

RESEARCH ARTICLE

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Perioperative care in COVID-19 patients requiring emergency surgical procedures: A systematic review

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ABSTRACT

Aims: The novel coronavirus infection (COVID-19) was first discovered in Wuhan, Hubei province, China and has spread to various continents of the world. This pandemic has beyond doubt affected patient care as reallocation of resources to the care of COVID-19 patients is now the order of the day. **Methods:** We conducted a systematic review to identify demands of conducting surgical procedures during the COVID-19 pandemic. Our search strategy involved using the following databases: PubMed, MEDLINE, Google Scholar, and other medical databases. The search terms were “COVID-19,” “surgery,” “COVID-19 and Surgery.” Titles and abstracts of articles available in English were examined. The identified full texts were screened for original data, and related references were retrieved and checked for relevancy based on the inclusion criteria. **Results:** Studies that met the inclusion criteria were thoroughly reviewed. We gathered that COVID-19 has greatly impacted the perioperative management of patients requiring emergency procedure during the pandemic. Preoperatively, venues and materials needed for surgery, including surgical personnel have been defined. There is also significant impact on intraoperative activities including ventilation of the patient, use of some equipment that could cause aerosol generation, and also postoperative care of the COVID-19

patient. **Conclusion:** This study provides a framework for navigating through the muddy waters of performing surgery on COVID-19 infected patients, with emphasis placed on the prevention of cross-transmission in the hospital. All hands therefore must be on deck at every stage of management of COVID-19 infected patients.

Keywords: Anesthesia, COVID-19, Health care workers, Surgery, Transmission

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INTRODUCTION

The novel coronavirus outbreak began in Wuhan, China in December 2019. As a result of its rapid spread to other parts of the world, the World Health Organization (WHO) declared the virus as a pandemic on March 11, 2020. Currently, there has been over 5 million reported cases and more than 300 thousand confirmed deaths as a result of this deadly virus worldwide [1]. Now popularly called COVID-19 [2], the virus has caused a global disarray, shaking nations and having not only health impact but also economic and political implication [1, 3, 4].

The overall case fatality rate of COVID-19 is about 1.4%, however, the risk of death in individual infected increases with increasing age with about case fatality ratio (CFR) of 1% in children less than 10 years of age to 8% in those who are 80 years old and above [3].

COVID-19 is a viral respiratory infection whose clinical features are closely related to the influenza H1N1 [5, 6] and it runs a clinical course similar to those of Severe Acute Respiratory Syndrome (SARS) and Middle East Respiratory Syndrome (MERS), which were also declared pandemic between 2000 and 2003 [7–9]. While its mode of transmission is not fully understood, transmission from contact with infected persons has been documented [7–9].

Also known as SARS-CoV2, the documented risk factors for COVID-19 are extremes of ages, chronic diseases such as diabetes mellitus (DM) [10], coronary artery disease (CAD), cerebrovascular disease (CVD), chronic obstructive pulmonary disease (COPD), and cancers. Males are also at higher risk than females [11], with extremes of ages and presence of other comorbidities being highly correlated with increased CFR [7, 12–16].

Infected individuals can manifest the signs and symptoms ranging from fever, dry cough, headache, and respiratory distress [9, 15]. Other documented clinical features include sore throat, fatigue, lethargy, diarrhea, and chest tightness [15], while some other infected persons may remain asymptomatic throughout the incubation period with the ability to transmit the infection to others [17], with incubation period of COVID-19 being between 2 and 14 days [8, 18, 19]. Given that the symptomatology is closely related to other viral respiratory infections such as flu, MERS, SARS, this poses a challenge on early detection and diagnosis of COVID-19 [14, 20, 21]. The most pronounced feature of SARS-CoV2 is acute respiratory distress syndrome (ARDS) [8, 14, 20, 22, 23], increasing the need for mechanical ventilation in those infected. The impact of COVID-19 outbreak on patient requiring any form of medical care is pronounced, with the attention of health care team being shifted to combating COVID-19 outbreak [24]. It has been recommended that all elective surgeries be cancelled [15, 25–29]. About 10% of SARS-CoV2 infected patients will require intensive care unit (ICU) admission, of which 20% will require one form of surgical procedures or the other [30, 31]. Of the percentage that had operative procedures done, only about 30% will eventually survive [30, 32], with most patient dying from complications arising from these procedure [31]. Any form of surgical procedure is a stressor to the patient. Therefore, patients with COVID-19 needing operative procedures are not only at higher risk of transmitting the infection to others (health care team) [30], they may also experience exacerbation of symptoms, and are sometimes more prone to death resulting from the infection following these procedures [13, 28]. Despite the documented evidences concerning COVID-19 infected patient requiring any form of operative procedure during their period of care, there is however paucity of data concerning precautionary measures needed to be taken during such procedure. In order to minimize infection transmission and to

