

Special Article

How to Manage Perioperative Patient Flow during COVID-19 Pandemic: a Narrative Review

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Abstract

The COVID-19 pandemic due to the novel Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV2) has affected many aspects of the health system. One of those groups that are at very high risk are those health care personnel (including physicians, nurses, and managerial personnel) delivering the perioperative care; including preoperative care, intraoperative care and postoperative care. This is the same challenge for the patients who need to be admitted in hospital while they are feared of being affected by SARS-CoV2. This review considers the safety precautions for perioperative protection of healthcare personnel and patients based on the available evidence.

Keywords: SARS-CoV2, COVID-19, personal protection, infection control, safety precaution, perioperative care

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Introduction

The novel Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) pandemic started in December 2019, in Wuhan, Hubei Province, China. However, this newly emerged member of the Coronaviridae could create one of the greatest world challenges in the last decades, known as Corona Virus Disease 2019 (COVID-19). Health system in all countries is undoubtedly one of the most sections hit by COVID-19 (1-3).

Besides managing the COVID-19 patients, health sector has to manage the other health issues, including other communicable diseases and also, non-communicable problems. Hospitals, Day care settings and outpatient are among the most important section of the health system that should be managed.

Though a considerable part of elective procedures and patient could be postponed, the remainder need to be managed as emergent, semi emergent or urgent patients.

How to manage these patients is a critical issue not only for the health system managers and healthcare personnel but also for the patients and their families; since the chance for human to human transmission is high for the novel SARS-CoV2 (4-6).

However, studies in China have demonstrated that following strict and rigorous infection control guidelines could lead to a low infection rate in the perioperative period; especially in the health care workers; though anesthesiologists, intensivists and nurses who work in ICU or OR are at increased risk; mandating sophisticated care (5, 7, 8).

This manuscript discusses the available evidence regarding patient management in the perioperative period in 4 parts:

- General recommendations
- Preoperative consideration
- Intraoperative consideration
- Postoperative considerations

In addition, each part considers both healthcare personnel and the patients. However, the audience should consider that due to the relatively short time from the start of the COVID-19 outbreak, the level of available evidence is not generally high worldwide; so, these are considered the least level of precautions.

The study proposal was assessed and approved by Research Ethics Committee, Shahid Beheshti University of Medical Sciences, Tehran, Iran; coded: IR.SBMU.RETECH.REC.1399.014.

General considerations

Viral dynamics of the novel SARS-Cov2 virus has demonstrated a strong relationship between mean viral load and severity of the disease; the viral load has been demonstrated to be about 60 times higher in severe cases than that of the mild cases; severe COVID-19 are often defined modified from the "Practical Guideline of the American Thoracic Society and Infectious Diseases Society of America" as (9-11):

1. respiratory rate ≥ 30 breaths/minute, demonstrating respiratory distress
2. SpO₂ (Arterial Saturation of Oxygen) at rest $\leq 93\%$
3. PaO₂/FiO₂ ≤ 300 mm Hg
4. More than 50% filling of the lung fields with infiltrations within 48 h
5. Severe COVID-19 complications (including but not limited to respiratory failure, obligatory need for mechanical ventilation, septic shock, other organ failure except for respiratory system)

However, pre-symptomatic transmission is likely in COVID-19 patients (12-14); though, there are studies demonstrating that viral load is one of the most determining factors in both strength and duration of transmission (15); besides, as mentioned above, this should not make a false counterfeit sense of safety (i.e. fake safety) regarding those who have mild symptoms or are symptomless.

With all these precautions in mind, a high viral

load means higher chance for transmission; and from a practical point of view, there are especial patient groups that have a higher chance of virus transmissibility because of higher serum viral load, in which more protective measures are mandatory (9, 15-18); while not forgetting to protect against the others (Table 1).

Perioperative period, especially in major surgeries, mandate considering blood reservation. Which precautions should be considered when ordering blood or products? As a matter of fact, there are both similarities and differences between SARS-CoV2 and its previous family members; i.e. SARS-CoV and MERS. The blood banks should consider all safety precautions in collecting, producing and providing blood and its products (14). In addition, clinicians should be aware of these risks. Also, they should remember that during the epidemic, the process of blood donation might become disturbed leading to decreased available blood and its products especially for the rare groups. Keeping in mind that unless a vaccine or effective therapeutic agent is manufactured and distributed worldwide, the COVID-19 pandemic would probably become an endemic state. So, these considerations should be learned at least for a while.

