

SYSTEMATIC REVIEW**Surgical Practice in the Shadow of COVID-19 Outbreak**Reza Abdi, MD¹; Reza Shojaeian, MD¹; Sara Hajian, PhD Candidate²; Shahrzad Sheikh, MD¹*Research performed at Clinical Research Development Unit of Akbar Hospital, Mashhad University of Medical Sciences, Mashhad, Iran
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Abstract

Background: COVID-19 epidemic rapidly spread all around the world with over 1500 thousand infected cases and 95000 deaths. This rapid pandemic may overwhelm health care capacity and shortage of resources is a major concern. Literature provided guidelines on management of COVID-19 patients but healthcare service to the normal population should be continued meanwhile. Health system should act immediately and wisely to support essential surgical care while fighting against COVID-19.

Methods: We conducted a comprehensive search in the major data bases since 2020, using the combination of MeSH words of "COVID-19 " and "surgery" and finally 34 full texts entered to data extraction phase to define a plan for surgical practice during COVID-19 pandemic.

Results: Healthcare workers are at the higher risk of contamination by COVID-19 especially in early stage of outbreak when they were not aware of the different aspects of COVID-19 pandemic. All healthcare staff must be trained to properly use PPE. All patients have to be screened at the hospital triage. All elective surgical interventions must be postponed. Operation room is considered as a place with high risk of cross infection so the highest level of protection should be maintained. Anesthesia, endoscopy and oral surgery are considered as aerosol producing procedures with very high risk of contamination. There is not any evidence to support the risk of infection trough blood products. Postoperative respiratory problems are more common among COVID-19 patients that may increases the estimated risk of morbidity and mortality.

Conclusion: COVID-19 pandemic is a dynamic challenge for health system to save the healthcare staff and equipment resources by timely decisions. Healthcare workers are at the higher risk of contamination by COVID-19 especially in early phase of epidemic when the protection is sub-optimal.

Level of evidence: III

Keywords: Coronavirus, COVID-19, Outbreak, Pandemics, Surgery

Introduction**COVID 19 outbreak and it's prospective**

On 30th January 2020, World Health Organization (WHO) declared the state of emergency on a new coronavirus outbreak, which is called SARS-CoV-2 with its associated disease of COVID-19 (1-3). COVID-19 epidemic started from Wuhan, China, and rapidly spread all around the world with over 1500 thousand infected cases and 95000 deaths. This raise a major concern

for many countries struggling with the Coronavirus outbreak in order to managing their human resources and delivering appropriate care to people in need (4).

COVID-19 is considered highly contagious with an estimated mortality rate of 3.4% (5). The possible routes of COVID-19 human to human transmission are mainly documented as direct contact, respiratory droplets and touching the contaminated surfaces.(1, 6) Feco-

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oral route, vertical route through mother to child or transmission during breast feeding in addition to infected blood products are yet to be assessed (2, 7, 8).

COVID-19 is supposed to be not only asymptomatic during its incubation period (for up to almost two weeks), but also highly contagious that will make the control of COVID-19 outbreak more challenging (9). Fighting with COVID-19 pandemic is a dynamic challenge. The governmental strategies must promote the safety and health of the community while avoiding panic state (10).

Published literature has provided guidelines on management of COVID-19 patients along with protocols for infection control. Health systems should act immediately and wisely to support essential surgical care to protect patients and staff against COVID-19 (11). Thus, we conducted a review of literature to propose a plan for surgical practice during COVID-19 pandemic.

Materials and Methods

A comprehensive search was conducted through the major data bases including PubMed central, Scopus, EMBASE, SciELO, Cochrane Database, and google scholar from beginning of 2020 to 5 April 2020, using the combination of MeSH words of "COVID-19" and "surgery".

The eligibility criteria consisted of English language articles focusing on COVID-19 from the surgical point of view in human population. From 2190 identified articles, a total of 62 studies were included by reading the titles and abstracts. Letter to editors, view points and duplicated articles were excluded. After applying the eligibility checklist, 34 full texts entered to data extraction phase.

Results

Health care staff and COVID-19

Healthcare workers are at the higher risk of contamination by COVID-19 especially at the early stage of outbreak when they are not aware of the risks of COVID-19 and the personal protections are suboptimal (1)(12). At the beginning of the epidemic, about 30% of the infected cases in Wuhan were healthcare workers (6). It has been stated that continuous exposure to high concentration of virus may increase the risk of transmission, significantly (13).