improve outcome [30, 32], the managing team must be informed of what needs to be put in place, necessitating this review [33].

Several articles have addressed different parts of the demand of operative procedure. Based on the existing body of knowledge, this review will be putting to the perspective of the peri-, pre-, intra-, and postoperative demands and measures required to minimize transmission of infection to the medical team and to improve patient outcome.

MATERIALS AND METHODS

Literature search strategy

A systematic electronic literature search was carried out by two independent individuals first on April 6 and was repeated for the last time on May 26, 2020. PubMed, MEDLINE, Google Scholar, and other related medical databases were searched using the following search terms: “COVID-19,” “Surgery and COVID-19,” “Coronavirus,” “SAR-CoV2,” “SARS-CoV2 and Surgery,” and “Surgical procedure in COVID-19.” The search was limited to manuscripts published in English language. We examined titles and abstracts of articles that were available in English language.

Inclusion and exclusion criteria

Two reviewers evaluated the topic and the abstract of the articles and the relevance of the articles were determined. Articles initially recruited for the review were selected based on meeting any of the inclusion criteria: Published online on COVID-19 between December 2019 and May 26, 2020, addressing component of the perioperative management of COVID-19 patient, and focusing on either minor or major surgical procedures relating to management of COVID-19 patient. However, final article selection was done based on meeting the first criterion and either second or third criterion. The retrieved results were jointly cross-examined and disagreements were solved by discussions among the team members. Articles that did not meet the inclusion criteria such as those addressing the epidemiology and clinical characteristics were excluded from the review.

Data extraction

Having gone through various screening stages, we selected articles that met the inclusion criteria as stated above. Three reviewers independently examined the literatures with each focusing on the preoperative, intraoperative, and the postoperative aspect of the articles and the data was subsequently extracted and collated.

RESULTS

1. Preoperative

Risk assessment

It has been shown that surgical procedures can increase the rate of disease progression especially in previously asymptomatic patients and also that the mortality rate is higher in this category of patients [30, 34]. Therefore, the need for the surgical procedure must be objectively assessed, ensuring that the benefit of the procedure outweighs the associated risk. Elective surgical procedures should be postponed as this would help preserve scarce resources including personal protective equipment (PPE) and also maintain treatment space for critical patients [34–37]. Also recommended is that all elective procedures that may result in aerosolization be deferred and if indicated, appropriate PPEs should be worn [13, 38–41]. COVID-19 pandemic is associated with fear, therefore, aversion for surgery may increase in them. As a result, pragmatic steps must be taken to ensure that patient is calm and less anxious prior to the procedure [42].

Operating room

It is important that each hospital has dedicated operating areas to COVID-19 patients requiring urgent/emergent surgeries. Operating rooms closest to the entrance of the theatre block should be the designated ones to this category of patients [15, 43, 44]. Minimally invasive procedures for COVID-19 patients should be done in separate rooms different from the uninfected patients [38, 40, 45].

However, it is recommended that if a hospital has provisions for satellite operating complexes, they should be deployed for the use of COVID-19 patients as this would reduce the risk of contamination of other operating rooms (ORs) [46]. While in transit, the COVID-19 positive patient should move directly to the dedicated OR without stopping at any other place [15, 24, 44]. Negative-pressure OR (below 5 Pa) is required as this would be ideal to prevent dissemination of the virus [32, 35, 43, 46, 47]. More so, high-efficiency particulate air (HEPA) filters can be placed in positive pressure operating rooms. In addition to this, a high air exchange cycle rate (≥ 25 cycles/hour) will effectively reduce the viral load in the operating room [6, 38, 44, 46]. This is especially important for aerosol generating procedures. Also, in positive-pressure ORs, the clean air conditioning system should be shut off [35, 38].

