



# Perioperative Considerations in Surgical Patients with COVID-19 Infection

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**Objectives:** This article reviews the perioperative care and anesthetic considerations in patients with suspected or confirmed COVID-19 infections.

**Methods:** Several recently reported large-scale clinical cohort studies and the opinions of experts in perioperative care were reviewed to summarize the most updated clinical recommendations for the perioperative care of COVID-19 patients when surgical intervention is unavoidable. Strategies to protect surgical healthcare workers and to maintain a safe operating environment were also discussed.

**Results:** Cumulative evidence indicates that perioperative mortality and major complication rates were significantly higher in patients with COVID-19. Male sex, age over 70 years, American Society of Anesthesiologists (ASA) physical status > III, and oncology and emergency surgeries were independent risk factors for major postoperative complications. Personal protective equipment should be applied to all the surgical healthcare providers and a negative-pressure operating room is preferred when operating on patients suspected of being infected.

**Conclusion:** All non-urgent surgical procedures involving patients with COVID-19 should be postponed whenever possible, especially elective general or oncology procedures. In situations where surgical intervention is necessary, every effort should be made to prevent the spread of the virus to other patients and healthcare workers. We recommend a standardized collaborative multidisciplinary approach to the perioperative care of surgical patients with COVID-19.

**Key words:** anesthesia, COVID-19 pandemic, negative-pressure operating room, perioperative risks, surgical outcomes

## Introduction

The COVID-19 global pandemic began in November 2019. The Taiwan Centers for Disease Control (CDC) first identified COVID-19 as a severe pneumonia caused by novel pathogens on January 15, 2020. The Ministry of Health then classified this highly

contagious pathogen as Category 5 communicable disease. By October 2020, the World Health Organization (WHO) reported over 39 million confirmed cases of COVID-19 with one million deaths.<sup>2</sup> COVID-19 can infect people of all ages, ethnicities, and socioeconomic statuses and spread at an exponential rate in communities. COVID-19 causes extensive alveolar-interstitial inflammation with a

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Received: September 09, 2020

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high risk of acute respiratory distress. It also induces a systemic inflammatory response, potentially causing early multisystem organ failure. Since patients with COVID-19 may be subjected to unavoidable surgeries, serious considerations should be given to perioperative patient care and medical personnel protection when operating on such patients. This review specifically focuses on issues of perioperative care and anesthesia in patients with suspected or confirmed COVID-19 infections.

### Preoperative Considerations

A significant number of medical centers experienced a drastic cancellation of scheduled and elective operations during the COVID-19 pandemic in 2020. Two hospitals in New York City experienced a dramatic decrease in the number of surgical procedures in just one month from 62 per day on March 17, 2020 to 15 per day on April 15, 2020. Most of these procedures were classified as urgent or emergent.<sup>6</sup> A recent international multicenter cohort study investigated the number of surgeries between January 1 and March 31, 2020 at 235 hospitals in 24 countries.<sup>7</sup> The authors reported a total of 1128 surgical patients of whom 835 (74.0%) received emergency procedures. Surgical indications for these patients mainly involved benign diseases (54.5%), cancers (24.6%), and trauma (20.1%). Another matched cohort study conducted in the general, vascular, thoracic, orthopedic and neurosurgery units in Italy during the COVID-19 pandemic also found that up to 78.8% (97 of 123 cases) of surgical procedures performed during the study period were emergent operations.