All hospital staff should strictly stick to the infection prevention rules, highly dedicated to hand hygiene and using the personal protective equipment (PPE) (2). The minimum standard of PPE for those who take care of COVID-19 patients consists of NIOSH certified N95 respirator (or equivalent such as FFP2 standard), personal goggles, full face shield, cap, gown, and gloves (1). It is crucial to fit the mask properly; for instance, beard is required to be shaved (14). The role of shoe cover in infection prevention is not clear and there is no evidence regarding COVID-19 contamination by footwear (15).

All healthcare staff must be trained to properly use provided PPE and how to remove, store, and disinfect their PPE (1). The risk of contamination at the time of removing PPE is considerable (16). Standard tight fitted face mask is the most effective protective equipment which is essential for all health workers in COVID-19

ward (17).

Hospital staff who take care of COVID-19 patients must be separated from those who are responsible for other patients. Working shifts must balance to avoid healthcare providers burnout (4). All clinical staff must focus on control of the new COVID-19 outbreak and other outpatients while all elective services must set to the minimum level (4). Pregnant and immunocompromised healthcare providers should not get involved in the management of COVID-19 patients (1).

Body temperature of all staff must be checked at the hospital entrance and twice daily. Those who develop fever have to be assessed for respiratory signs and symptoms of COVID-19 and remain in quarantine until the COVID-19 PCR test be performed (1).

Reforming of a general hospital in COVID-19 outbreak

All patients have to be screened at the hospital triage aiming to protect the healthcare staff and identifying infected patients (12). Although less than half of COVID-19 positive cases may develop fever at the early stages, temperature monitoring must be performed at the entrance for all visitors. As fever focused surveillance may fail to identify all patients, it should not be considered as a reliable pre-operative screening method (12).

A standard questionnaire have to be designed focusing on primary evaluations such as self-declaration of an affected family member, direct contact with a COVID-19 infected person during the last two weeks, history of travelling to highly affected areas, symptoms such as fever and chill, fatigue, dry cough, headache or sore throat, and signs of acute respiratory disease including shortness of breathing, tachypnea and low O2 saturation (12). Highly suspicious cases are candidates for the PCR test and chest tomography (12). It is also recommended to separate the waiting area from examination room and schedule the outpatients with reasonable intervals to avoid hospital crowding (12).

Healthcare staff and protective equipment's shortage is an anticipated hazard that may increase the mortality rate during a rapid progression of COVID-19. Therefore, high standard protective equipment and the most expert personal must be reserved to use in COVID-19 isolation ward and ICU (4). Trainees should be set aside from clinical services during COVID-19 outbreak and benefited from on-line teaching methods (11).

Surgery wards and preoperative course during COVID-19 outbreak

As the prospective of COVID-19 pandemic is yet unclear, we have to get ready for its long-term consequences. We must have clear plans and protocols to manage the patients who need surgical interventions (16). In this light, it is suggested to categorize all surgical interventions into three main groups:

1. Emergency surgery that should be performed immediately in a lifesaving situation such as trauma surgery, fractures, burns, acute abdomen, testicular torsion, foreign body aspiration and ingestion and most congenital anomalies.

2. Urgent cases or limited time surgery that the pathology

is rapidly progressing to a constant adverse effect such as cancer surgery, Biliary Atresia, Cholelithiasis and etc.

3. Elective surgery that could be planned for several months later without any considerable risk such as inguinal hernia, reconstructive surgeries, bariatric surgery and etc (2).

It is suggested to postpone all elective surgeries and endoscopies at the early stage of COVID-19 outbreak to save the health care providers for the anticipated overwhelming phase. Limiting the surgeries to the emergencies at the growing phase of the disease will help reducing the personal contacts as a major step to decrease cross infections between the care providers, inpatients, and outpatients (1, 5, 16). This strategy was succeeded to prevent 2445 new infections over a month in Washington state according to a model analysis (5). Urgent surgeries can be resumed gradually during the steady state of the outbreak for unaffected patients or after two consequent negative PCR test for a recovered COVID-19 patient (2).

It should be mentioned that patients are asymptomatic during the incubation period of COVID-19 while they are highly contagious. Performing surgery in this phase may accelerate COVID-19 course and increases the morbidity and mortality rate of surgery significantly (A reported mortality rate of 20% and almost 44% ICU admissions) (9). However, all these considerations should not delay an emergent surgery for a suspected COVID-19 patient (16).

Hospital stay must decrease to the shortest possible during COVID-19 outbreak to save the hospital capacity and decrease the risk of transmission and contamination. Thus, it is recommended to perform laboratory tests and imaging before hospital admission (1). Body temperature should be monitored every four hours for all patients during COVID-19 outbreak to detect any febrile patient for further evaluations (12).

It is recommended to keep physical distance in surgery wards and design single bed rooms as it is possible (2). It is suggested to open the windows for an hour twice a day for natural ventilation and ward daily decontamination. Positive SARS-CoV-2 samples has been detected in various locations around the COVID-19 patient's room, including the patient's bed, sink, bathroom, light switches, and doors (6).