The OR complex should be divided into different sections: the entry dressing room, where the basic PPE is worn, the anteroom, where disinfection and surgical dressing take place, the operating room itself, the exit room where PPE is removed, and the exit dressing room where the staff can shower. Each room should be properly labeled to enhance distinctness [46].

The selection of equipment

Disposable supplies are the best choice to use for this category of patients [35, 44]. Disposables needed for surgical procedures include gloves, face masks (FFP2 and FFP3), eye protective goggles, disposable long-sleeved waterproof gowns or Tyvek suits, face shield, disposable head caps, and alcohol-based dispensers (Table 1). When gloves have been contaminated, they should be discarded and replaced so as not to contaminate other surfaces [13, 15, 26, 31, 38, 43, 44, 48].

Concerning the non-disposable equipment, it is recommended that their use be dedicated to COVID-19 patients only, that is, they should remain in the OR reserved for COVID-19 patients. These include the anesthetic machines, nebulizers, humidifiers, and so on [35, 43, 48]. It is advised that heat and moisture exchangers be placed on the expiratory limb of the breathing circuit, and both the heat and moisture exchanger filters and the soda lime should be changed after each procedure [38, 43].

Table 1: Materials needed for personal protection

Materials for personal protection
Surgical gloves
Face masks (FFP2 and FFP3)
Long-sleeve waterproof gowns or Tyvek suits
Disposable head caps
Eye protective goggles
Face shield
Alcohol-based dispensers

FFP: filtering face piece.

OR personnel

All OR staff have to wear the required PPEs before meeting the infected patient. It is very important to take precautions during the intraoperative period to protect the patient and the operating room staffs. Whether a case is being suspected or it has been confirmed already, they must be treated as positive until proven otherwise in order to minimize spread of infection. Dedicated senior staff should be allocated to important management roles and all staff should have proper training on the use of PPEs [6, 31, 40]. This consideration must be made across all surgical modalities. Also, it is very important that the number of people working in a particular dedicated operating room should be as minimal as possible [35, 44].

It is important that once the patient is in the operating room, the door should be shut. It is also very important that all the personnel involved in the surgery enter in a timely manner, that is, entering the suite when their services are needed as this would minimize the time spent with the patient [6, 38]. Also, it is imperative to avoid moving out of the operating suite until the end of the procedure. Each health care worker must be properly

dressed in their PPEs before coming in contact with the patient [6, 38, 44, 45]. In addition to wearing of protective materials, they should take universal precautions [48]. During the procedure, a runner nurse should be stationed outside the operating room just in case additional drugs or equipment will be needed. These will be placed on a trolley that will be left in the anteroom for the OR team to retrieve [43].

The choice of anesthesia procedures and the management

In COVID-19 patients, general anesthesia or monitoring anesthesia is usually adopted. The principle is that adequate oxygen supply should be maintained, anesthetic agents should be adequate, cough reflex and agitation should be avoided and the safety of the patient and staff should be ensured. While preparing to induce the patient, spontaneous breathing and oxygen inhalation by continuous positive airway pressure (CPAP) should be maintained [35, 38].

It is recommended that fast induction of anesthesia should be performed to prevent the patient from coughing. Induction agents should be administered in this order: muscle relaxants, intravenous general anesthetic agents, and opioids to avoid cough [32]. Patients who are yet to be intubated should put on a face mask until induction [15, 44]. Intubation should be carried out by an experienced anesthesiologist and awake intubation techniques should be avoided. This will help to avoid failed attempts and improve first-time success rate. Of note is that unless it is specifically indicated, fiber-optic intubation should be avoided [44]. There could be occasions of difficult airways in which case a laryngeal mask should be placed after the first failed attempt. After an anesthetist has intubated the patient, end-tidal CO₂ and chest rise are the best indicators of correct intubation. For the ventilator settings after intubation, it is recommended to use lower tidal volumes (3–8 mL/kg), lower airway pressures (below 30 cm H₂O), and higher frequency ventilation to protect the lungs. If manual ventilation is needed small current volumes should be used [35, 44, 48].