Regarding Personal Protective Equipment (PPE) the current pandemic best matches Level C of National Institute for Occupational Safety and Health (NIOSH) classification. The full description of this classification is beyond the scope of this text (19-21). However, the following recommendations are the least necessary ones (Figure 1):

1. PPE is a rule for health care personnel; no one should bypass it before providing care; both for the own protection and also, for protecting others
2. In order to guarantee the appropriate method of PPE, each healthcare personnel should be supervised and assisted for correct application of PPE before entering high risk areas (including areas with aerosol-generating procedures including endotracheal intubation, non-invasive ventilation, manual mask ventilation before intubation especially with positive pressure ventilation, cardiopulmonary resuscitation, tracheostomy and bronchoscopy, application of high flow nasal cannula "HFNC"; etc.) (22, 23)
3. After termination of the procedure, i.e. during the

process of PPE removal, another one should just supervise him/her; this time the second person should not assist; just supersession is required (22, 23)

4. After removal of PPE, some sources have recommended taking shower and using disinfectants for mouth, nose and external ear/external auditory canal (23)
5. Timely use of intubation and invasive ventilation support is preferred to HFNC and Bilevel Positive Airway Pressure Ventilation "BiPAP" in some references; though more studies are still needed; according to Meng, et al. "timely, not premature, intubation is the keyword in decision-making" of COVID-19 patients (23, 24).

Preoperative period

The preoperative period should be shortened as much as possible. Routine and sophisticated evaluations should be changed to necessary and essential ones. Besides, telemedicine services using social media and other approaches should be used as much as possible in preoperative setting (25).

However, there is risk of viral transfer through human-to-human transmission. All the patients should have face masks when transferred to the operating room (26). The patients and health care personnel both inpatient and outpatient should consider social distancing with at least 6 feet distance, personal protective equipments (Level C) and consider environmental safety precaution regarding sterility over the surfaces and ventilation of the closed spaces. Those patients with higher transmissibility (Table 1) should receive more precautions while others should not be neglected.

For patients undergoing any surgical operation, a thorough baseline evaluation of the organ systems with specific COVID-19 target organs (including but not limited to the respiratory system, cardiovascular system, genitourinary system and the neurologic system) should be performed during preoperative evaluations (27, 28). Besides, a thorough examination of the airway is even more important than the normal situation since especial maneuvers should be done for safe intubation of COVID-19 patients with minimal spread of the viral agent into the operating room

atmosphere; this is discussed more in Tables 2 to Table 6 (22, 29).

Intraoperative care

The design of the operating room (OR) should be checked. If there is possibility to separate the COVID-19 confirmed cases, there should be a separate OR for these patients or part of the OR should be divided and protected for these patients; otherwise, all parts of the OR need to be managed with full protection protocols since in such conditions, both COVID-19 patients and non-COVID-19 patients and all the health care personnel are present in the same atmosphere (30-33). In addition, there are a number of important safety precautions for safety and infection control in physical, instrumental, environmental and interpersonal relationship inside the operating room; which should be followed to reduce the chance of intraoperative transmission. All health care personnel; physicians and nurses should strictly follow these tasks to decrease intraoperative risk of viral transmission (Tables 2 to 6).

There is always great considerations regarding human-to-human viral transfer inside the operating room. There are four probable pathways for viral transfer inside the operating room:

1. from the patient to the healthcare personnel; i.e. physicians and nurses
2. from healthcare personnel to the patient
3. between health care personnel
4. between patients

General anesthesia has higher risk than spinal/epidural anesthesia or peripheral blocks; unless neuraxial block is otherwise contraindicated, many studies confirm this finding especially in pregnant women undergoing cesarean delivery (26, 27, 32, 34-36).

The main routes for patient to healthcare transfer are:

- 1- direct transfer from the breathing air of the patient when the patient is not anesthetized and also, during spinal anesthesia; all these patients should have face masks
- 2- viral spread while the patient is anesthetized and mask ventilated but still not intubated
- 3- viral shed when the patient is intubated by

anesthesiologist especially when there is risk of patient bucking

- 4- viral spread from the anesthesia machine when the circuits are not well protected by filters or have leakage
- 5- viral spread when the exhaust of the anesthesia machine
- 6- other sources besides airway; the biologic samples like serum, blood, urine, seminal secretions and cerebrospinal fluid (CSF), etc. through chance of transmission is not always high but the risk is real (27).

The main routes for viral transfer between health care personnel are:

1. direct viral transfer between health care personnel which is highly probable since they work in closed space and very often, could not have the safe 6 feet distance from each other
2. risk of indirect transfer between healthcare personnel; including the touching and contact with surfaces that have been touched by others

The most probable routes for viral transfer from a COVID-19 patient to a COVID-19 free patients includes the following; both through air (when there is less than 6 feet distance) and through surfaces that have been touched before by a COVID-19 patient:

1. pre-OR holding area or pre-induction area
2. the Post Anesthesia Recovery Unit
3. inside the operating theatre
4. while the patient is transferred from ward to the operating room or vice versa

Postoperative care

Postoperative care starts in PACU; it is recommended to extubate the patients inside the same room that surgery has been done and not to crowd the patients in PACU. Direct transfer from the room to ward switch stage helps prevent viral spread. PACU related complications are managed there.