Operation room during COVID-19 outbreak

It is recommended to re-design the operation theater to specify a marginal room with separate entrance and recovery for COVID-19 cases. This part must fully equipped with necessary instruments and drugs to avoid further movements between the two separated sections in the operation theater (19). Alarming signs are needed to emphasize on the high level of protection in this area. The operation room for COVID-19 patients should be ventilated by negative pressure system at -5Pa while connected to a high efficacy particulate air (HEPA) filter. If this is not available, a marginal room with the best ventilation condition is preferable. Laminar flow must be turned off during the surgery. It is also suggested to cover all the instruments and equipment by plastic sheets and

move out all unnecessary equipments (16).

Disinfection procedure in this section should be performed three times a day at least for 30 minutes each time and also after confirmed COVID-19 contamination (16). Sodium hypochlorite solution (2000 mg/L chlorine concentration), Plasma air sterilizers, 1% hydrogen peroxide air spray, and ultraviolet lamp can be used for disinfection of the operation room during COVID-19 outbreak (16, 20). Grossly contaminated instruments should be cleared and disinfected by 5000 mg/L chlorine solution (16).

The operation room is considered as a place with high risk of contamination and cross infection. COVID-19 could be transmitted via respiratory tract aerosols spreading during intubation, suctioning and endoscopies or even by droplets in laparoscopic gas. As smoke could produce during cauterization, it is recommended to set the electric knife to the minimum effective power with a smoke suction device (2, 11, 16).

The highest level of protection should be maintained in COVID-19 operation room consisted of covering all polyethylene-coated fabric gowns, either N95 respirator plus face shield and apron or powered air-purifying respirator (PAPR) when needed such as aerosol producing procedures (17, 21). A report from Singapore indicated zero rate of surgical team cross contamination by using surgical or N95 mask for protection in spite of presenting near patients at the time of intubation (18).

Double gloves is recommended in operation room or COVID-19 designated ward in order to change the outer pair when contaminated (1). The surgical team must drink enough water before wearing PPE to avoid dehydration during operation (18). Wearing full PPE could interfere with personal communication during operation as the voice becomes baffled and hearing and lateral vision may become limited. The surgical team have to be sure to understand each other clearly to keep the safety (22).

A straightforward open surgery is superior to minimally invasive procedures during COVID-19 outbreak because of easier preparation and device sterilization, shorter operation time, and lower risk of contamination (2).

Anesthesia

Anesthesia team are at high risk of cross infection as intubation and even electrocardiogram electrode placement have been identified as high risk exposures (14). Supplemental Oxygen is better to be provided by nasal cannula covering with face mask while venture mask is discouraged (1).

Regional anesthesia is superior to general anesthesia for a patient with confirmed COVID-19 infection. This procedure should be adopted regarding the standard protocols for those cases that a perfect anesthesia could be provided by regional techniques (1).

Droplet and contact precautions are suggested in providing a routine care while at the time of aerosol generating procedure such as intubation, the highest level of protection by antiviral PPE including well fitted N95 respirator, face shield, gown, and double gloves are recommended. Meticulous hand hygiene is essential

before and after the exposure. The number of personnel should be limited at the time of induction and intubation (23). If general anesthesia is inevitable, HEPA filter should be connected to the respiratory circuit. Five minutes of pre-oxygenation with 100% oxygen and adequate muscle relaxation is recommended (23). Rapid sequence induction is recommended followed by removing the facial mask at full expiration and endotracheal intubation by the most expert operator (1, 23, 24). Using video laryngoscope is beneficial to increase the safety and success of intubation. It is suggested to cover the patient's mouth and nose with a double layer wet gauze (2, 19). The tracheal tube cuff should be inflated after confirmation of correct intubation (1). Small tidal volume should be used for ventilation support to avoid lung injury in vulnerable COVID-19 patients (24).

Close line suction is more preferred rather than frequent tracheal suction (1). Tracheal tube should be clamped before disconnecting from the anesthetic machine (1). Finally, COVID-19 suspected patients should be fully recovered in operation room before transmission to isolation ward (19).

Specific considerations for surgical interventions during COVID-19 outbreak

• Endoscopic procedures

Given a high risk of contamination in both upper and lower endoscopies, they are considered as aerosol producing procedures that necessitate the highest level of protection against COVID-19 (6).

• ENT

Nose and throat examination are considered as high risk interventions and suggested to be deferred during COVID-19 outbreak. In case of emergency, extensive local anesthesia by anesthetic spray is suggested to suppress the coughing reflex and nausea (12).

