



Coronavirus Disease 2019 Occupational Considerations for Surgeons: A Review Article

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Abstract

The severe acute respiratory syndrome coronavirus 2 virus and its associated disease, called coronavirus disease 2019 (COVID-19), first appeared in Wuhan, China in December 2019 and quickly spread around the world. Coronavirus was officially named COVID-19 by the World Health Organization and was recognized as a pandemic due to its rapid spread worldwide. Based on the published data, it is hoped to provide a source for later studies and to help prevent and control the contagious COVID-19 and its characteristics, and considerations that surgeons and medical staff must observe during the epidemic.

Keywords: SARS-CoV-2, COVID-19, Surgery

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Introduction

The severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) and its related disease, called coronavirus disease 2019 (COVID-19), was first detected in Wuhan, China in December 2019 and rapidly spread worldwide, infecting thousands of people and killing many in 160 countries around the world. All ages of people are prone to SARS-CoV-2 (1). On February 11, 2020, SARS-CoV-2-associated disease was officially named COVID-19 by the World Health Organization (WHO) and recognized as a pandemic due to its rapid global spread. On the same day, the International Committee on Virus Classification named it SARS-CoV-2 (2). Meanwhile, some countries have postponed non-emergency surgeries in hospitals due to possible risks to the patient and medical staff (3). Given the above-mentioned explanations, this study intended to review the present research according to the pattern of disease transmission and assess the risk of transmission through surgical procedures in order to perform elective surgery and the risks and the required considerations for medical staff.

Viral Profile

SARS-CoV-2 belongs to the β -coronavirus family, and COVID-19 is the third most well-known zoonotic coronavirus disease after acute respiratory syndrome (SARS) and the Middle East respiratory syndrome (MERS). SARS and MERS also belong to the same family (4). Zhu et al (5) confirmed that the SARS-CoV-2

belonged to the Botulinum genus of the Coronaviridae. According to current data (6), initial COVID-19 cases were linked to the Huanan seafood market, and the possibility of human-to-human transmission is no exception. The WHO declares that SARS-CoV-2 can be detected in environmental specimens collected from the seafood market although it is yet unclear whether a particular species of animals carry this virus (6). The high similarity of the SARS-CoV-2 with the bat coronavirus hypothesizes its transmission from bats to humans (7). The findings of other researchers also confirm this issue (8, 9). Recently, in addition to confirming the close association of SARS-CoV-2 with the bat coronavirus, Zhou et al (10) and Wu et al (11) have found 79.5% genetic similarity with SARS-CoV-2. Unlike the similarities of this virus with the bat virus, no intermediate hosts have been yet mentioned for it.

COVID-19 Symptoms

Zhao et al (12) found that the SARS-CoV-2 receptor is the enzyme that converts angiotensin 2 (ACE2), which is expressed in type I and II alveolar epithelial cells in the human normal lung. Among them, 83% express alveolar type II ACE2 cells. Connecting SARS-CoV-2 to alveolar cells can lead to damage, and thus a series of systemic reactions and even death. Wrapp et al (13) reported that the SARS-CoV-2 can connect to its receptor 10 to 20 times stronger than SARS-CoV. Thus, according to Benvenuto et al (7), the symptoms are similar to those

of other respiratory infections, including fever (43%-98%), cough (82%-68%), fatigue (38%-44%), sore throat (9.13%-17.4%), dry cough (59.4%), and sputum production (28%-33%). However, the other features of upper respiratory infections such as nasal congestion (4.8%) and rhinorrhea (4%) are extremely rare (14-16). Among the patients, there were also reports of olfactory and taste failure in China, Italy, and Iran (17). Laboratory results of other studies (14, 18) included lymphopenia (35%-83%) and increased *C-reactive protein*, as well as increased lactate dehydrogenase (27%-92%) and increased *erythrocyte sedimentation rate* (above 85%). The diagnosis of SARS-CoV-2 is currently performed by the polymerase chain reaction (PCR) test on nasopharyngeal swabs. Unfortunately, PCR testing may be negative first, and become positive in repeated trials (19). A serological test for antibodies to COVID-19 can also be performed, and a positive test shows that the person has a safe immune response to SARS-CoV-2 and is recovering (20-22). In a report from 1,000 Chinese patients for achieving the accuracy of various diagnostic tests, including chest CT scans, 98% sensitivity was observed compared to 71% RT-PCR sensitivity (23).