In the aftermath of the operating room, patients either go to a regular ward or to ICU. In each of these situations, those health care personnel escorting the patient should be completely aware of PPE and safety precautions; while the patient should have a mask to prevent himself/herself from any viral contamination or spreading viral load to others. Inside the ward, each

patient should be in a separate room while preferably no companions should be with the patient.

The care of the patients inside ICU is a very detailed topic which mandates a separate discussion; however, the general principles for personal protection are the same as mentioned in the above paragraphs. Add to the above, the heavier viral load when there are patients with severe COVID-19 who are under HFNC, BiPAP, mechanical ventilation or other aerosol-generating procedures. Add to the above, the procedures that are needed in ICU, like vascular catheters, dilatational tracheostomy, suctioning, etc. in all of them, there should be protocols to reduce aerosol production as much as possible; using in line suctioning for endotracheal tube, using drapes for procedures (Figure 2) and other similar measures should be considered and implemented.

Finally, the health care personnel need to be strong regarding spirituality; working together with sympathy, hope and team work (Figures 3 & 4).

Conflicts of Interest

The authors declare that there are no conflicts of interest.

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Table 1: Patients with higher serum viral load and increased risk of virus transmission in COVID-19 (9, 15-17)

- during the early phase of the illness; especially the first week of viral infection when the immune response is not elicited enough yet
- older patients especially above 60 years who have lower antiviral immunity and hence higher viral load
- those with the most severe clinical signs and symptoms
- those with suppressed immunity who would have the higher probability of viremia load and lower level of immune response against the virus
- those health care personnel or other professions who are at accumulated chance for viral transmission risk (both regarding contact time and those locations with highest concentration of virus)

Table 2: Precautions for physical safety and infection control inside the operating room (1, 2, 4, 5, 7-9, 19-23, 26, 29-31, 33-35, 37-40)

- each of these operating rooms should have a separate ventilation
- all these patients should have face masks throughout the procedure
- there should be a separate integrated high-efficiency particulate air (HEPA) filter in each of these OR's
- decrease passage of people to each room as much as possible and restricting the entry/exit for every rooms to one door only
- the post anesthesia care unit (PACU) is recommended to be separate in the obligatory one-operating room strategy; in addition, even in the divided operating room strategy, it is recommended that patients pass their recovery as much as possible in the room that surgery has been done and then be directly transferred to the ward or ICU, in case of necessity
- for decreasing the viral load, a high frequency of room ventilation and air changes (25 air changes per hour; with a minimum of 12 air changes per hour) would be an appropriate; besides, negative pressure air conditioning is another requirement of course if available

Table 3: Precautions for procedural and equipment related safety and infection control inside the operating room (1, 2, 4, 5, 7-9, 19-23, 26, 29-31, 33-35, 37-40)

- it is recommended that in each day, only one operation would be done in each room
- after each operation, everything inside the room should be wiped out using standard disinfectants; an ethanol+chlorhexidine mixture is appropriate
- all infected and/or suspected items should be discarded safely into biohazards bin
- single used instruments are preferred as much as possible; including single used endotracheal tubes and laryngoscopy blades
- the anesthesia machine or any ventilation device should not be disconnected at all; instead, all connections should be secured and twisted and meanwhile, guaranteed with COVID-19 resistant filters
- each of the rooms in OR should be equipped with at least one intubation cart which is fully equipped and prepared for any difficult airway and extra safety devices available

Table 4: Precautions for human resource related safety and infection control inside the operating room (1, 2, 4, 5, 7-9, 19-23, 26, 29-31, 33-35, 37-40)

- the health care personnel and the patient routes to each of these OR's, their lounges and their equipment supply should be separated
- the turnover of the personnel (including physicians and nurses) between different wards of the hospital and between several hospitals should be limited as much as possible
- all anesthetic and surgical devices should be single used as much as possible; especially the airway devices; otherwise, strict sterilization protocols should be followed
- the anesthesia machine circuit should be connected to filters; both the inflow and outflow tracts of the machine; the Soda-lime canister could be considered as part of the machine when the filters are used
- room should become sterile with ultraviolet lamps throughout the night for the next day
- those health care personnel who have any underlying disease (hypertension, diabetes, and cardiovascular disease), or are above 60 years old or are pregnant should be out of the care of COVID-19 patients

Table 5: Precautions for personal protection related safety and infection control inside the operating room (1, 2, 4, 5, 7-9, 19-23, 26, 29-31, 33-35, 37-40)

