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## Review Article

## Modification in practice of anaesthesia in COVID-19 pandemic: A review article

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## ABSTRACT

During current COVID-19 pandemic, anaesthesiologists should modify their practices and take high precautions. Anaesthetist should reduce their exposure to respiratory secretions and risk of perioperative transmission. In this article we explore the practical considerations, concerns for anaesthesiologist and measures recommended for conducting safe anaesthesia. We also emphasise on ensuring safety of healthcare workers, protection of equipment, and prevention of infection. We tried to illustrate the importance of infection control practices in anaesthesia. A proper plan of anaesthesia for management of COVID-19 patients will result in the best possible outcome for both healthcare workers and patients.

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## 1. Introduction

Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) is a novel virus causing infection in humans belonging to SARS-CoV-2 belongs to family Coronaviridae and order Nidovirales.<sup>1</sup> SARS-CoV-2 is a member of Betacoronavirus (Family Coronaviridae) along with two other viruses of very high pathogenicity i.e. SARS-CoV (Severe Acute Respiratory Syndrome human coronavirus) and MERS-CoV (Middle Eastern respiratory syndrome coronavirus).<sup>2</sup> SARS-CoV-2 is a single-stranded RNA (positive sense) (+ssRNA) virus along with presence of an envelope with a diameter of 60 nm to 140 nm associated with projections in the form of spikes on the surface visible under the electron microscope as crown like appearance.<sup>3</sup>

SARS-CoV-2 infection is prevalent in adult males.<sup>4</sup> The infection is more likely to occur in a population with comorbidities such as hypertension, diabetes mellitus, chronic renal disease, immunosuppressed

states, cardiovascular and cerebrovascular diseases. A vast majority of severe cases have been reported in geriatric population, in adults'  $\geq 60$  years of age, and in patients having pre-existing aforementioned comorbidities. Severe clinical manifestations may also occur as a result of superinfection by bacteria and fungi. Children less than 15 years of age are less prone for infection as well as development of serious complications.<sup>4,5</sup>

The main route of transmission of COVID-19 is droplet and close contact.<sup>6</sup> Infection via oral or conjunctival routes is not currently known, however SARS-CoV-2 has been detected in tears.<sup>6</sup> Human-to-human transmission of SARS-CoV-2 occurs mainly between people who are in intimate contact with patients or carriers in the incubation period. The main source of infection are thought to be Fomites. Studies have shown the persistence of coronaviruses for days on uncleaned surfaces.<sup>7</sup> Recently, SARS-Cov-2 was isolated from faeces, suggesting a possible route of faecal-oral transmission.<sup>8</sup> Recent studies did not reveal any evidence of third trimester vertical transmission after caesarean section in infected pregnant women.<sup>9</sup>

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Transmission of infection in healthcare workers was noted in 3.8% of COVID-19 patients as reported by the National Health Commission of China on 14 February 2020.<sup>10</sup> By contrast, the transmission of SARS-CoV occurs mostly via the nosocomial route. The major source and route of transmission remains elusive till date. The virus can remain viable on surfaces for days in favourable atmospheric conditions but are destroyed in less than a minute by common disinfectants like sodium hypochlorite, hydrogen peroxide etc.<sup>11</sup>

The incubation period ranges from 1 to 14 days and majority of patients are likely to develop symptoms within 12.5 days of exposure.<sup>4,12</sup> These data warrants a quarantine period of 14 days for the people who have been exposed and for persons who have been in close contact of known COVID-19 case. However, an incubation period of 19 days was reported in an asymptomatic carrier which suggests a complicated mechanism of pathogenesis.<sup>13</sup> The most common symptoms are fever, cough, sore throat, headache, diarrhea, haemoptysis, runny nose, fatigue, myalgia and breathlessness; which cannot be differentiated from other respiratory infections.<sup>14,15</sup> The disease can progress to pneumonia, acute respiratory distress syndrome and multi organ dysfunction, respiratory failure and death which is associated with a vast increase in inflammatory cytokines such as IL2, IL7, IL10, GCSF, IP10, MCP1, MIP1A, and TNF $\alpha$ .<sup>5</sup> Most of the patients with severe symptoms had one or more pre-existing comorbidity e.g. hypertension, diabetes mellitus, liver cirrhosis, chronic kidney disease, coronary heart disease, Parkinson's disease and cardiovascular disorders, also there is increased mortality amongst geriatric population.<sup>16,17</sup> It has been reported that neonates, infants and children have significantly milder symptoms as compared to adults.<sup>14</sup>