In pediatric patients, because they may be anxious when separated from parents which could result in crying and spraying of saliva, midazolam or dexmedetomidine should be administered before the patient enters the operating room. Also, intravenous sedatives or masked inhaled sevoflurane should be used for induction [35].

For American Society of Anesthesiologists (ASA) class I–II patients, intravenous anesthesia combined with regional nerve block or caudal without intubation is recommended excluding brain surgery, craniofacial, cardiothoracic, ear-nose-throat, and laparoscopic surgeries. Patients in ASA class III or above should be anesthetized with tracheal intubation with general anesthesia [35, 42].

2. Intraoperative

Personnel

Limit the number of personnel in the OR to essential staff only [24, 31]. The OR doors must be closed as soon as the patient enters and individuals should remain in the OR until the surgery is over [24, 44].

A runner nurse should be stationed outside the OR to help get extra drugs and equipment when needed. There is an anteroom with a trolley where this individual places the needed items while wearing PPE. This trolley can also be used to send out specimens like arterial blood gases sample [43].

Highly experienced staff with pre-established routines are preferred in carrying surgical procedures like tracheostomy [15, 47]. This coupled with efficient communication between team members would quicken operating time and thus minimize the chance of transmitting the virus by reducing exposure time [6, 39].

The surgeon and other members of the team should only be allowed to enter the OR after adequate disinfection and dressing [46]. All personnel in direct contact with the patient must wear a double pair of latex gloves at all times [44].

Procedure

The surgical treatment of trauma and orthopedic cases involves the use of power tools like drills, bone saws, reamers, and electrocautery. The use of these tools should be minimized because they generate aerosols which can facilitate virus spread. It is advised that these tools are operated at low power settings [31, 46, 49].

Special precautions should be taken when involved in procedures associated with increased risk of transmission. An FFP3 mask should be worn before procedures like endotracheal intubation, noninvasive ventilation, tracheostomy, cardiopulmonary resuscitation, manual ventilation before intubation, and bronchoscopy [24, 34, 41, 45]. These procedures are high risk because they are very likely to release aerosols [38, 41, 44]. During tracheostomy, it is advised that exposure time to aerosolized secretions be reduced by ensuring complete paralysis of the patient throughout the procedure, stopping mechanical ventilation just before entering the trachea and minimizing suction use during the procedure [13, 45, 47]. Open tracheostomy is preferred to percutaneous tracheostomy due to the lesser chance of aerosolization [41, 47]. Thomas-Rüddel et al also advocate for sufficient relaxation of the patient before tracheostomy [15]. Smoke extraction devices should be used with caution because they have the potential to increasing aerosol generated during intraoperation [24, 31, 40, 49]. Where and when available, a triple filter system should be used [39].

In the treatment of head and neck tumors, minimally invasive approach is highly recommended [31, 42]. This helps to reduce duration of surgery. Surgical defects should also be reconstructed with local flaps rather than

revascularized flaps [50]. Incision and port sites should be managed well to avoid escape of air from the peritoneum during laparoscopic procedures. Also, number of skin incisions must be minimized and of moderate sizes to fit the endoscopic devices. Insufflations must be done with care. Insertion and removal of the trocars should be carefully done to avoid spillage of body fluids [24, 39]. Aerosolization of the coronavirus increases during endoscopic sinus surgery and skull base surgery, hence, all endoscopic procedures should be postponed unless considered necessary [38]. If these procedures must be carried out, oral and nasal mucosa must be adequately anesthetized using anesthetic pledgets instead of anesthetic sprays in order to reduce cough and sneeze reflex. Also, it is preferable to use smallest diameter scopes for these procedures so as to reduce coughing and sneezing. Appropriate PPE for aerosol exposure is recommended [13, 38].

Suctioning during surgical procedures should be avoided if possible [47]. If suction is to be used, suction devices with the ability to remove smoke and aerosols should be made available during aerosol generating procedures [46]. Suction used within a closed system is recommended [15, 24, 40, 47, 51], preferably with a viral filter [47].