Although the outbreak of COVID-19 occurred just a year ago at the end of 2019, there have already been several important clinical epidemiology studies reporting the perioperative outcomes of patients with confirmed COVID-19 infection. After analyzing 1,128 surgical patients with confirmed COVID-19 (SARS-

CoV-2) infection within seven days before or 30-day after surgery, the incidence of postoperative pulmonary complications was 51.2% with a 30-day mortality as high as 38.0% (219 of 577).<sup>7</sup> Consistently, Italian researchers reported a significantly higher 30-day postoperative mortality rate in patients with COVID-19 compared to that of the matched controls (odds ratio 9.50; 95% CI: 1.77 – 96.53). That study also demonstrated a higher rate of postoperative pulmonary complications in patients with COVID-19 (odds ratio 35.62; 95% CI: 9.34 – 205.55). Another retrospective cohort study on patients receiving surgeries at the New York Presbyterian Hospital, Columbia University Irving Medical Center, and Weill Cornell Medical Center during the peak of the COVID-19 pandemic in New York City provided further evidence that perioperative mortality rates were significantly higher in patients with COVID-19 in comparison with those without the disease (16.7% vs. 1.4%, respectively; adjusted relative risk 9.29; 95% CI: 5.68 – 15.21).<sup>6</sup> In addition, serious complications such as cardiac arrest, sepsis, respiratory failure, pneumonia, acute respiratory distress syndrome, and acute kidney injury had a higher incidence in patients with COVID-19 during the perioperative period.<sup>6</sup> Other outcomes such as length of operation, postoperative oxygen therapy requirement, and length of hospital stay were found to be signifi-

*Table 1. Perioperative risk factors associated with increased postoperative 30-day mortality in patients with COVID-19 infection.\**

Predictor	Odds ratio	95% Confidence interval
Age (> 70 years)	2.30	1.65 – 3.22
Male	1.75	1.28 – 2.40
ASA PS $\geq$ III	2.36	1.58 – 3.53
Cancer surgery <sup>†</sup>	1.55	1.01 – 2.39
Emergency surgery	1.67	1.06 – 2.63
Major surgery	1.52	1.01 – 2.31

\*Adjusted model of predictors for 30-day mortality reported by the COVIDSurg Collaborative.<sup>7</sup> ASA PS: American Society of Anesthesiologists physical status; <sup>†</sup>compared with benign, obstetric or trauma surgery.

cantly increased in patients with COVID-19.

**Common recommendations for surgical indications**

Due to the extremely high perioperative mortality and surgical complication rates in patients with COVID-19, all surgical procedures involving patients with COVID-19 should be postponed whenever possible, especially elective general or oncologic procedures.<sup>8,10,11</sup> On the other hand, no significant differences in surgical outcomes were found in patients with COVID-19 undergoing solid organ transplants and obstetric operations before and during the pandemic.<sup>12</sup> However, it is difficult to draw any conclusions regarding the surgical outcomes of this particular patient population, as the number of cases observed was too small and the setting was mostly restricted to single centers.

**Perioperative risk factors**

The risks of developing major perioperative complications were similar between symptomatic and asymptomatic patients and also in those tested positive for COVID-19 before or after surgery.<sup>7,9</sup> Currently there are few large-scale clinical studies investigating the perioperative risk factors associated with mortality and complications in patients with COVID-19. A large-scale international cohort study on data from 24 countries found that male gender, age over 70 years, American Society of Anesthesiologists (ASA) physical status > III, as well as oncology and emergency surgeries were independent risk factors for patients with CO-

VID-19 developing major postoperative complications.<sup>7</sup> Besides, COVID-19 patients with poor respiratory function on admission and evidence of alveolar infiltration on chest radiography (i.e., high Brixia score) are more likely to have major complications than controls.<sup>8</sup> Table 1 provides a summary of commonly reported patient characteristics and perioperative risk factors for mortality and major complications in patients with COVID-19.

**Clinical diagnosis**

Patients with COVID-19 commonly present with fever, dry cough, myalgia, fatigue, and respiratory distress.<sup>13</sup> The severity of disease is classified into four categories (i.e., mild, moderate, severe, and critical) (Table 2).<sup>13</sup> However, the prevalence of symptomatic surgical patients with COVID-19 was only about 26% (95% CI: 14 to 39).<sup>10</sup> Leucopenia (e.g., lymphopenia) and elevated levels of lactate dehydrogenase, creatinine kinase, liver enzymes, and C-reactive protein levels are common laboratory findings.<sup>13</sup> Chest imaging studies (i.e., plain films or computer tomography) may show multiple patchy lesions and interstitial changes in the peripheral lung fields. In more severe cases, ground-glass opacities and lung consolidation can be found (Table 2). It is recommended that preoperative screening for COVID-19 infection should include viral RNA detection using real-time reverse transcriptase-polymerase chain reaction (rRT-PCR).<sup>11,12</sup> Patients who are at high risk of COVID-19 infection should be routinely screened before operations even if

