing to provider, patient, and system vulnerabilities. It also highlights how we might adapt our prototypical ERPs to address some of the challenges in perioperative care that have surfaced during the COVID-19 pandemic. Although the use of minimally invasive surgical

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techniques is a defining enhanced recovery intervention, it is only 1 important part of the equation and should not be the sole focus of surgical practice. Thus, this review is intended for surgeons interested in more broadly considering the principles of safe surgery and how protocolized perioperative care using tools such as ERPs might support this in times of crisis.

### Impact of the COVID-19 Pandemic on Surgeons

Surgeons and surgical teams are life-saving frontline healthcare workers facing high risk of serious illness and death from communicable disease, with severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) being the “contagion of the moment.” The prevalence of COVID-19 infection among frontline US and UK healthcare workers was reported to be 2747 per 100 000 cases between March 24, 2020, and April 23, 2020. However, this is very likely a gross underestimate. Pei et al [1] showed that the odds ratio that a healthcare provider will be infected may exceed 30 times that of nonhealthcare workers. According to Médecins Sans Frontières, healthcare providers represented 8% of the total COVID-19 cases in Italy as of March 16, 2020 [2]. During the 2003 severe acute respiratory syndrome epidemic, healthcare workers accounted for 20% to 40% of the cases, largely owing to inadequate access to, and use of, personal protective equipment (PPE) [3]. The 2003 severe acute respiratory syndrome outbreak exposed a general lack of knowledge among medical professionals about respiratory virus pathogenicity and transmissibility, as well as a number of deficiencies in hospital and community infection control systems. This was an impetus to apply the lessons learned on a worldwide scale to help prevent the spread of other new infections predicted to emerge. However, this failed to move forward, and in the United States the COVID-19 pandemic now threatens a healthcare delivery system with the pre-existing problems of a financial crisis, poor access, unresolved inefficiencies, and high rates of physician burnout.

A pandemic of physician burnout predates the COVID-19 pandemic, with the rate of burnout among American surgeons approaching 50% [4]. Stress and burnout have a negative impact on individual surgical providers as well as team dynamics, leading to higher rates of medical errors and worse patient outcomes [5,6]. Stress and burnout are intensified by sleep deprivation and lack of psychosocial support, with nearly all those tasked with keeping surgical services running during a pandemic faced with these impairments. For surgeons operating, there were, and remain, a multitude of other factors that increase stress levels beyond an already high baseline. Surgeons were/are charged with sustaining safe and high-quality patient care during a time of continual change in hospital policy and workflow, with limited resources and loss of their usual teams. Surgeons must also contend with unknown, but conceivably high, exposure risk associated with various

surgical activities in the operating room (OR). There is an abundance of literature demonstrating the deleterious effects of these symptoms on cognitive functioning, particularly on executive functioning resources such as working memory capacity [7]. For this reason, high-risk organizations, including aviation and the military, undergo formal training in interventions such as activating checklists and protocols to mitigate the risk of preventable harm in critical times of psychologic distress [8].

At the same time, scores of surgeons were sidelined outside of elective ORs during the early months of the pandemic. Many surgeons have never taken a break of more than a week or 2 from operating, outside of parental leave, in their careers. A third of the surgeons take 14 days off annually at most [9]. There are some data that time away can hurt a surgeon’s job performance [10,11]. For example, as the temporal distance, in a span of days and not months, between performing coronary artery bypass grafting cases increases for a given surgeon, they are less likely to recognize and address life-threatening complications. This has been linked to a transient uptick in mortality, and the effect size is larger for low-volume surgeons [12]. Robotic skills are known to degrade after 4 weeks of inactivity [13]. For example, an increasing number of days between performing robot-assisted laparoscopic prostatectomy cases correlates with higher blood loss and operative time, suggesting that technical performance is adversely affected by breaks from operating [8].