3. Postoperative

This period is marked by the end of the surgical procedure and the initiation of anesthesia reversal. Removal of the PPE by any member of the operating team must be carefully done in a stepwise manner [43, 44, 46]. After removal of a layer of the PPE, the hand must be disinfected with alcohol-based sanitizer before the removal of the next layer [46]. This phase is very important because the risk of transmitting the infection is very high, therefore, all precautions need to be strictly adhered to. It is recommended that medical team should exit the operating room via an exit that is different from the entry point [46].

The most senior member of the anesthetic team commences the extubation of the patient, while doing this, full level 3 PPE with N95 or PAPR must be worn because there is a risk of coughing from the irritation of the airway thereby increasing the risk of infection transmission. Transport of all specimen must be done in a tightly fitted container [13, 15, 42, 44, 46, 52].

Waste disposal and cleaning of the operating room

Cleaning of the operating room must begin immediately the procedure is over. This begins with the decontamination of the anesthetic equipment [30, 32, 48]. Operating table, tray surfaces, and other reusable materials must be well decontaminated with alcohol-based sanitizer [44, 46]. Surgical instruments must

be washed, dried, decontaminated, packed in a sealed container and sent for sterilization immediately after the procedure [46].

After the surgical procedure is over, proper cleaning and disposal of used and unused consumables that may be regarded as contaminated must begin. While still adequately protected by PPE, all consumables to be disposed must be packed and sealed in a container [42, 44]. Any unused drugs or other consumables present in the OR must be assumed contaminated and therefore disposed [30, 32, 43, 44, 46, 47]. It is recommended that such container is labeled for easy recognition and for possible awareness to others [42, 44, 46]. Having carefully packed the waste into a labeled and sealed container, it is then transported by an assigned perioperative staff to a designated COVID-19 point of disposal [6, 13, 35, 42, 44]. During the transportation of the waste, all precautionary measures must be ensured and contact with other surfaces must be avoided to reduce the risk of transmission of the disease [42, 44]. The waste disposal area for COVID-19 related waste must be separate and easily identifiable. Members of the perioperative staff saddled with these responsibilities must wear their level 3 PPEs [6, 13, 43, 44, 46, 50].

Planning for a next procedure can be exceptionally stressful with full repeat of all the precautionary measures. Usually, an interval of 1–3 hours is recommended before the start of another procedure using the same operating room [44]. This recommendation is based on the pervasiveness of aerosol of COVID-19 in air. It can stay much longer on surfaces. Adequate interval also gives room for reusable materials to be well sterilized [42].

Patient transfer and monitoring

After each procedure, the transportation of patient is done and the decision of whether patient is taken to ICU or isolation ward is based on the preoperative and immediate postoperative assessment by the managing team [30, 42, 43]. During the process of transiting from the OR, patients must have their PPEs on especially with N95 mask, and contact with other animate or inanimate object must be minimized [42]. Passages must be disinfected immediately. Patient who had aerosol generating procedures must be isolated. While in the Isolation ward or ICU [42, 44, 48, 50], each visit to patient must be kept short and targeted at meeting specific needs of the patient [37, 44, 46]. Hand washing facilities should be present at the entrance to the ward and also at patient's bedside [6]. Number of visiting medical team for a visit must be reduced and visiting members must have their PPEs worn and have their hands sanitized before and immediately after attending to the patient [42, 46]. Wearing of double gloves is recommended for perioperative staff who will be handling patient's blood, urine, and other secretions [44, 46, 50].

DISCUSSION

In the face of the ongoing pandemic, the safety of the medical team is of utmost priority while improving outcome of those infected with the disease [26, 53]. With health practitioners being at the forefront in the fight against COVID-19 pandemic, there is a need for not only for an institutionalized or local protocol but a well-defined, basic guidelines that govern the interactions of physicians with their patients [6, 38]. Since the onset of COVID-19 pandemic, there has been an increase in the number of health care workers dying from being infected with the disease. Since the onset of COVID-19 pandemic, there has been increase in the number of health care workers dying from the disease [7, 12, 42, 54] (Table 2).

