Review

ENT surgery during COVID-19 pandemic: Tips for safe surgery and how to prioritize them

Kadir Serkan Orhan, Cömert Şen, Levent Aydemir, Mehmet Çelik, Meryem Nesil Keleş Türel

Department of Otorhinolaryngology-Head and Neck Surgery, Istanbul University, Istanbul Faculty of Medicine, Istanbul, Turkey

ABSTRACT

The outbreak of coronavirus disease 2019 (COVID-19) has spread worldwide, causing health systems to collapse. The COVID-19 outbreak has disrupted outpatient and inpatient services, making it almost impossible for patients to access high-quality healthcare services. Additionally, there is a significant hesitation in the management of diseases in need of surgical treatment. Cancers, life-threatening infectious diseases, and injuries are cases where there is no option of treatment delay. Besides, mostly surgical methods are used in their treatment. Therefore, during the pandemic, hospitals need to reorganize themselves and continue to provide healthcare services that are not subject to postponement. While the COVID-19 outbreak continues, maintaining these services will put healthcare workers and patients at risk of transmission. Therefore, some articles about measures that hospitals and healthcare professionals should take were published. In this review, we developed a guide for the management of otolaryngological diseases which need surgical treatment.

Keywords: COVID-19, head and neck surgery, otorhinolaryngology, surgery.

In December 2019, several patients developed pneumonia and respiratory failure in Wuhan, Hubei Province, People's Republic of China, resembling the severe acute respiratory syndrome (SARS) epidemic in 2003.[1] On December 31st, 2019, officials of the Chinese government reported these cases to the World Health Organization (WHO).[1] A week later, it was announced that the cause of the cases was a new betacoronavirus called SARS-coronavirus 2 (SARS-CoV-2).[2] The SARS-CoV-2 (basic reproduction number [R0 value] about 2.5) caused coronavirus disease 2019 (COVID-19) that spread all over the world in a short time. Thus, the WHO declared a pandemic on March 11th, 2020.[3,4] A day earlier, Republic of Turkey, Ministry of Health announced the first COVID-19 case in Turkey.[5]

Fever, dry cough, shortness of breath, and myalgia are the most common symptoms of COVID-19. As the pandemic progresses, it has been reported that some patients may experience loss of smell and taste with or without other symptoms.[6-9] Therefore, it is crucial to question the loss of smell and taste in patients with suspected disease. Signs of pneumonia may develop on chest radiography or computed tomography (CT). Acute respiratory distress syndrome (ARDS), myocarditis, multiorgan failure (MOF), and even death are the most critical complications of the disease.[10-13]

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Correspondence: Cömert Şen, MD. İstanbul Üniversitesi İstanbul Tıp Fakültesi Kulak Burun Boğaz Hastalıkları Anabilim Dalı, 34093 Fatih, İstanbul, Türkiye.
e-mail: comert.sen@istanbul.edu.tr

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Transmission ability of the virus during the incubation period of approximately five days, as well as the patients having asymptomatic disease accounting for 30 to 50% of all patients, facilitates the spread of the disease and makes the control of the transmission difficult.[14,15]

While the pandemic changes our life in all aspects, its most dramatic effect is on health systems. The transmission characteristics of the virus has caused a rapid increase in the number of patients and the infected healthcare workers, leading to a decrease in the number of professionals providing healthcare. Therefore, the maintenance of healthcare services has been affected. In a significant portion of the patients, particularly in the elderly and patients with comorbidities, respiratory distress has developed, resulting in a need for intensive care. Thus, the number of available mechanical ventilators has become an essential issue for hospitals.

The viruses can be transmitted from person to person through droplets, aerosols, contact, and fecal-oral routes. The main transmission route of SARS-CoV-2 is thought to be by spreading large respiratory droplets carrying viral particles, which are formed during coughing, sneezing, and speech. These droplets stay in the air for a few seconds. They cover only a short distance before landing on the surfaces due to their weight. However, virus-bearing droplets occurring during certain procedures such as mask ventilation, intubation, tracheostomy, tracheal aspiration, and endoscopic examination may lose their amount of fluid and form the aerosols, mixing with the air. These aerosols can hang in the air for up to three hours. They stay on the surfaces even more time due to their lightness. The SARS-CoV-2 hanging in the air has been shown to cause extensive environmental contamination in negative-pressured rooms with COVID-19 patients, and viruses are detected on many surfaces including air vents.[16] Infection can also occur after inhalation of these aerosols or contacting the contaminated hands with the mouth, nose, or eyes.