It is also possible that the first few patients a surgeon cares for on their return from a break are disproportionately more morbid; they are first in line because they are sicker. The triage strategies used for restarting nonemergent surgery were devised to minimize the harm associated with delays in care; therefore, the most urgent, and often the sickest, patients were prioritized first [14,15]. For gynecologic surgeons, these are likely to be patients with excessive uterine bleeding despite medical management, who have failed conservative management of pelvic infection such as tubo-ovarian abscess, who have delayed re-presentation after unsuccessful medical abortion, or those with progressive cancer. Thus, having to operate on a series of patients with compromised health owing to delayed surgical intervention may explain the small transient increases in patient mortality after surgeon time-off [12]. This begs the question of how best to mitigate the adverse effects associated with stress and burnout in conjunction with long breaks from operating.

The time lag between acquisition of new medical knowledge and integration of that knowledge into clinical practice can span a decade [16,17]. In addition, the half-life of knowledge is estimated to be approximately 3 to 5 years, making evidence-based practice a moving target. The risks of mortality, morbidity, and financial toxicity are the consequences of this delay. We know that a concerted effort to apply best evidence results in improved patient outcomes [18,19], and patients are now “consumers” of this. Most

surgeons share the singular focus of providing quality service defined as “doing the right thing and doing it right.” “Doing it right” encompasses the benchmarks of timeliness, economy of resource use, and adherence to evidence-based standard of care. “Doing it right” integrates the experience of the clinical team, the values of the patient, and the best available scientific information to guide decision-making about clinical management [20,21]. This also involves changing the mindset of the surgeon from that of solo practitioner to a team-based approach [22]. In the midst of a crisis, such as a global pandemic, protocols can be an instrument of teamwork as well as of ready dissemination of new knowledge to a greater number of surgeons in a shorter timeline, thus shortening the evidence-to-practice gap.

### The Value of Protocols

Protocols are our fighting chance of “doing it right” as our surgical workforce grapples with the clinical, operational, and financial consequences of the pandemic. Protocols are a means to quality improvement in surgery. The use of protocols facilitates shared care, encourages multidisciplinary communication, and action in general. A well-established protocol used in surgery is the Universal Protocol, which is a mandatory quality standard introduced by The Joint Commission in 2004 to help prevent wrong site, wrong patient, and wrong procedure errors [23]. The steps of the Universal Protocol were designed to ensure correct patient identity, correct procedure, and correct surgical site by including the patient, the surgeon, and the surgical team in the verification process. This was a major step forward toward minimizing surgical errors by engaging every person on the team in the verification process and by encouraging an environment of teamwork and communication.

Protocols serve as frameworks for the build-out of new workflows and reinforce the existing channels of communication as well as facilitate the creation of new ones. Communication failures can affect up to 30% of the interactions in the OR [24]. Checklists may prevent more than half of those communication failures [25]. A historic example is the “time out” portion of the Universal Protocol, which was expanded to include secondary safety issues such as antibiotic and venous thromboembolism (VTE) prophylaxis [26].

Protocols are indispensable to maximizing the cross-training of staff because they help the staff to identify when and how to use their broader skills [27]. This has proved particularly important during the restructuring of medical facilities to handle the burden of COVID-19, with surgical patients admitted to alternative wards and cared for by different nursing teams less familiar with the specialty-specific postoperative course.

There are many advantages to falling back on protocols, including their familiarity and their kindling of “muscle memory” in instances of impaired cognitive functioning owing to stress and anxiety (see **Box**) [28]. Protocols

#### Box

The advantages of protocols

- Reduce unnecessary variability in care
- Proficient adoption of new information to the bedside
- Streamline care
- Incorporation of educational aids
- Improved communication
- Cost containment
- Decrease errors and improve patient safety
- Make the delivery of the standard of care location/provider-independent

Adapted from [28]

provide an opportunity for optimizing efficacy and capacity. The effective use of protocols allows resources such as beds and OR times to be better managed, demand scheduling to be facilitated, and the path to discharge mapped [20].