Table 2. Clinical classification of COVID-19 severity.\*

Mild	Moderate	Severe	Critical
<ul style="list-style-type: none"><li>• Mild symptoms</li><li>• No pneumonia on imaging</li></ul>	<ul style="list-style-type: none"><li>• Fever and respiratory distress</li><li>• Radiological findings of pneumonia</li></ul>	Coexisting with: <ul style="list-style-type: none"><li>• Tachypnea (&gt; 30/min)</li><li>• SpO<sub>2</sub> ≤ 93%</li><li>• PaO<sub>2</sub>/FiO<sub>2</sub> ≥ 300mmHg</li></ul>	Coexisting with: <ul style="list-style-type: none"><li>• Respiratory failure</li><li>• Shock</li><li>• Other organ failure that requires ICU care</li></ul>

\*Defined by the National Health Commission and National Administration of Traditional Chinese Medicine on March 3, 2020.<sup>13</sup> ICU: intensive care unit; PaO<sub>2</sub>/FiO<sub>2</sub>: arterial partial pressure of oxygen to fraction of inspired oxygen ratio; SpO<sub>2</sub>: peripheral oxygen saturation.

asymptomatic. In situations where emergent or life-saving operations are necessary, all surgical patients should be treated as COVID-19-positive and diagnostic tests should be carried out accordingly until infection status is confirmed.

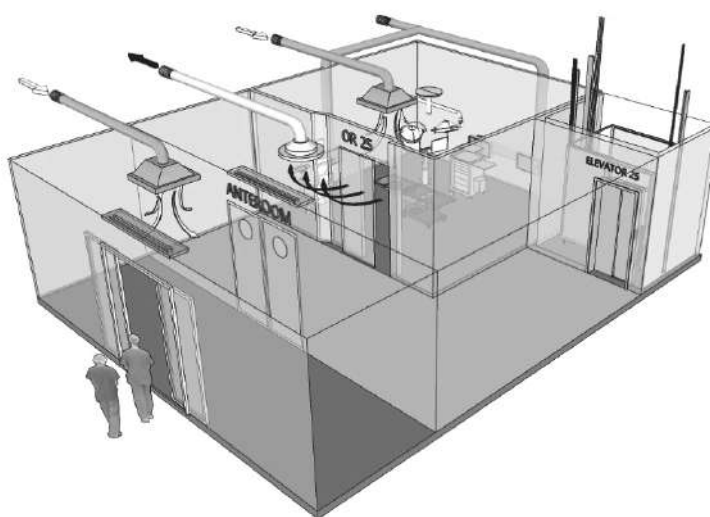
### Setting of a designated operating room.

A negative-pressure rather than a positive-pressure theater is more suitable for procedures involving patients with confirmed or suspected COVID-19 infection. A designated negative-pressure operating room located far away from the other operating theaters should be utilized to minimize air and environmental contamination to adjacent areas. In addition, infected patients should ideally be transported to or from the operating room using a dedicated elevator or corridor (Fig. 1). A temporary negative-pressure operating area can be set up by constructing a negative-pressure anteroom in a positive-pressure operating room (Fig. 1). A separate exhaust system can be equipped to

the anteroom for air discharge from the operating room and the negative-pressure in the anteroom should be maintained at  $\leq 2.5$  Pa (Fig. 1). The exhaust air should be filtered with a high-efficiency particulate air (HEPA) filter and evacuated to the external atmosphere. When a negative-pressure operating room is not available, the positive pressure system and air conditioner in the operating room must be turned off during operations.