Zou et al.[17] detected a higher viral load in the nasal cavity than the oropharynx, shortly after the onset of symptoms. Besides, they found that the amount of viral load of symptomatic patients was similar to that of patients with asymptomatic or mild symptoms. Based on these findings, the authors claimed that asymptomatic patients had a high likelihood of contagiousness. Therefore, the otolaryngologists may be exposed to a high viral load during routine physical examinations and interventional procedures, particularly in aerosol-generating procedures. One out of every seven new COVID-19 cases comprises the healthcare workers, including primarily emergency physicians, anesthesiologists, otolaryngologists, and pulmonologists.[17] Therefore, using appropriate personal protective equipment (PPE) is of utmost importance for healthcare workers.

Unfortunately, it is not possible to identify patients with COVID-19 during the incubation period using current diagnostic methods. It is also unknown how the surgical procedures under general anesthesia would affect the course of the viral disease in patients during this period. In the study which evaluated the outcomes of 34 patients who underwent miscellaneous surgeries during the incubation period of COVID-19, Lei et al.[18] reported that COVID-19 pneumonia occurred shortly after surgical procedures (one patient underwent laryngectomy, while the others had an orthopedic, brain, or general surgery). They also confirmed pneumonia with thoracic CT. The patients were operated on average 2.5 days after admission to the hospital, and COVID-19 symptoms appeared on Day 5. Dyspnea and ARDS developed 9.5 and 11 days after the first admission, respectively. The most common symptoms in these patients were fever (91.2%), weakness (73.5%), dry cough (52.9%), dyspnea (44.1%), and myalgia-arthralgia (32.4%). Fifteen of the patients needed to be taken care of in the intensive care unit (ICU), and seven of them died. The mean time to mortality was 16 days. Of note, the patients followed in the ICU were found to be older than the ones followed in the inpatient unit with more underlying comorbid diseases, more complicated surgery (longer surgery time), and poorer laboratory findings. According to this finding, it should be kept in mind that asymptomatic patients may be in the incubation period and, therefore, it is vital to take the safety precautions during pre-, and postoperative

period in terms of protection the healthcare workers from becoming infected, considering that all patients may be COVID-19-positive.

Currently, the fight against the virus has become the priority of health systems in many countries. Most of the healthcare services, except for emergencies, have been suspended. However, management of the diseases that may cause undesirable outcomes such as life-threatening emergencies and malignancies poses some difficulties in many aspects. The organization of outpatient services and surgeries during the COVID-19 pandemic can be challenging for physicians and hospital administrators. In this review, we present some information that may guide our colleagues in determining the priority of surgical procedures and performing safe surgical practices.

It is of utmost importance to determine the priority order of other diseases and to organize the healthcare system appropriately, as routine working system has been suspended, focusing only on the COVID-19 pandemic. Many guidelines and algorithms about the otolaryngological diseases have been reported in the literature, recently.[18-22] In this paper, we aimed to develop simple, understandable, and easy-to-apply algorithms recommended by the Turkish Society of Otorhinolaryngology and Head and Neck Surgery to increase the safety of both patients and healthcare workers against SARS-CoV-2.

Surgical procedures applied in the field of otolaryngology-head and neck surgery can be divided into four categories in order of priority.

Category A: Procedures for life-threatening emergencies. They must be performed within the first 48 hours.

Category B: Urgent procedures. They can be performed within the first month.

Category C: Non-urgent, but mandatory procedures. They can be postponed for three to six months.

Category D: Elective procedures; i.e., surgeries which may improve the quality of life or surgeries for aesthetic purposes They can be postponed for a year (Table 1).

The categorization of the procedures regarding the otology, rhinology, and head and neck surgery, based on the classification mentioned above, are presented in Tables 2, 3, and 4, respectively.[23-26]

Surgical procedures can be also classified in terms of transmission risk of the virus.[27] Viral exposure may increase by forming aerosols during upper airway surgeries, leading to an increased risk of transmission. Therefore, another classification can be made as aerosol-generating and non-aerosol-generating surgical procedures (Table 5).