Protocols with well-defined and meticulously tracked process and outcomes measures are key to operationalizing quality improvement. Protocols make it possible to detect when patients are receiving deviations in standard of care. This is exceedingly important in destabilized healthcare systems that are vulnerable to marked variations in the way care is administered. Thus, protocols can help guard against increasing health inequalities brought about by changes in service configuration.

### The Relevance of ERPs in the Era of COVID-19

Arguably, the most widely used perioperative care protocols fall under the umbrella of enhanced recovery after surgery (ERAS). The ERAS Society’s recommendations for perioperative care in gynecologic/oncologic surgery were published in 2016, and an updated comprehensive enhanced recovery and surgical optimization protocol for minimally invasive endoscopic and vaginal surgery for both benign and malignant gynecologic conditions is newly available [29–31]. Fundamentally, ERPs are evidence-based, best practice guidelines applied across the perioperative continuum to mitigate surgical stress, decrease complications, and accelerate recovery. ERPs are anchored around the 5 canonical components of patient/care-partner education, multimodal/opioid-sparing analgesia, nausea/clot/infection prevention, maintenance of euvolemia, and activity. In their most basic form, ERPs are a series of checklists for the preoperative, intraoperative, and postoperative phases of care. The results of a large meta-analysis suggest that across a range of studies at many hospitals, checklist use is associated with fewer postoperative complications and deaths [32].

Because surgical services are a foundational component of the healthcare system, providing surgical care in a manner that protects both patient and healthcare worker is imperative to the existence and solvency of healthcare

institutions. As Ljungqvist et al [33] summarized in their recent editorial, there are several undeniable and important reasons why ERAS should be applied worldwide now. ERAS has repeatedly been shown all over the world to reduce complications (reduced by 20%–50%), bringing down the need for hospital care from weeks to days without increasing the readmission rate and minimizing the need for care in the intensive care unit [33]. The beneficial effects of ERAS seem to be amplified by, and are synchronous with, the requirements of operating in the era of a pandemic. For example, the use of total intravenous anesthesia over volatile gas anesthesia on ERAS may increase the number of patients able to safely receive care by reducing potential spread of the virus through reduction in coughing and significantly decreasing the time spent in the recovery room [34]. To further minimize the risk of nosocomial COVID-19 infections, ERPs inform the operationalization of same-day discharge for patients undergoing minimally invasive procedures [31].

In addition, ERPs allow health cost savings of between \$5000 and \$8000 per case in major surgery with a return on investment ratio of approximately 4 [33]. We now have unprecedented need for value-based care of this caliber. With a decline in operating revenue and added COVID-19–related expenses, the already narrow hospital profit margins have decreased substantially [35]. Elective surgery volume usually drives a disproportionate share of revenue for hospitals. Between March 2020 and June 2020, the drop in elective procedure volume resulted in \$200 billion in financial losses [36]. Some of this deficit was offset by the federal Coronavirus Aid, Relief, and Economic Security Act and the Paycheck Protection Program and Health Care Enhancement Act but only by a fraction, and COVID-19 remains a persistent threat. As the pressure to reduce health system spending and to develop new operational efficiencies is intensified, ERAS implementation should be part of the solution.

### **ERP “Upgrades” Related to COVID-19**

The protocols we use must be adaptable to meet new, unmet patient needs, and ERPs have that functionality. As the COVID-19 pandemic evolves, our ERPs must do so simultaneously to ensure their viability and maximize their utility. The COVID-19 pandemic has introduced new considerations for patient education, preoperative testing, and prehabilitation. Concerns surrounding nosocomial COVID-19 infection have jeopardized the provision of minimally invasive surgery (MIS), a service that is core to the ERAS mission. This needs to be carefully considered, along with the lessons learned about interventions that may translate into fewer complications such as surgical-site infection (SSI) as we move forward.

#### ***Patient Education and Surgical Consents***

Patient/care-partner education is a major objective of every ERP; yet, it is 1 of the most difficult to accomplish.