### Protection of surgical healthcare workers

Standard personal protection equipment (PPE) for healthcare workers in designated COVID-19 operating rooms should include fluid-repelling coverall clothes/gowns, head covers, shoe covers, eye protection glasses, three pairs of surgical gloves for each worker, and N95 respirators (Fig. 2A). The anesthetic team is at a high risk of being exposed to patients' aerosol particles; therefore, it is recommended that they wear enhanced PPE, including a powered air-purifying respirator during airway in-



*Fig. 1 Floor plan of a temporary negative-pressure operating unit constructed by setting up a negative-pressure anteroom adjacent to the original positive-pressure operating theatre. Doors in the anteroom should not be opened simultaneously with the doors in the positive-pressure rooms to prevent aerosol spread to other areas of the operating units. Fresh air is supplied from an inlet duct (hollow arrows) and air in the anteroom is discharged through an exhaust duct (solid arrow), in which the exhaust air is filtered with a high-efficiency particulate air (HEPA) filter and evacuated to the external atmosphere. The anteroom is used for application and removal of health-care workers' personal protective equipment. A confirmed or suspected COVID-19 surgical patient is transported into and from the operating unit via a designated elevator.*



strumentation (e.g., endotracheal intubation or extubation) (Fig. 2B).

### Intraoperative Considerations

In respect of anesthesia, the choice of anesthetic techniques used in patients with confirmed or suspected COVID-19 should be tailored to suit the patient's physical condition and surgical requirements. However, the use of regional anesthesia is preferred whenever possible to reduce the risk of exposure to the patient's airway secretions. Patients who are not intubated should have a surgical or N95 mask donned at all times. When general anesthesia is indicated, endotracheal intubation is better than supraglottic airway in preventing aerosol leaks from a patient's airway. According to the WHO COVID-19 interim guidelines, endotracheal intubation should be performed by an experienced provider following preoxygenation with 100% oxygen for at least 5 min and rapid sequence induction should be used to avoid the risk of coughing and the need for assisted positive pressure ventilation. Video-assisted

intubation devices are preferred over direct laryngoscopy because the distance between patient's airway and the face of anesthesiologist performing the intubation is significantly increased to reduce the risk of exposure to the patient's expectorated secretions. A closed airway suction system is recommended to reduce viral aerosol production. Besides, the number of airway suction using a non-closed suction system should be kept to a minimum if a closed system is not available. The key recommendations for anesthesia induction and airway management in patients receiving general anesthesia are outlined in Table 3.

When focusing on surgery, aerosol-generating procedures (e.g. bronchoscopy, thoracoscopy and laparoscopy) can be associated with an increased risk of viral transmission via aerosols for surgical health care providers. Intraoperative use of electrocautery and other coagulation devices should be adjusted to the lowest effective power possible and the use of a continuous smoke evacuator is also recommended. In comparison to laparotomies, laparoscopic surgeries have the advantages of