RT-PCR is used for diagnosis which includes specimen as nasopharyngeal and oropharyngeal swab, Broncho-alveolar lavage (BAL) or tracheal aspirate. Swab from the upper airway is primary and preferred specimen. The specificity is quite high, although false-positive results may be reported due to swab contamination, however, sensitivity rate is estimated to be around 66–80%.<sup>18</sup> A single negative test does not exclude the possibility of infection.

## 2. Screening of Cases

There are criteria for a suspected case of Covid-19 infection in a patient i.e. occurrence of fever and symptoms of respiratory tract infection, history of travel to areas affected by pandemic, community or nosocomial close contact within 14 days of illness onset with a symptomatic person with confirmed or highly suspicious Covid-19 infection or laboratory exposure to Covid-19 biological material.<sup>19</sup> Strict compliance with routine precautions for febrile respiratory illness in general should reduce the potential risk of Covid-19 infection. All the patients coming to

the hospital should be screened according to a standard questionnaire, and those fulfilling the criteria for suspected Covid-19 infection are to be isolated and tested for the virus. Elective surgeries are to be postponed in suspected as well as confirmed cases. Number of Visitors to the hospital should be regulated very strictly.<sup>20</sup> The number of surgical procedures should be reduced which grants time for institutions to: plan for handling the surge of COVID-19 patients; managing the stock of PPE; and planning of placement of healthcare staff appropriately.<sup>21</sup> All elective surgeries should be postponed reducing the risk of exposure to healthcare workers and to preserve the capacity of the healthcare personnel and resources for the ever increasing demand during pandemic.<sup>22</sup> Anaesthetic care should be reserved only for emergency. Triage of non-emergency situations and surgical procedures may vary depending on the community spread in the region and should change during the course of the pandemic.<sup>23</sup> Preparation for anaesthesia includes screening of all patients and determining the COVID-19 status. Since the community spread of COVID-19 infection is now at an alarming rate even the asymptomatic patients should be presumed to be COVID-19 positive, if no testing has been performed or results are pending.

Emergency cases who are possible suspects of Covid-19 requiring critical care support may present to the emergency department directly, or via inter-faculty transfer. In either case, routine questioning about risk for exposure through screening is pivotal in ensuring proper infection control protocol which includes isolation of the patient and use of personal protective equipment [PPE] by healthcare workers in managing the patient within the emergency departments, in-patient wards and the Intensive Care Units. In case of any doubt, patients with febrile respiratory illness of unknown etiology should be treated as a suspected case of Covid-19 with all the necessary infection control precautions until the infection control team can provide further clarification. Regional healthcare system should designate specific institutions with better isolation and quarantine facilities. Telemedicine screening should be promoted in approaching the most appropriate facility. Vigilant screening for Covid-19 risk must be incorporated into every step.

## 3. Transportation of Patient

Transportation of a suspected or a confirmed COVID-19 patient from the isolation ward to the operating room (OR) poses a great risk for contamination of both the environment and healthcare personnel. In the institution even patients should wear a surgical face mask during transfer and the healthcare workers wear proper PPE, National Institute of Occupational Safety and Health-certified N95 mask, eye protection (either goggles or full face shield) and gloves. We transport the patients are being transported along a fixed

designated route in order to avoid contact with other people, monitored by a nurse and security personnel to prevent risk of infection, environmental contamination and implementation of proper infection control protocol.<sup>24</sup>

Designated COVID operating areas (COA) must be allotted for emergency surgeries. The OR which is nearest to the entrance of the OR block entrance should be allocated for COVID patients. If more than one surgery are to be performed, ORs must be utilized in the order of proximity to the main entrance in order to reduce the risk of contamination of the OR block.

The pathways and lifts being used for transportation must be sanitized at regular intervals. If there occurs any unexpected contamination during transport, proper sanitization according to the protocol should be done immediately. A trained cleaning team of the hospital staff should be ready at all times which is considered as an important resource.