Most patients depend on care partners to reinforce the bulk of information needed to prepare for, and to recover from, surgery. Restricted in-person patient visits and visitor access at most healthcare facilities have necessitated the use of audiovisual technology for perioperative counseling. To provide patients with the full advantage of ERPs, it is critical that patient/care-partner education still occurs at each pivotal point along the perioperative continuum. This requires extra work and planning because care partners are remote. In addition, preoperative education needs to be expanded to include information and counseling about the signs and symptoms of COVID-19 (including instructions on whom to notify if symptoms develop), point-of-care acceptable COVID-19 testing, the appropriate use of PPE, hand hygiene, and physical distancing. Likewise, preoperative teaching should include a debriefing about what to expect on arrival on the day of surgery in terms of symptom interrogation, universal masking, PPE donning by providers, and reconfiguration of the clinical workspace/workflow to ensure physical distancing; in effect, communicating to the patients that the Centers for Disease Control and Prevention guidelines are being followed in the interest of their safety.

After all, to undergo surgery, patients must willingly come in to the hospital; be exposed to scores of healthcare workers who have been working on all levels of the front and back lines; be placed on a ventilator, at least briefly; possibly need an intensive care unit bed; and possibly need a hospital stay ranging from hours to weeks. The informed consent process must somehow encompass the new life-threatening risk of nosocomial COVID-19 infection that this represents for surgical patients. Two distinct but inter-related components characterize informed consent: the information about risks, benefits, and alternatives, as well as consent to undergo the proposed surgical procedure. The underlying assumption made during the consent process is that surgeons are aware of the risks and benefits with a reasonable degree of certainty and able to weigh them in comparison with the alternative treatment options. However, COVID-19 has confounded this process because there is uncertainty about the extent to which COVID-19 can affect surgical risk and postoperative recovery because currently available risk-stratification methods do not account for COVID-19 exposure. Despite all the current literature, no study has stratified surgical risks related to COVID-19. A COVID-19 risk-scoring system that can be used across surgical specialties, with risks calculated on the basis of the type of operation performed and patient-specific clinical variables, is not available [37–39]. What we do know is that there are higher cardiorespiratory and microembolic/thrombotic complications in symptomatic COVID-19–positive patients who undergo surgery. In a case-control analysis from Italy, Doglietto et al [40] showed that the 30-day risk of mortality for patients with COVID-19 undergoing surgery (n=41) compared with patients without COVID-19 (n=82) was significantly higher (19.51% vs

2.44%; odds ratio 9.5; 95% confidence interval, 1.8–96.5) [40]. These rates are significantly higher than those found in the highest-risk surgical groups predating the COVID-19 pandemic. However, there is considerable uncertainty about the risks of undergoing an operation or general anesthesia in individuals who are asymptomatic or presymptomatic. How nosocomial COVID-19 infection negatively affects postoperative recovery is also not well known. Furthermore, the impact of pandemic-associated healthcare-resource shortages on the care of the postoperative patient needs to be explored and characterized. For example, the quality of care delivered to patients admitted to a nursing unit different from the one that their surgical service typically admits to because of staffing shortages or other factors may be in jeopardy.

There may be the option of delaying surgery when other viable alternatives exist, including close surveillance, less-invasive operative interventions, and/or noninvasive medical management. In these cases, a detailed discussion regarding the risk–benefit ratio of proceeding with vs delaying definitive surgical management is necessary. Transparency about the potential but unknown risks of nosocomial COVID-19 infection and honest admission of the current limited understanding about the surgical outcomes among patients with COVID-19 need to be clearly explained. The high false-negative rate of currently available viral screening tests should be disclosed as part of this discussion. Communication of this information should be diligently documented during the process of obtaining informed surgical consent.