PREOPERATIVE PREPARATION

Hospital preparations

It is reasonable to take multidisciplinary decisions for surgical procedures during the COVID-19 pandemic. Firstly, clean and dirty units should be determined while organizing the hospital and the outpatient units and operating rooms should be organized accordingly. If the hospital infrastructure is suitable, negative-pressured operating rooms should be reserved for COVID-19-positive patients.

Personal protective equipment

- N95/FFP2 and N99/FFP3 masks, goggles, face-shields, full-body covering gowns must be kept ready to use. Education about donning and doffing procedures of PPE must be given to healthcare workers.

Table 1. Classification of surgical procedures based on urgency

Category A	Procedures for life threatening emergencies	Within 24-48 h
Category B	Urgent procedures	Within 48 h-1 month
Category C	Non-urgent but mandatory procedures	Can be postponed for 3-6 months
Category D	Elective procedures. Surgeries that increase the quality of life or surgeries for aesthetic purposes	Can be postponed for 1 year

Table 2. Otology

Category A (Emergent surgeries) Must be performed within 24-48 hours	Category B (Urgent surgeries) Should be performed within 1 month	Category C (Non-urgent but mandatory surgeries) Should be performed within 1-6 months	Category D (Elective surgeries)
Surgeries for complications of otitis media (brain abscess, sigmoid sinus thrombosis, mastoiditis, facial nerve palsy, etc.)	Surgeries for traumatic facial nerve injury/Bell's Palsy with an indication for surgery	Surgeries for early stage cholesteatoma	Tympanoplasty/ Myringoplasty
Ventilation tube insertion for a complication of otitis media	Surgeries for traumatic cerebrospinal fluid otorrhea	Cochlear implantation for other indications	Stapes surgeries
	Advanced cholesteatoma surgeries	Cochlear implantation for the second side	Ossicular reconstruction
	Cochlear implantation after meningitis	Ventilation tube insertion for bilateral otitis media with effusion	Surgeries for small jugular foramen tumors
	Surgeries for malign tumors of the temporal bone (according to the decision of a tumor board)	Surgeries for large vestibular schwannoma causing brainstem compression	Surgeries for small vestibular schwannoma
	Decompression surgeries for tumors causing brainstem compression	Surgeries for vertigo resistant to medical treatment	Middle ear implantation
			Surgeries for bone-anchored hearing aids
			Ventilation tube insertion for unilateral otitis media with effusion

- Powered air-purifying respirators (PAPR) operate with a mobile electric motor that filters air and transmits it to the protective hood. However, it is not clear exactly how much this system reduces the risk of viral transmission.[20] The protection factor reported for PAPR varies depending on the filter types, between 25 and 1,000, while 10 for the N95 mask.[28] However, there are no reliable and comparative studies on this subject, yet. In our clinic, we have the opportunity to use PAPR in risky procedures. The main advantage of this system is that it increases the comfort of the user, as the air comes into the hood, thus nor sweating, neither misting problems occur. However, its main disadvantage is that the hoods are personal, and the new supply is not possible during the pandemic. Our recommendations and clinical practice are the use of the N99/ FFP3 or N95/FFP2 mask and PAPR, as there are not enough data available on the PAPR's protection factor. Thus, the risk of contamination can be minimized by providing dual protection.

The decision of surgical indication

- Firstly, it should be decided which group, as specified in Table 1, the patient belongs to. This decision can be solely up to the discretion of the physician in some cases. However, in complicated cases such as head and neck tumors, life-threatening

Table 3. Rhinology

Category A (Emergent surgeries) Must be performed within 24-48 hours	Category B (Urgent surgeries) Should be performed within 1 month	Category C (Non-urgent but mandatory surgeries) Should be performed within 1-6 months	Category D (Elective surgeries)
Surgeries for complications of sinusitis (orbital abscess, cavernous sinus thrombosis, meningitis, brain abscess, etc.)	Maxillofacial trauma surgeries	Surgery for paranasal benign tumors	Nasal polyposis surgeries
Surgeries for invasive fungal rhinosinusitis	Surgeries for paranasal benign tumors causing orbital or optic nerve compression	Cerebrospinal fluid rhinorrhea surgeries	Septoplasty/ Septorhinoplasty
Surgeries for bilateral choanal atresia (newborn)	Surgeries paranasal sinus malign tumors (according to tumor board decision)	Surgery for severe nasal polyposis resistant to medical therapy	Surgeries for antrochoanal polyps
Surgeries for epistaxis not manageable with conservative treatments	Optic nerve decompression surgeries	Surgeries for paranasal mucocele/mucopyocele (if symptomatic)	Osteoma surgeries
Surgeries for septal abscess/hematoma	Surgeries for nasopharynx malign tumors	Surgeries for paranasal fungal infections	Surgery for chronic sinusitis
Surgeries for paranasal foreign body (especially batteries)			Sleep surgeries
Surgeries for traumatic optic nerve injuries			Endoscopic dacriocystorhinostomy