#### 4. Environmental Infection Control

The major route of transmission is said to be contact/droplet spread related to respiratory secretions. However, with respect to critical care and anaesthesia, airborne transmission may occur. Risk factors for airborne transmission depends on the nature of intervention being performed. Critically ill patients might have increased viral shedding, acting as “super shedders” with increased transmission from such patients. Interventions which are prone for aerosol generation are bag-mask ventilation, non-invasive ventilation, and intubation in spontaneously breathing patients, which increases the risk of airborne transmission to the individuals performing and assisting in the procedure.

The unstable suspected or confirmed Covi-19 patients should be isolated in an airborne isolation room (i.e., single room, negative pressure, frequent air exchange) or placed in a single room with closed doors and portable HEPA filters or negative air flow, which tend to decrease the risk in a single room. There should be sufficient space available for donning and doffing of PPE able adjacent to airborne isolation rooms.<sup>25</sup>

Inside the hospital wards regulating airflow can effectively increase the risk of nosocomial transmission of SARS. During the prior SARS outbreak, negative airflow isolation rooms, wards and ICUs were created. In such cases, complete PPE has to be worn inside the patient room which is considered as the hot zone without independent airborne isolation which should be removed on exit. N95 masks, gowns, and gloves should be worn in the negative pressure ICU outside of individual patient rooms considered as the warm zone. PPE is not required outside of the ICU (“cold zone”).<sup>26</sup>

#### 5. Personal Protective Equipment (PPE) Considerations

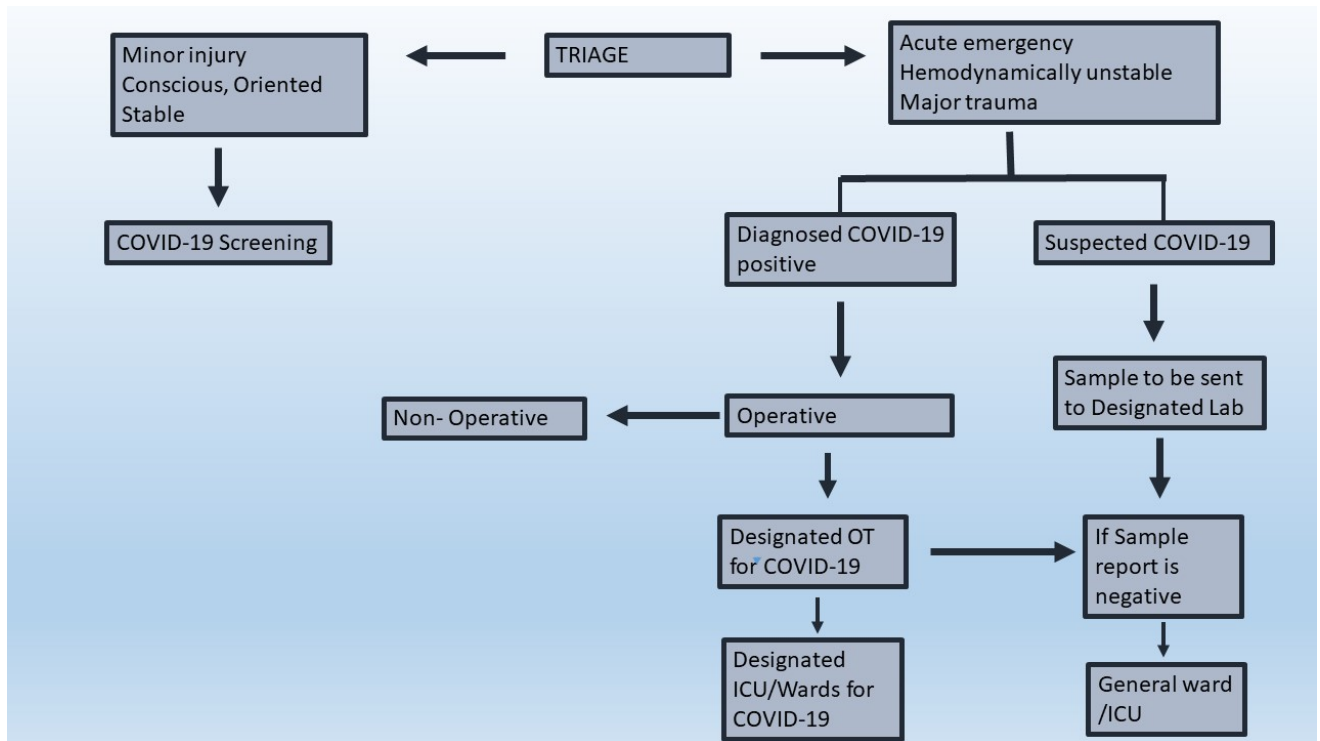
Protection of healthcare personnel during the COVID-19 pandemic scenario demands use of adequate PPE, especially in lieu of PPE shortage. PPE can be classified into three levels as follows: contact precautions; droplet precautions; and airborne precautions.<sup>27</sup> It was observed in a retrospective, cohort study that the airborne precautions PPE had a lower risk of transmission risk to anaesthetists while giving spinal anaesthesia than with contact precautions PPE.<sup>28</sup>