### ***Preoperative COVID-19 Testing***

Depending on the community disease burden, asymptomatic carrier rates among adults presenting for surgery have ranged between 0.5% and 2% [41]. In the current pandemic, performing completely elective surgery on a patient without assessing for active COVID-19 infection with symptom screening and a nasopharyngeal viral RNA test or with the use of chest computed tomography for equivocal cases should be a never event. It is imperative to identify patients who are asymptomatic but who have been infected with SARS-CoV-2 so that their surgery can be safely postponed. This process protects the patient, the healthcare worker, and other patients by avoiding unnecessary exposures. Thus, point-of-care preoperative COVID-19 screening must be integrated into our ERPs so that we can (1) reduce the risk of horizontal viral transmission and (2) reduce perioperative complications from unrecognized SARS-CoV-2 infection.

On the basis of rapid literature review, evidence-based recommendations have been produced along with a proposed schema for the preoperative screening of surgical patients for COVID-19 infection. Reverse transcriptase–polymerase chain reaction (RT-PCR) testing remains the gold standard diagnostic test for COVID-19 infection. Testing should be performed 48 to 72 hours before surgery. The

sensitivity of rapid antigen tests is generally lower than that of RT-PCR. Thus, they are not an acceptable substitute for preoperative RT-PCR testing at most centers. Serologic testing also has little utility within preoperative screening for COVID-19 because it can neither confirm nor exclude a diagnosis of acute COVID-19 infection nor provide information on potential infectivity. The sensitivity of antibody tests is too low in the first week since symptom onset to have a primary role for the diagnosis of COVID-19. Antibody tests are likely to have a useful role for detecting previous COVID-19 infection if performed 15 or more days after the onset of symptoms. However, the duration of antibody rises is currently unknown, and we found very little data beyond 35 days postsymptom onset. Relevant patient history suggesting potential exposure to the virus and clinical presentation, particularly the presence of hyposmia or hypogeusia as well as a temperature of  $\geq 37.3^{\circ}\text{C}$  ( $99.1^{\circ}\text{F}$ ), must also be incorporated into the preoperative screening for COVID-19. A 14-day quarantine before surgery should be considered for patients who are asymptomatic but with a history of potential exposure to the virus to allow time for presentation of the symptomatic phase. Repeat testing up to 48 hours before discharge to a group care facility should be considered [42,43].

There is little information about whether postponing surgery for patients with a previous SARS-CoV-2 infection leads to a clinical benefit, as well as about the optimal length of delay. The American Society of Anesthesiologists currently recommends that “elective procedures should be delayed until the patient is no longer infectious and has demonstrated recovery from COVID-19” [44]. The Centers for Disease Control and Prevention–recommended test-based strategy includes resolution of symptoms without the use of medications, improvement in any respiratory symptoms, and negative results from 2 SARS-CoV-2 tests more than 24 hours apart [45]. The COVIDSurg Collaborative study was a prospective cohort study of patients undergoing curative elective cancer surgery during the COVID-19 pandemic up to May 24, 2020. The investigators performed a preplanned subgroup analysis of patients undergoing surgery with a previous SARS-CoV-2 positive swab who were not suspected to have active COVID-19 at the time of surgery. Propensity-score matching was used to match previous patients with a SARS-CoV-2 positive swab to patients with no positive swab test in a 1:4 ratio. Multivariate logistic regression was used to explore the associations of a previous SARS-CoV-2 positive swab with the rates of postoperative pulmonary complications and death in matched groups. When split by time from swab to surgery, both pulmonary complications and mortality were lowest (0%) with a >4-week delay between a positive swab test and surgery. Pulmonary complications and mortality were observed in 11.7% and 3.4% of those operated after a 2- to 4-week delay. These data suggest that elective surgery should be delayed >4 weeks (not 14 days as previously recommended) for patients who have tested positive for SARS-CoV-2 [43,46].

### **Prehabilitation**

To date, ERPs have had a limited focus on prehabilitation. However, the upshot of self-quarantine is that people, especially those aged >65 years who are at highest risk owing to age and comorbidities, stay at home to avoid exposure risk. At home they are sedentary and quickly become deconditioned, and their physical health has often appreciably deteriorated. Once health conditions are impaired in older adults, recovery to the original health status can be challenging, given the declined intrinsic capacity [47]. Two weeks of daily step reduction (<1000 steps/d) precipitates loss of muscle mass and strength as well as impaired glycemic control and inflammatory status [48]. Thus, pandemic-oriented ERPs should include the addition of prehabilitation.