infections, and anterior or lateral skull base lesions, joint decisions can be made with either intra-clinical or multidisciplinary boards. If a physical meeting cannot be held, meetings can be organized online, considering the patient and healthcare workers' safety.

- After the surgical indication is decided based on the classification as specified in Table 1, Table 5 should be referred to distinguish surgeries according to the viral transmission risk. Then, the team and the operating room should be organized (Table 6).

Preoperative patient preparation

- SARS-CoV-2 has a high transmission risk. Viral pneumonia can be fatal with MOF and related complications. The incubation period varies between 2 and 14 days (mean: 5 to 6 days).[14-16]
- The impact of surgery on the immune system which makes the patient vulnerable to SARS-CoV-2 is still unclear.
- It is essential to evaluate whether the patient has COVID-19 before surgery. Rapid diagnostic kits evaluating immunoglobulin (Ig) M and IgG against the virus, reverse transcriptase polymerase chain reaction (RT-PCR), low-dose thoracic CT, complete blood count, and biochemical parameters can be used for the diagnosis.
- Low-dose thoracic CT should be performed in all preoperative patients whether diagnostic testing is available or

Table 4. Head & Neck surgery[23-27]

Category A (Emergent surgeries) Must be performed within 24-48 hours	**Category B** (Urgent surgeries) Should be performed within 1 month	**Category C** (Non-urgent but mandatory surgeries) Should be performed within 1-6 months	**Category D** (Elective surgeries)
Tracheotomy (for life threatening upper airway obstructions)	Tracheotomy (for prolonged intubation or pulmonary hygiene)	Surgeries for benign head-neck tumors	Surgery for benign head-neck pathologies (branchial cleft cyst, Thyroglossal ductus cyst, schwannoma, lipoma, paraganglioma)
Surgeries for neck trauma (causing vascular, visceral or airway damage)	Surgeries for high grade head-neck malignancies	Surgeries for low grade head-neck malignancies	Surgeries for benign vocal cord pathologies (vocal cord polyp, Reinke's edema, granuloma, etc.)
Surgeries for infections of the deep neck spaces (if refractory to medical treatment and compromising airway)	Surgeries for infections of the deep neck spaces (if refractory to medical treatment)	Surgeries for Graves disease refractory to anti-thyroid medication	Surgeries for benign salivary gland pathologies (sialolithiasis, mucocele, ranula, etc.)
Surgeries for laryngeal foreign body	Biopsies in case of malignancy suspicion (Larynx, Hypopharynx, etc.)	Surgeries for goiter narrowing trachea to a <1 cm diameter or substernal goiter	Surgeries for thyroid cancer without metastasis and airway obstruction
	Lymph node excision (In case of lymphoproliferative disease suspicion when Tru-Cut biopsy is non-diagnostic)		Surgeries for basal cell carcinoma
	Salvage surgeries		

Table 5. SARS-CoV-2 transmission risk classification of surgical procedures

Virus transmission risk levels of operations	
High risk (Aerosol-generating procedures, AGP)	Aerosol generating surgical procedures. Upper airway surgeries and otologic surgeries that require the use of drill.
Low risk (Non-aerosol-generating procedures, NAGP)	Non-aerosol-generating, soft tissue procedures. Procedures not dealing with airway or middle ear/mastoid mucosal surfaces.

not, according to the Republic of Turkey, Ministry of Health guidelines.

- There may not be enough time to perform COVID-19 diagnostic tests preoperatively in Category-A surgeries. In such cases, the symptoms and thoracic CT findings of the patient are evaluated. If the patient is not suspected of COVID-19, he/she is taken in a clean operating room. The operation is carried out with maximum safety precautions.
- Category B surgeries can be postponed for 10 to 14 days, since the disease may be in the incubation period. The patients may be quarantined (at home or in the hospital) during this period.