- all health care personnel inside the operating room should have fit-tested N95 respirators
- all health care personnel should have full coverage of the eyes with eye protecting goggles, eyewear and/or full face shield
- all health care personnel need to have full body covering gown and fluid-protective covers for their shoes
- regular washing of hands should be cautiously and repeatedly done; before and after each procedure
- all health care personnel inside the OR should be assessed regarding their COVID-19 infection; based on the nationwide protocols
- the health care personnel should be at its minimum needed; preferably those who are most experienced
- it is preferred that there would be no or minimum exchange of people inside each operating room

Table 6: Precautions for Anesthesia related safety and infection control inside the operating room (1, 2, 4, 5, 7-9, 19-23, 26, 29-31, 33-35, 37-40)

- any kind of aerosol-generating procedures should be strictly prohibited; these include but are not limited to endotracheal intubation, non-invasive ventilation, manual mask ventilation before intubation especially with positive pressure, cardiopulmonary resuscitation, tracheostomy and bronchoscopy during intubation, consider double gloves
- anesthesiologist should perform thorough preoperative assessment of the airway to be more prepared and vigilant if there would be any difficult airway
- tracheal intubation is among the high risk procedures in COVID-19 patients
- Canelli et al, have demonstrated a mocked model that how intubation could lead to widespread expulsion of the droplets; so, they have proposed using a fenestrated box model in order to protect the intubating person
- minimum needed people should be present at the time of anesthesia induction, intubation and extubation; preferably those who are most experienced
- fogging of goggles could be fixed with a thin layer of transparent hand sanitizer administered to the inner side of the goggles
- regular washing of hands should be cautiously and repeatedly done; before and after each procedure, including intubation and extubation
- the process of anesthesia induction would be preferably preceded by 5 minutes of spontaneous ventilation with 100% oxygen followed by rapid sequence induction or modified rapid sequence induction
- the goal of rapid sequence induction is to reduce the mask ventilation while the patient is unconscious and not intubated yet; muscle relaxants could facilitate intubation both inside and outside the OR
- if rapid sequence induction is contraindicated, very small volumes of tidal volume should be used for manual ventilation
- during the period of anesthesia induction, if there is an obligation to ventilate with mask, two persons should be involved; one would take the mask in a two handed fit manner and the other one would ventilate if available, videolaryngoscopy is preferred to laryngoscopy and all are superior than fiberoptic bronchoscopy
- fiberoptic bronchoscopy should not be used unless there is an obligation and a definite indication without any option in hand and mandates full disinfection protocol after use
- endotracheal tubes are preferred to laryngeal mask airway; since there is higher chance for aerosol production with laryngeal mask airway
- during cardiopulmonary resuscitation, chest compression should be stopped to prevent direct spread of virus containing aerosol towards the face of the intubating person
- all safety precautions applied for intubation, should be kept in mind during extubation; both in OR and ICU
- the ventilation strategy inside the operating room for COVID-19 patients is much similar to the ventilation strategy in ICU; i.e. TV about 6mL/Kg; Frequency less than 30/minute, PEEP equal or more than 5 cmH₂O, Peak pressure less than 30 cmH₂O and finally, FiO₂ less than 50% if tolerated

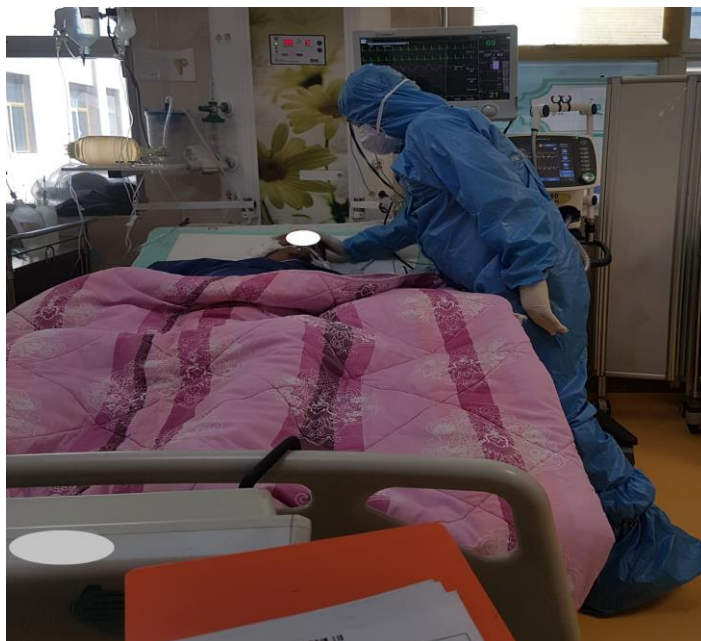


Figure 1: A health care provider in a COVID-19 ICU; having N95 respirator, protective eye-cover, scrubs, fluid proof cover for the shoes and gloves.



Figure 2: using a drape for insertion of central venous line in COVID-19 ICU



Figure 3: Health care team trying to cope with the work stress



Figure 4: Health care teamwork to cope with the work stress