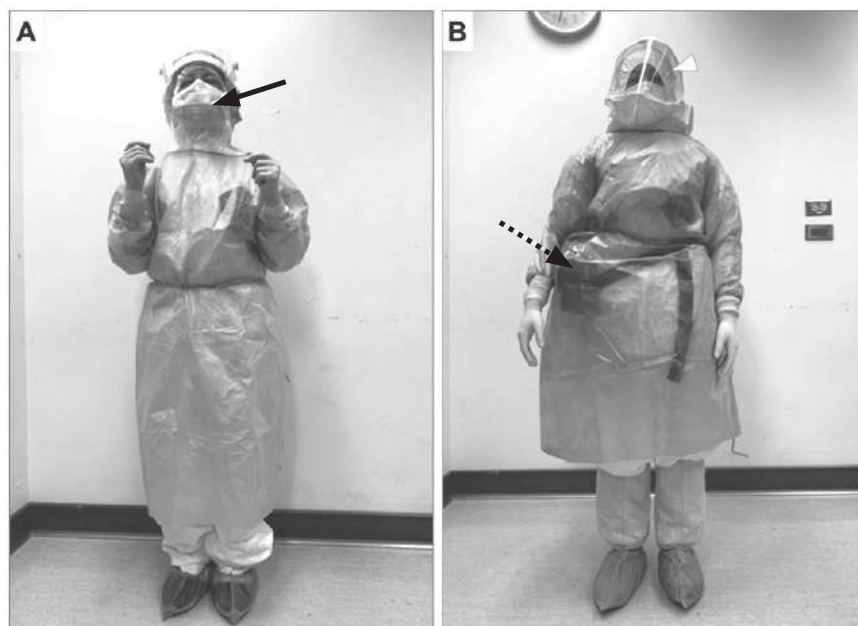


Fig. 2 Components of personal protective equipment (PPE) for health-care workers. (A) The standard PPE including a fluid-repellent gown, head cover, shoe covers, eye protection face shield, surgical gloves and N95 mask (N95 is worn inside the surgical mask, solid-line arrow), (B) An enhanced PPE, which includes a portable powered air-purifying respirator (dotted arrow) connected to the head-top cover (arrowhead).

Table 3. Key recommendations for airway management and anesthesia induction in patients with confirmed or suspected COVID-19 receiving general anesthesia<sup>9, 16, 17</sup>

Airway management
Preoxygenation with 100% oxygen (gas flow 6 L/min) for at least 5 min
Tight-fitting facemask applied with a 2-handed technique
Application of viral filter on the inspiratory and expiratory limbs
Do not routinely apply assisted positive bag-mask ventilation
Use of video-assisted laryngoscope or intubation stylet
Disposable blade should be used
Anesthesia induction
Use of rapid sequence intubation technique
Slow titration administration of rapid onset opioids and intravenous hypnotic agents
Administration of succinylcholine (1.5 mg/kg) or rocuronium (1.5 mg/kg) for complete paralysis before intubation
Successful intubation should be confirmed by exhaled end-tidal CO <sub>2</sub>
Ventilation should commence only after cuff inflation
Use of closed in-line suction system, if necessary
Maintain anesthesia with volatile anesthetics or total intravenous anesthetics

minimal cardiopulmonary compromise, reduced surgical pain, and faster post-operative recovery. However, the processes of gas insufflation to produce pneumoperitoneum and deflation in patients with COVID-19 can generate aerosols containing viral particles, potentially exposing the operating team to the virus. We recommend that laparoscopic surgeries can still be performed with the appropriate precautions due to its advantages over open surgery and the current lack of evidence showing COVID-19 transmission through the laparoscopic route.<sup>19</sup>

### Postoperative Considerations

A patient confirmed with or suspected COVID-19 should be transferred directly to their original negative-pressure ward or a negative-pressure room in the intensive care unit (ICU) after operations. The use of a designat-

edlevator or corridor is also recommended to transfer patients with COVID-19 to minimize the risk of environmental cross-contamination. Awake patients should put on a N95 mask at all times while being transported after regional anesthesia. If general anesthesia was performed, the endotracheal tube should be removed in the patient's original negative-pressure room or in ICU. Antiemetics and deep extubation should be considered to limit the spread of viral droplets from vomiting and coughing. Medical and nursing staff should use standard PPE during postoperative visits. If there is a suspicion of COVID-19, all surgical and anesthetic staff should be isolated and quarantined until a negative test is confirmed. Otherwise, team members need to be isolated for 14 days after the operation.

### Conclusions

COVID-19 infection is associated with significantly increased perioperative mortality and major postoperative complications. Non-urgent elective surgical procedures should be postponed and non-operative therapeutic approaches should be chosen when possible. In situations where surgical intervention is necessary, every effort should be made to prevent the spread of the virus to other patients and health care workers. We recommend the implementation of a collaborative multidisciplinary protocol for the perioperative care of surgical patients with confirmed or suspected COVID-19 infection.

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