A multimodal approach to prehabilitation improves outcomes compared with a single modality [49]. An ideal prehabilitation program includes aerobic, strength, and flexibility exercises; cessation of negative health behaviors; psychologic support; and nutrition. In a 2012 Cochrane study looking at 8 randomized controlled trials on preoperative physical therapy for elective cardiac surgery patients, preoperative physical therapy with inspiratory muscle training could prevent some postoperative complications, including respiratory complications, and decrease length of hospital stay [50]. A second Cochrane review of 12 randomized controlled trials, including 7 trials with major abdominal surgery, further supported the use of inspiratory muscle training [51]. Preoperative inspiratory muscle training can be performed with aerobic exercise or with breathing exercises using an inspiratory tapered flow resistive loading device. The use of a pedometer can be helpful to provide feedback to the patient and progress and compliance to the provider [52]. The ability to walk >4000 steps per day is associated with lower respiratory complications postoperatively [53].

### **Route of Surgery in the Era of COVID-19**

A minimally invasive approach is frequently considered the standard of care for emergency and elective gynecologic surgery. There are many reasons for this, not the least of which is that endoscopic abdominal access is associated with better preservation of the immune system than open surgery [54]. Although a timeless benefit consistent with the ERAS mission to minimize surgical stress and complications, this is particularly advantageous in the context of a global viral pandemic. Patients who have COVID-19 at the time of surgery may have improved outcomes because MIS is less traumatic than laparotomy and is associated with lower rates of venous thrombotic events and respiratory complications postoperatively [55].

Throughout the COVID-19 pandemic, some have proposed that abdominal access be universally performed through laparotomy owing to the concerns about

aerosolization of viral particles related to laparoscopic and robotic electrosurgery and pneumoperitoneum. At the time of this writing, this recommendation is mainly reactionary as opposed to 1 based on logic, common sense, and data. Unnecessary conversion of minimally invasive cases to laparotomy has negative downstream effects on patient outcomes [56]. Although a number of studies show that surgical smoke contains viral nucleic acids, an increased risk of HIV and hepatitis viral transmission from surgical plume or pneumoperitoneum with laparoscopy has not been documented. The risks related to OR pressure (positive vs negative) and intubation are independent of surgical approach. Smoke evacuation may be even better controlled by MIS than by open surgery, and the effects of tissue extraction and desufflation are not well known. Electrosurgery may be comparable, and blood-splash risks are estimated to be 48.5% in laparoscopy and 45% in open surgery [2]. Thus, at this time there seems to be no reason to abandon laparoscopic surgery in favor of open surgery.

Until additional data about COVID-19 transmission in the OR is available, surgery should be considered a high-risk activity regardless of surgical approach. The surgeon and surgical team should don adequate PPE (level III PPE), with an N95 protective mask, face shield, gown, gloves, and shoe coverings. We should consider our faces as contaminated fields [2]. As airway manipulation is aerosol-generating, we should minimize the number of nonessential personnel in the OR during intubation and extubation and ensure that those involved don appropriate PPE. In most ORs, it takes 14 to 30 minutes to ensure clean air for staff wearing a basic surgical mask in standard positive-pressure ORs. The time estimates are based on an empty, uncluttered room and on OR biomechanics in terms of the number of air changes per hour for the removal of 99% of the airborne contaminants. Standard positive-pressure ORs typically allow 15 to 25 air changes per hour. For ORs on the low end of this (15 air changes per hour), 18 minutes and 28 minutes are required for the removal of 99% and 99.9% of the airborne contaminants, respectively [57]. Of note, the gynecologic oncology service at Johns Hopkins Hospital operated at 62% of the normal volume and provided MIS to 70% of the women presenting for urgent/emergent surgery during the 10-week period of the pandemic at its peak from March 14, 2020, to May 31, 2020. This MIS rate exactly mirrored that during the same time period in 2019 and did not precipitate any known cases of nosocomial COVID-19 infection. We followed all these precautions except for the wearing of N95 masks by the surgeons operating.