The goal of inpatient care of COVID-19 patient is to improve their outcome, minimizing infection transmission to the healthcare team. Based on the documented knowledge, this review further highlights the implication and the rudiments of all that needs to be put in place in managing COVID-19 patient needing any form of surgical procedure [27, 41, 47, 55]. It also provides a framework for navigating through the muddy waters of performing surgery on COVID-19 infected patients, with emphasis placed on the prevention of cross-transmission in the hospital [35, 42, 44, 46]. An important first step in the prevention of COVID-19 among surgical patients and

their care providers is the postponement of all elective procedures [27, 29, 42–44, 46]. Risk stratification is of essence [27, 47], comparing the benefit of the procedure with the associated risk. Irrespective of the indication for the procedures, all patients must be treated as positive for the disease, hence, the need for adequate precautionary measures on the part of the attending health care workers [7, 22, 36, 46]. So all emergency surgical procedures must be approached as a case of COVID-19 [37, 44]. Adequate first responder system must be in place to attend to new admission. While performing their duties, clinicians must understand how predisposed they are without adequate self-protection.

It is not enough to have a dedicated room for operative procedures, an interval of 1–3 hours or more should be between cases due to the pervasiveness of COVID-19 aerosols in the air and much more on surfaces [8, 13, 23, 32, 42, 46]. However, other OR that meets the requirement needed can be used in the face of urgency. First, the choice of surgical modality must be determined. Open procedures have been recommended above endoscopic ones largely due to the more aerosol-generating nature of latter [24, 49] which may increase the risk of cross-infections between patient and OR personnel [6, 24].

There are no enough evidences to substantiate the presence of COVID-19 RNA in smokes generated

Table 2: Summary of perioperative management guidelines for COVID-19 patient

Preoperative	Intraoperative	Postoperative
<ul style="list-style-type: none"> • Risk of surgery should outweigh the risk • There should be dedicated ORs for COVID-19 patients • ORs should be negative pressure rooms ideally with air cycle exchanges of >25 exchanges/hour • ORs should be divided into different sections with each section appropriately labeled • Disposable materials are the best to use • Non-disposable equipment should be dedicated to COVID patients • OR personnel should wear required PPEs before meeting the patient • The number of OR staff should be as minimal as possible • General anesthesia is preferred • Before induction, spontaneous breathing should be maintained • Fast induction of anesthesia should be carried out • Intubation should be carried out by an experienced anesthesiologist • Ventilation should involve use of low tidal volume (3–8 mL/kg), lower airway pressures (below 30 cm of H₂O) 	<ul style="list-style-type: none"> • Limit the number of OR personnel • A runner should be outside the OR to help get extra drugs and equipment when needed • Highly experienced staff should carry out surgical procedure • All personnel in direct contact with patient should be double-gloved at all times • Use of power tools should be reduced to the barest minimum • FFP3 masks should be worn when performing aerosol generating procedures • In head and neck surgeries, minimally invasive technique is highly recommended • Suctioning during surgical procedures should be avoided if possible 	<ul style="list-style-type: none"> • The most senior member of the anesthetic team should perform extubation • Transport of all specimen should be done in a tightly fitting container • Removal of PPE should be carefully done • OR personnel should exit the room via an exit different from the entry point • Cleaning of the OR should begin immediately after the procedure • Proper decontamination of surgical instruments should be done • Proper disposal of used and unused consumables should be carried out • Members of the perioperative staff involved should wear level 3 PPE • Depending on postoperative assessment, the patient should be transferred to the ICU or isolation ward

OR: operating room; PPE: personal protective equipment; FFP: filtering face piece; ICU: intensive care unit.

during electrosurgery and other endoscopic procedures. However, there are also no enough data to the contrary [41]. Therefore, minimally invasive surgical modalities should be considered only when the benefits outweigh the associated risk to the patient and health care personnel [24, 38, 49, 51, 56]. Though more aerosols generating, minimally invasive procedures may help to reduce the number of OR personnel with minimal tissue damage and body fluid loss thereby reducing risk of cross-infection intraoperatively and shortening patient recovery time which may be of advantage in centers with limited facilities for patient admission [31, 39, 51]. Prioritizing patients care while maintaining infection control will help arrive at a better choice.

Stricter measures need to be taken when performing aerosol generating procedure and other procedures involving the head and neck region [29, 44, 47].