Recommended PPE for contact with confirmed or suspected Covi-19 infection include fluid-resistant gown, gloves, eye protection, full face shield and fit-tested N95 respirators. Head should be covered by hoods. Gloves with Longer sleeves gloves are preferred, to prevent exposure of the wrists. Full face shields are capable to provide both eye protection and avoid contamination of face and mask. Shoes worn should be impermeable to fluids and able to be decontaminated and should be used with shoe covers. Hand hygiene must be performed at each step of PPE removal and even after removing PPE to avoid contamination of the hands by touching dirty surfaces of PPE during removal.<sup>26</sup>

The anticipation of probability of conversion of regional anaesthesia to general anaesthesia is an essential factor for use of PPE. While giving General anaesthesia or intra-operative conversion to general anaesthesia which is an aerosol-generating procedure, it is recommended to use airborne precautions PPE with the use of a N95 respirator mask. It is recommended that all patients must wear a surgical mask to restrict spread via droplets.<sup>29,30</sup> Airway management should be performed by most experienced person on the team. The donning of PPE should be done before entering the OR. The presence of a nurse for observing the correct method during the donning and doffing procedure is advised. Training sessions should be conducted routinely for donning and doffing of PPE.<sup>31</sup>

#### 6. Preparation of Operation Room

The patient should be examined, anaesthetised and recovered inside the OR in order to restrict contamination. The number of personnel inside the OR should be kept to a minimum. Only necessary equipment and drugs required should be kept inside the OR to limit contamination and wasting as unused drugs should be discarded after recovery of patient from anaesthesia. Additional unanticipated equipment can be obtained via a “runner”. There should be segregation of ORs for COVID and non-COVID patients. PPEs and stock of sanitizers required for hand hygiene must be adequately available at all times. An area should be specifically allotted for entry of suspected or confirmed COVID patients and it should be equipped with PPEs and hand hygiene station. Adequate management of potentially



**Fig. 1:** Design of an ideal Triage system in present COVID-19 pandemic

infected linen should be done. The machinery used for transfer of patients should be kept at minimum. OR doors must be kept closed along with accessory rooms, sterilization spaces and any equipment not necessary should be kept away.

Routine record must be maintained of healthcare personnel involved in anaesthesia and surgery of suspected or confirmed COVID infected patients. The staff must be fully equipped with PPEs for receiving the patient in the OR and shifting to the operating table to minimize environmental contamination. All patients undergoing neuraxial or regional anaesthesia must wear a surgical mask. Medical records should remain outside the OR and any update should be added after doffing, while Intraoperative documentation should be avoided.

Negative pressure ORs are considered ideal for minimizing risk of infection.<sup>32</sup> Normally The ORs have positive pressure air circulation, however an air exchange cycle rate of  $\geq 25$  cycles/hour can effectively decrease the viral load within OR.<sup>31</sup> Use of OR Equipment should be kept to a minimum on case to case basis. Once the surgery begins, efforts to utilise the available equipment and drugs in the OR should be done in order to reduce the movement of staff in and out of the OR. Standard anaesthetic trolleys emergency crash carts should be kept ready in advance. Infectious Risk Health Waste (IRHW) containers must be used for disposal. Alcoholic solution for hand hygiene must be utilised. It is recommended to

prefer the use of Disposable material. The anaesthetist, surgeons, nurses technicians etc. Should wear proper PPE before entering the OR timely and effort should be made to reduce the time spent inside the OR. Healthcare personnel should not leave until the surgery is completed, and after exiting should not re-enter.