Energy use should be minimized for all surgical approaches, and the use of smoke evacuation/filtration systems to minimize the potential release of viral particles into the OR is reasonable. The potential aerosolization of COVID-19 occurs with any use of electrosurgery, which affects both laparoscopy and laparotomy. In laparotomies, the smoke plume is dissipated into the air more readily, with a 50% loss of smoke into the room even if the suction

is placed within 2-cm of the Bovie tip (Bovie Medical Corporation, Clearwater, FL). With laparoscopy, there is the potential of some leakage from the trocars around the trocar, around the instruments in the port, or with instrument changes, but smoke generated overall is contained within the peritoneal cavity.

With laparoscopy, one should use the lowest intra-abdominal pressure needed for visualization and tight-fitting trocars, as well as endeavor to match the instrument size with the trocar size. The surgeon should release the pneumoperitoneum in a controlled manner with a smoke evacuation/filtration system before the removal of specimens and at the completion of the surgery.

### **Decreasing Prescription Opioids**

Available work on COVID-19, although highly limited in scope, has suggested that the pandemic is associated with clinically significant increases in the psychiatric symptoms of anxiety, depression, stress, and substance use within our populations. Pre-COVID-19 opioid users are at highest risk for opioid use for coping with COVID-19-related fear and worry [58]. In turn, the paucity of, and decreased access to, street drugs as well as the disruption in treatment and recovery programs are catalysts for the misuse of prescription drugs. Currently, many people, especially young adults (approximately 15%), use prescription drugs for nonmedical reasons [59]. Thus, it has never been more important to minimize postsurgical opioid prescribing. The administration of opioid-sparing multimodal analgesia is optimized through ERAS. This includes preoperative pain prophylaxis with nonsteroidal anti-inflammatory drugs, acetaminophen, dexamethasone, prudent use of intraoperative local/regional nerve blocks, and postprocedural intravenous ketorolac. Current ERAS guidelines also advise on the use of other nonopioid adjuncts for the prevention and treatment of surgical pain, particularly for patients who are opioid-tolerant. With regard to the dispensation of postdischarge opioids, existing data support prescribing no more than 10 to 15 oxycodone 5-mg equivalents after minimally invasive gynecologic surgery and the use of prescribing algorithms on the basis of inpatient opioid use in oral morphine equivalents in the 24 hours leading up to hospital discharge after laparotomy [31].

### **SSI and Thromboembolism Prophylaxis**

SSI prevention is a key component of ERPs, and some emerging data indicate that the nosocomial infection prevention measures implemented during the pandemic actually resulted in lower SSI rates. The Italian Society of Surgery recently evaluated how scrupulous hygiene rules and the restriction of human contact during the COVID-19 pandemic affected the SSI rate of the general surgery department at its tertiary center in Trieste, Italy. During the peak pandemic period in March and April 2020, the

department had a lower global SSI rate (3.3% vs 8.4%), fewer superficial SSIs (0.8% vs 3.4%), and no deep SSIs (0% vs 3.4%) compared with historic controls in 2018 and 2019. On multivariate analysis, measures to reduce the SARS-CoV-2 spread (World Health Organization global guidelines for contact and droplet precautions to protect healthcare workers during the care of patients suspected to have COVID-19) were independently associated with the observed reductions in total as well as superficial and deep SSIs. Simple and easily viable precautions such as wearing surgical masks (both patient and surgeon), limiting movement of staff in and out of the OR, and restricting visitors emerged as promising tools for SSI risk reduction [60].