Perioperative precautions

Conditions to be questioned in surgical planning during the COVID-19 pandemic

- The urgency of the surgical procedure
- Type of surgical procedure
- Availability of PPE
- COVID-19 status of the patients
- Conditions of the operating rooms

Table 6. Patient management

	Category A (Emergent surgeries) Must be performed within 24-48 hours	**Category B** (Urgent surgeries) Should be performed within 1 month	**Category C** (Non-urgent but mandatory surgeries) Should be performed within 1-6 months	**Category D** (Elective surgeries)
Aerosol-generating procedures (AGP)	**COVID-19 (+) patient** The procedure is performed in a COVID operating room. 1. PAPR + N99 (For otologic surgeries that require drilling, use of microscope with N99 + surgical mask + goggles is suggested since the use of PAPR is difficult when drilling.) 2. Protective overalls 3. Double gloves **COVID-19 (-) patient** The procedure is performed in a clean operating room. The possibility of being in the incubation period should always be kept in mind. 1. At least N95 + surgical mask 2. Protective overalls 3. Goggles 4. Double gloves **COVID-19 test results are not obtained or unknown** The procedure is performed in a clean operating room. 1. PAPR + at least N95 mask (For otologic surgeries that require drilling, use of microscope with N95 + surgical mask + goggles is suggested since the use of PAPR is difficult when drilling). 2. Protective overalls 3. Double gloving	**COVID-19 (+) patient** If possible, postpone the procedure until COVID-19 treatment of the patient is over. If RT-PCR (-), regression in viral pneumonia is observed, and the patient's condition is favorable, the procedure is planned in a COVID operating room because it is shown in some studies that transmission might continue for a long time. 1. PAPR + N99 (For otologic surgeries that require drilling, use of microscope with N99 + surgical mask + goggles is suggested since the use of PAPR is difficult when drilling.) 2. Protective overalls 3. Double gloves **COVID-19 (-) patient or the status is unknown.** The patient is quarantined at home or in the hospital for 14 days preoperatively. Contact isolation precautions are applied during this period. The procedure is performed in a clean operating room. 1. N99 + surgical mask 2. Protective overalls 3. Goggles 4. Double gloves	Postpone the procedure for 3-6 months or discuss alternative treatments to surgery with a multidisciplinary board (such as medical treatment, local administrations, radiotherapy or chemotherapy).	Postpone the procedure until the pandemic is over.

Table 6. Continues

	Category A (Emergent surgeries) Must be performed within 24-48 hours	**Category B** (Urgent surgeries) Should be performed within 1 month	**Category C** (Non-urgent but mandatory surgeries) Should be performed within 1-6 months	**Category D** (Elective surgeries)
Non-aerosol generating procedures (NAGP)	COVID-19 (+) patient The procedure is performed in a COVID operating room. 1. N99 + surgical mask 2. Protective overalls 3. Goggles 4. Double gloves COVID-19 (-) patient The procedure is performed in a clean operating room. The possibility of being in the incubation period should always be kept in mind. 1. N95 + surgical mask 2. Protective overalls 3. Goggles 4. Double gloves COVID-19 test results are not obtained or unknown The procedure is performed in a clean operating room. 1. N99 + surgical mask 2. Protective overalls 3. Goggles 4. Double gloves	COVID-19 (+) patient If possible, postpone the procedure until COVID-19 treatment of the patient is over. 14 days after the end of the COVID treatment, if RT-PCR is (-), regression in viral pneumonia is observed, and the patient's condition is favorable, the procedure is planned in a COVID operating room because it is shown in some studies that transmission might continue for a long time. 1. N99 + surgical mask 2. Protective overalls 3. Goggles 4. Double gloves COVID-19 (-) patient or the status is unknown. The patient is quarantined at home or in the hospital for 14 days preoperatively. Contact isolation precautions are applied during this period. The procedure is performed in a clean operating room. 1. N95+ surgical mask 2. Protective overalls 3. Goggles 4. Double gloves	Postpone the procedure for 3-6 months or discuss alternative treatments to surgery with a multidisciplinary board (such as medical treatment, local administrations, radiotherapy or chemotherapy).	Postpone the procedure until the pandemic is over.