Viral Transmission Method

It is thought that the initial method of transmission occurs through the release of droplets, which remain in the air for a few seconds due to their weight and move only a short distance before arriving at the surface. However, virus particles can spread in the air and increase the risk of spread under certain conditions such as when ventilating a mask bag or bronchoscopy. Research has shown that SARS-CoV-2 in the form of airborne causes widespread environmental contamination in COVID-19 patients in rooms under negative pressure (24). According to (25), the survival time of SARS-CoV-2 varies considerably with the surface area, and the aerosol form can last up to 3 hours although the longest survival time has been on plastic and stainless steel (over 72 hours). These findings emphasize the importance of cleaning the surface with antiviral agents such as bleach, quaternary ammonium, and hydrogen peroxide (26). Personal protective equipment (PPE) is also useful in reducing the risk of nosocomial infection (27). The Centers for Disease Control and Prevention and the WHO also advise health care workers to wear clothing, gloves, goggles, and a medical mask that should protect against drip transmission. Research has demonstrated that health care workers are at high danger for infections when removing or replacing PPE (27). The SARS-CoV-2 virus such as the prevalence of SARS, influenza A (H1N1) infection in 2009, and MERS requires more caution in order to reduce exposure to respiratory secretions and the risks of transmitting the virus for health care staff and other patients during the operation (28-30). It should be noted that the clinical manifestations of the disease varied, and

most patients had respiratory symptoms (16, 31, 32). In a study on 1099 patients with COVID-19, 19%, 41%, 5%, and 2.3% of cases represented shortness of breath, needed oxygen, had a worsening disease, and needed aggressive mechanical ventilation, respectively (14).

Considering the above-mentioned explanations, this study focused on control measures to ensure patient and staff safety, equipment protection, and infection prevention in patients in the surgical ward.

Considerations for Anesthesiologists

Anesthesiologists in the operating room at the forefront of surgical patient management, as part of measures for reducing the prevalence of COVID-19 in the hospital, are required to take precautionary measures and anesthesia that are appropriate for patients. By minimizing many of the performed aerosol-induced procedures during general anesthesia, they can reduce patients' exposure to respiratory secretions and the risk of transmitting the virus to treatment staff and other patients during the surgery. In addition, methods leading to the production of airborne particles (aerosols) during general anesthesia should be minimized, including ventilation with a bag-mask, open-air suction, and intra-trachea piping (33). In hospitals, this is in line with the WHO recommendations for disease prevention and control centers, including increased monitoring, administrative and environmental controls, environmental health, proper work practices, and the individual use of PPE. Similarly, some considerations have been suggested to decrease the risk of hospital-acquired viral transmission during airway management in COVID-19 approved or suspected patients (34, 35).

Considerations for Ear, Nose, and throat (ENT) Specialists

Many otolaryngologists visit both adults and children. A study of 72 314 patients from the Centers for Disease Control and Prevention (CDC) found less than 1% of cases in 10-year-old children or younger were symptomatic except for those under one year of age. Children seem to have relatively milder symptoms compared to adults. Further, 15% of children with positive COVID-19 were asymptomatic in Wuhan Children's Hospital. This statistic emphasizes the hidden role of virus transmission in society. Therefore, ENT specialists need to be informed of the danger of the disease spreading from children to health care workers and other patients (36).

Accordingly, adherence to the following recommendations by ENT specialists can prevent the transmission of infection to the physician (37):

1. The nasal cavity of patients and the mucous membrane of the pharynx should be well anesthetized to decrease cough and sneezing reflex.
2. Topical anesthetics of the gel type should be used instead of sprays in order to reduce the production of aerosols.