Likewise, the appropriate use of perioperative VTE prophylaxis is a major aim of ERPs. SARS-CoV-2 infection is associated with extreme inflammatory response, disordered hemostasis, and high thrombotic risk. However, there are no data to inform whether patients with VTE risk factors (e.g., cancer or on hormonal preparations such as oral contraceptive pills or megestrol for treatment of abnormal uterine bleeding) delayed for surgery owing to being asymptomatic or having even a mild SARS-CoV-2 infection should receive chemoprophylaxis for VTE prevention while awaiting surgery. Observational studies suggest that the risk of thromboprophylaxis in outpatients with asymptomatic or minimally symptomatic SARS-CoV-2 is low. The bleeding risk may very likely exceed the thrombosis risk in these patients, leading many to recommend against the prescribing of thromboprophylaxis to patients with baseline VTE risk factors while their surgery is delayed for recovery from asymptomatic or minimally symptomatic SARS-CoV-2. First-line hemostasis tests such as activated partial thromboplastin time, prothrombin time, fibrinogen, and D-dimers have been proposed for assessing thrombotic risk and monitoring hemostasis, but their reliability and clinical relevance are questionable [61]. Thus, the indication for preoperative thromboprophylaxis for patients on hold for operative intervention during recovery from asymptomatic or minimally symptomatic SARS-CoV-2 remains unknown [62].

### **Opportunities for Acquisition of Patient Outcome Data**

There is concerted effort dedicated to the timely acquisition and analysis of patient outcome data from surgical services rendered during the COVID-19 pandemic. A new rapid cancer reporting system is coming online soon, and the Society of Gynecologic Oncology COVID-19 Task Force has made this a priority. Other clinical registries associated with the American College of Surgeons will provide insight into the nature of the effect of COVID-19 on surgical conditions, such as the American College of Surgeons National Surgery Quality Improvement Program (NSQIP) module for COVID-19. This provides opportunity to evaluate the impact of COVID-19 on patients using the NSQIP infrastructure. Importantly, data gathering is inclusive of



non-NSQIP hospitals. In addition to the usual demographic and physiologic data, the COVID-19 registry will collect the dates of intubation and inflammatory indices that have become important in the assessment of COVID patients, such as procalcitonin and D-dimer. Also included are interventions that have been empirically tried in patients who have failed conventional therapy such as pressure support ventilation, prone positioning, interleukin blockers, and convalescent plasma [63]. The GlobalSurg-CovidSurg Week was a multicenter international snapshot study planned for October 2020 and explored research questions aimed at determining the optimal timing for surgery after COVID-19 infection, as well as key global surgical indicators such as postoperative mortality rates. Remarkably, more than 1300 centers are registered in 105 countries, with representation across all surgical specialties [64]. In step with these massive data collection efforts, patient acuity must be accurately coded so that the measurement of the quality and safety of the care delivered is appropriately risk-adjusted. In turn, it is our duty to report and interpret data with high integrity. This has tremendous bearing on the scope of the health inequities that we are able to ascertain and eliminate.

## Conclusion

The long-term effects of COVID-19 on surgical care have not been fully realized, but they will be lasting. ERPs can serve as “survival guides” for best practice, allow for transition through extraordinary upheaval and uncertainty, and adapt with integration of new knowledge. For example, prehabilitation before surgery to reverse the deconditioning owing to the more sedentary lifestyle of quarantine is likely 1 of the most impactful changes that we can make to our ERPs. However, best practice surrounding prehabilitation in this instance needs to be defined. Furthermore, whether the beneficial effects of ERAS are synchronous with, or even amplified by, the demands of operating in the era of a pandemic remains to be seen. This in part depends on how well we pass the test of resiliency as surgeons. In taking this test, we are challenged to be self-actualized about our own limitations. We must drive the development of routine support processes for the psychologic stress we face as well as strategies for mitigating the potential negative impact of being out of practice. The importance of the reintegration process for surgeons needs to be explored. In the end, many of us will have the privilege of reviewing surgical data from the COVID-19 pandemic and thus a chance to lead our field in achieving more meaningful changes in outcomes. For now, we have a duty of care according to best practice for the benefit our patients. Of the many reference points for this, ERPs are easily accessible and adaptable. They are a resource that galvanizes us to be better together, and we should prioritize their implementation now.

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