Tracheostomy may be needed for a COVID-19 patient which is a high risk intervention. It should be performed under maximum protection including PAPR system.

• Urology

COVID-19 has been detected in urine specimen in 6.9% of COVID-19 patients. Although, there is no evidence supporting disease transmission by urine contamination (25).

• Orthopedics

Although blood contamination has not been approved as a route for COVID-19 transmission, orthopedic tools such as hammer and drill are aerosol-producing devices (7). Plasma PCR had been negative in COVID-19 patients. It seems the orthopedic surgery could be considered less hazardous for HCP. American Academy of Orthopedic Surgery recommends elective surgery to be performed depending on the location, curve of disease, availability of personnel and resources (PPE, ICU bed, etc.) while it is rational to defer elective surgeries (26).

• Pediatric surgery

It was believed that children are less susceptible to

COVID-19 as just 1% of identified cases were younger than 10 years in primary reports (27). Although, several asymptomatic infected children were identified in family clusters of COVID-19 patients by the widespread availability of COVID-19 tests and extensive screenings (28). These asymptomatic carriers are considered as potential sources of COVID-19 transmission as well as a serious risks for health care staff specially during early phase of COVID-19 outbreak (29, 30).

• Oral surgery and dentistry

Dentists are the workers most exposed to the high concentrations of infected aerosols and splatters transmitted during dental procedures (31). In addition to the general guidelines for preventing the transmission of Covid-19, in case of dental emergencies in order to relieve pain or control an infection such as dento-alveolar trauma, progressive facial space infection and root canal therapy, some specific percussions should be followed (32). The use of pre-procedural mouth rinse with oxidative agents such as 1% hydrogen peroxide or 0.2% povidone-iodine, use of disposable devices, rubber dam isolation, the anti-retraction high-speed hand pieces and high volume saliva ejectors are recommended (13). Extra-oral dental radiographies, such as panoramic radiography and cone beam CT, absorbable suture after tooth extraction and use of chemical agents and manual instruments instead of rotary ones are appropriate alternatives (10). Special attention should also be paid to disinfecting prosthodontics materials such as impressions with at least middle level disinfectants (33). Not to mention, the supine position with posterior local anesthesia could be useful in preventing patients' gag reflex and its consequences (33).

Maintaining blood products supply during COVID-19 outbreak

Potential risk of COVID-19 transmission through contaminated blood products is an unproven theory (7). However, patients with respiratory symptoms and signs, COVID-19 patients even after recovery, those with direct contact to a confirmed case of COVID 2019 and those who declare traveling to highly infected areas should be refrained from blood donation at least for 28 days (7).

Regarding the anticipation on the shortage of blood products during COVID-19 outbreak, the strategy of encouraging healthy donors, testing of blood supply from suspected or symptomatic donor, Pathogen Reduction Technologies (PRTs) for plasma and platelet resources should be applied (7). Standard laboratory and clinical safety regulations against COVID-19 should be maintained to ensure about mitigating the risk of contamination and cross infection during blood donation (7).

Postoperative course

Patient transportation to operation room or other sections should be with the least accompanying person and with minimal contact, if possible. The patient should wear a face mask and the nurse is in full PPE (1, 19). A highly suspected or confirmed case of COVID-19 must be transferred to the negative pressure isolation ward for

acute respiratory disease (12).

Postoperative respiratory problems are more common among COVID-19 patients that may increase the estimated risk of morbidity and mortality (16).

It is suggested to substitute the routine frequent post-operative visits with online checking of patient's documents on hospital electronic information system (HIS) and short daily visits or phone calls (1). Viral shedding will be continued even after recovery from COVID-19 acute phase (34).

While Anti-emetics and a perfect pain control is recommended during post-operative period, NSAIDs such as ibuprofen should be avoided in course of COVID-19 as an analgesic or antipyretic agent (16). Coughing should be suppressed aggressively and inhalers are superior to nebulized medications to reduce the risk of droplet spreading (4).

Discussion

- COVID-19 pandemic is a dynamic challenge for health system and each country should have a clear estimation of its health service potential and equipment resources to make effective timely decisions.
- Healthcare workers are at the higher risk of contamination by 2019-nCoV especially in the early phase of epidemic when the protection is sub-optimal. Medical centers, clinics, and general hospitals should

be re-designed to cope with this highly contagious pandemic to decrease the risk of cross contamination to the minimum level.

- Surgical interventions should be categorized into emergent, urgent, and elective procedures while elective interventions must be postponed.
- Anesthesia, Endoscopies, and oral surgeries are considered as aerosol producing procedures that necessitate maximum level of protection.
- The health policy makers and all healthcare staff must consider the risk of shortage in resources during COVID-19 outbreak and try to be prepared and responsive.

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