There is paucity of data concerning COVID-19 patients needing organ transplant during their care. When organ transplant is required as a life-saving process, both the recipient and the donor must be tested and cleared of COVID-19 [57–59]. It is recommended that transplantation surgeries should not hold but be deferred in a patient with COVID-19 [59, 60]. This submission is due to the potential negative impact of these procedures on the outcomes of this group of patients [60]. However, it is recommended that transplantation surgery should not hold and should be deferred in a patient with COVID-19 [59, 60].

LIMITATIONS OF THE STUDY

As at the time of this review, and the period of literature search, only few literatures have been published on the subject of interest. This poses a limitation to this study. However, with rapid increase in the advancement in knowledge of the COVID-19 and the quest to understand better precautionary measures and management approaches of infected individuals daily, more insight will be gained, hence, the recommendations. Also, there may be unpublished works which are unavailable to us. A limitation of this study is the inability to address the management of non-COVID-19 surgical patients who need non-emergent life-saving treatment, for example, patients with chemosensitive tumors who need chemotherapy or patients with resectable malignancies. The implications of this neglect cannot be completely elucidated until the pandemic is over. Furthermore, the article does not address the anesthetic complications peculiar to COVID-19 patients that may arise postoperatively and how to manage them. In addition, the article does not address the peculiarities of managing COVID-19 in resource poor centers. Many of the materials and infrastructure needed to prevent the spread of the virus in developing countries are mostly unavailable.

RECOMMENDATIONS

Given the peculiarities of various medical facilities globally, and the differences in the resources available, we recommend that these protocols are modified to suit the various practicing conditions that may be in immediate reach of the physicians. Hence, the findings in this review present a guide to the elementary requirement for enhancing health workers' safety as they give their all to managing COVID-19 patients. We also advise that protocols and treatment guidelines are validated by heads of departments or any other local bodies capable of assuming such responsibility. Review of the treatment guidelines in various settings is done from time to time in order to ensure effectiveness and functionality. Therefore, treatment guidelines should be flexible enough to accommodate for adjustment when necessary. This is also a wakeup call to policy makers in resource poor nations to rise up to the challenge and provide necessary equipment to health care workers who would help mitigate the spread of the virus.

CONCLUSION

Emergency surgical procedure on a COVID-19 patient may be necessary in the course of care. Surgeons and other health care workers will give their best to COVID-19 patient care if their safety is guaranteed. Therefore, necessary and adequate protective measures must be put in place to ensure safety of perioperative team members.

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Data Availability

All relevant data are within the paper and its Supporting Information files.

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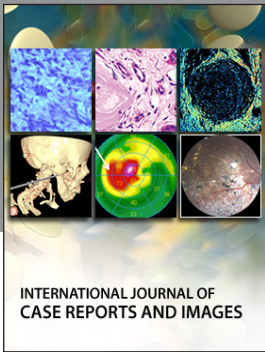
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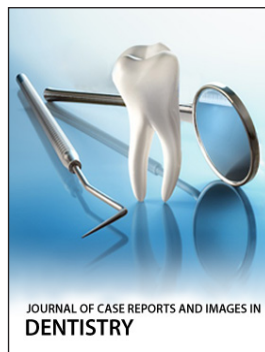
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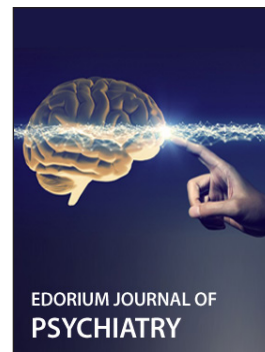
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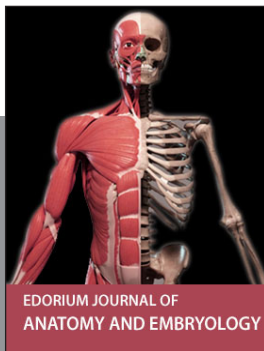
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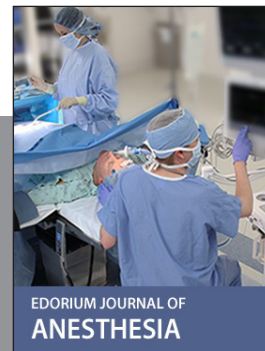
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