3. The smallest size of examination equipment should be applied to reduce the risk of cough and sneezing.

There is currently no official guideline on the most reliable method of reducing the risk of transmitting the SARS-CoV-2 virus during the use of flexible fibroblastic laryngoscopy (FFL). Therefore, it is recommended that all endoscopies should be postponed unless necessary (including malignancy or airway obstruction), and doctors should wear clothing, an N95 mask, and a face protector when performing FFL (38).

Tracheostomy indications in these patients include emergency airway and long-term mechanical ventilation. Data from the SARS experience in Hong Kong suggest that the virus may not be transmitted to surgeons or staff if tracheostomy is necessary. Thus, the key recommendations are reducing aerosol production possibilities, including complete paralysis to prevent coughing, ventilation only by inflating the cuff, preventing ventilation before entering the airway, avoiding reactions, as well as PPE by staff (39).

Considerations for Neurosurgeons

Endoscopic surgery on the sinuses and skull base is most at risk for transmitting the disease. Given that the patient is symptomatic or asymptomatic, the amount of virus in the nasal cavity is greater than the throat. As previously mentioned, once aerosolized, SARS-CoV-2 particles may reside in the air for at least 3 hours. During sinus endoscopic and cranial surgeries, there are various mechanisms for feasible mucosal and viral aerosolization. In general, 14 neurosurgeons in Wuhan have also been diagnosed after the endoscopic and endoscopic surgery of the pituitary gland in patients with COVID-19. This increased risk for endoscopic surgeons was also observed in Iran and Italy, thus appropriate PPE should be used during this type of surgery while limiting the use of anesthesia sprays in the clinic. On the other hand, the use of anesthesia and anti-congestion can reduce the transmission to the surgeon (25, 40, 41).

Considerations for Orthopedic Surgeons

Patients with severe fractures usually need hospitalization and surgical procedure, thus the risk of COVID-19 infection increases in these patients and they are at raised risk of death due to infection. Several strategies can be used by an orthopedic specialist in patients with fractures and pneumonia caused by COVID-19 in order to reduce mortality in these cases, including:

1. Non-surgical treatment should be considered for aged patients with fractures including radius distal fractures.
2. Strict measures to control infection should be taken for patients with fractures, especially those undergoing surgery.
3. Patients with fractures and COVID-19 pneumonia should be monitored and treated more aggressively.

4. Surgical procedures for patients with COVID-19, fractures, and pneumonia should be performed at a negative pressure in the operating room.

Most patients with hip fractures are adolescents and many of them are in relatively poor physical conditions and may suffer from other underlying diseases such as hypertension, diabetes, and heart disease. These patients are usually advised to have surgery as soon as possible. This method not only improves fractures while reducing the risk of pneumonia and deep vein thrombosis (42-44).

Considerations for General Surgeons and Thoracic Surgeons

Another at-risk group of health care teams is general and thoracic surgeons. Patients who are admitted to thoracic surgery and have surgery are more likely to develop lung infections before or after the surgery. Therefore, treatment management in these patients is highly important for preventing surgeons from infection.

The surgery itself can lead to lung dysfunction and reduced immunity, thus SARS-CoV-2 infection following thoracic surgery can cause worse and more severe results. COVID-19 is mainly manifested by a fever with cough, lethargy, muscle aches, chest discomfort, shortness of breath, gastrointestinal manifestations, and other symptoms. Patients may also have fever, cough, and chest discomfort in the postoperative period that should be differentiated from COVID-19. In the early stages, the contrast between COVID-19 and other respiratory infections is not well understood, thus it is extremely difficult to diagnose a patient with SARS-CoV-2 and use proper protective devices to prevent nosocomial infection (45). Moreover, postoperative infection is mainly due to insufficient drainage caused by bacteria, typically occurs 3-7 days after the surgery, and is accompanied by sputum coughing and increased white blood cell count. However, most people with COVID-19 had normal or reduced WBC counts and fewer lymphocyte counts (46). Additionally, those with COVID-19 are highly infectious in the thoracic surgery unit. For example, Tuite et al found that the mean baseline infection (R0) for SARS-CoV-2 on January 2020, was 2.3, and the effective infection rate (Re), decreased to 1.5 after effective protective actions in February. Therefore, effective protection measures can reduce R0. Health care workers are highly susceptible to COVID-19 despite standard protection equipment (47, 48). Therefore, it is recommended that thoracic surgeons pay attention to the following issues in this regard:

1. Limit surgeries and delay elective surgeries because elective surgery on infected patients, especially the asymptomatic or mild form of COVID-19 can cause the contamination of the room and operating equipment and the risk of infection transmission to the surgical team and other health care providers in the hospital.
2. Strictly perform emergency surgery indications at

the time of the outbreak.

- Asymptomatic patients should be considered, and all patients suspected to COVID-19 should be considered as definitive cases. Accordingly, routine blood tests, chest CT scans, and PCR tests for SARS-CoV-2 should be performed before their surgery (48, 49).

Considerations for Colorectal Surgeons

Another group of at-risk specialists is colorectal surgeons. Endoscopy means a high risk of transmitting COVID-19 to this group of specialists. The short physical distance between patients and the doctor, aerosol formation, and digestive fluid aspiration may play a role in the unknown spread of the disease, especially in asymptomatic patients. In addition, the ACE-2 receptor, which SARS-CoV-2 binds to, is highly represented in the gastrointestinal tract, and viral RNA has been identified in the saliva and feces, indicating oral transfusion as a potential alternative route for transmission (31, 50-53). In another study, Zhang et al (53) recommended that the virus could be detected in feces regardless of the severity of the disease and reported that it remained in the feces much longer than other samples such as nasopharyngeal swabs and saliva. According to the international community, it is best to postpone and reschedule all routine endoscopies. Further, outpatient visits and follow-up visits should be delayed or conducted by telephone consultation. Endoscopy is limited to life-threatening gastrointestinal hemorrhage, the removal of the foreign body, blockage of food bolus, and ascending cholangitis. Furthermore, all patients should be scanned for fever (temperature > 37°C) before endoscopy, and the Triage Questionnaire should be used to share the risks associated with this procedure. To manage the disease in colorectal emergency surgery, only life-threatening emergencies need to be treated (e.g., the perforation of the bowel, obstruction, and bleeding) since the CO₂ flow in the abdominal cavity can increase the risk of nosocomial infections by the aerosolization of SARS-CoV-2 particles (54-56).

In summary, SARS-CoV-2 is highly infectious and hospitalized patients and health care workers at this epidemic are at high risk for infection. Therefore, comprehensive protective measures such as quarantine and disinfection are required to command nosocomial infections.

Conclusion

The outbreak of COVID-19 poses a major hurdle in the management of patients undergoing surgery. COVID-19 can accompany the pre- and post-operative period with diagnostic challenges and high mortality. Thus, the advantages and disadvantages of elective surgery should be strictly considered depending on the availability of resources and the severity of an epidemic. In places with extensive infections and limited facilities, the risk of

elective surgery for the individual and the community may exceed the benefits. In some cases, postponing elective surgery may be the right decision and can provide a therapeutic space for critical patients in addition to retaining resources such as PPE. Moreover, the management of COVID-19 patients in the requirement of surgery should be as conservative as possible without exposing patients to additional risks. The surgical staff must receive sufficient training and instructions and follow the necessary training. Additionally, another solution is routine screening or the selection of COVID-19 patients before elective surgery, which is considered at least acceptable. Remote therapy and virtual visits using smartphones for pre- and post-operative visits can also be an option for reducing the risk of spreading the infection. Although many questions about COVID-19 and surgery remain unanswered, surgical associations need to be responded appropriately to improve patient outcomes and minimize the burden on the health care system.

Conflict of Interest Disclosures

The authors declared no conflict of interests.

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Ethical Statement

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Authors' Contribution

SHB and DH supervised the manuscript, other authors involved in literature reviewing.

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Informed Consent

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