Clean and dirty operating rooms should be determined, and triage should be performed according to the patient's infection status. Patients with a positive COVID-19 test or suspicious clinic should be operated in dirty operating rooms, while the patients with negative test results or without clinical suspicion should be operated in clean operating rooms.

In cases of suspected or confirmed COVID-19 and after the decision of that the procedure is emergent or urgent, the surgeon should determine which PPE to use according to aerosol-generating potential of surgery. The PAPR, full-body covering gowns, long shoe covers, and double gloves should be preferred in the procedures having a high risk of aerosol formation. In the microscopic surgeries, which are not suitable for PPAR use, it is appropriate to wear an N99/FFP3 mask covered with a surgical mask, instead of the PAPR. The protective goggles, full-body covering

gowns, long shoe covers, double gloves, and an N95 mask is thought to be adequate in low-risk surgeries which do not generate aerosols.

In COVID-19 (-) cases, considering the possibility of being in the incubation period, an N95/FFP2 mask, goggles, full-body covering gowns, shoe covers, and double gloves equipment should be provided.

Negative-pressured rooms have been reported to minimize the risk of infection transmission in previous studies.[29,30] However, as the regular operating rooms have positive-pressured ventilation systems, the air circulation cycle becomes essential. This cycle is dependent on the number of air exchange/h of the room. This number should be increased the level of at least 25 exchange/h.[31]

The door of the operating room must be always closed, and additional personnel must not be allowed to enter the room in the intraoperative period. The delivery of surgical materials to the operating room from outside must be also prevented during surgery. Therefore, the scrub nurse should prepare the surgical table in cooperation with the surgeon before surgery begins. Related personnel should not leave the room during surgery. All surfaces which may be contacted, including electromedical devices, should be covered. The surgical team covers the patient according to the procedure. All personnel who contact with the patient must always wear double gloves while working. Before the next operation starts, it should be waited as much time as possible for air circulation of the room to minimize the risk of airborne transmission. The waiting time is dependent on the number of air exchange/h. The air exchange cycle should be increased to at least 25 exchanges/h.[31] All areas at risk of contamination in the room should be cleaned and disinfected. The tissue samples planned to send to the pathology department should be marked with warning signs to minimize the risk of contamination. However, there are no data on the viral particles of COVID-19 in body fluids or tissue samples, yet.

Postoperative care

After the operation, COVID-19 patients should be taken to ICU or inpatient ward designated for the COVID-19 pandemic. They should be followed according to individual protocols of each healthcare center. Patients without a suspected or confirmed COVID-19 diagnosis should be treated in the clean units.

Postoperative fever or pulmonary complications may lead to misdiagnosis and make the patients' recovery difficult. In patients with postoperative pulmonary symptoms, the differential diagnosis includes infectious pneumonia, aspiration pneumonia, pulmonary embolism, and pulmonary edema. Some diagnostic tests may be also required for further management of the patients. It is important to be able to treat suspected COVID-19 patients by making the correct diagnosis and prevent the spread of the virus during the current outbreak.

If COVID-19 infection has not been confirmed, no specific treatment is required for SARS-CoV-2. The diagnosis and treatment of other diseases which may cause fever or pulmonary complaints should be managed.[32] Thoracic CT screening and RT-PCR testing should be performed for patients with high risk who develop postoperative fever and cough. Patients diagnosed with a suspected or confirmed COVID-19 during the postoperative care should be transferred to the pandemic units, and adequate oxygen supply and medical treatment should be provided. These patients have a significant risk for complications such as deep vein thrombosis and secondary pulmonary infections. They are also candidates for nutritional problems and multiorgan damage. If patients have more than three-day period without fever and the respiratory symptoms are significantly reduced or the infection markers become normal level, RT-PCR, and antibody tests can be performed. If these tests yield negative for two times (recommended sampling interval ≥24 hours), isolation measures can be removed and the patients can be transferred to the clean units or discharged.[33]

In conclusion, surgical planning during the current outbreak should be done in a collaborative way. The surgical team, anesthesia team, and nurses should be worked together, and every member of the team should be fully aware of their role in advance of operations. Safety precautions should not be compromised.

Healthcare workers should be educated about all issues regarding protecting themselves and patients against potential risks of COVID-19.

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