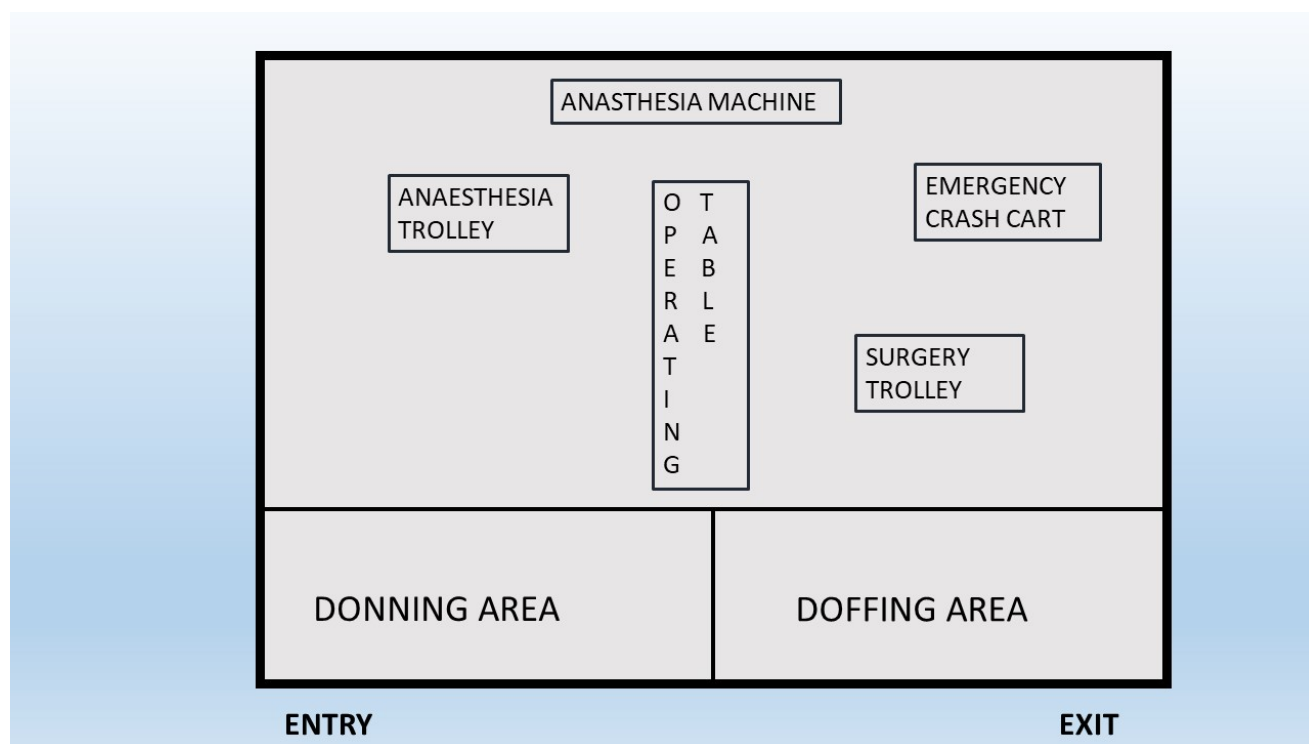
## 7. Consideration for General Anaesthesia

A proper plan for anaesthesia and surgery should be explained in detail to the team and necessary preparations should be done regarding the same. Communication is tough after donning of PPE, therefore special attention should be paid to facilitate communication during the procedure. There are two major goals of Anaesthesia in current COVID scenario: patient safety and infection prevention. Infection prevention measures include limiting aerosol-generating procedures e.g. airway manipulation, bag and mask ventilation, open airway suctioning as much as possible.<sup>31</sup> Awake intubation techniques must be discouraged as it results in coughing and atomized local anaesthetic may cause aerosolization of the virus. Non-invasive positive pressure ventilation and high flow nasal cannulae must be avoided to decrease the risk of generation of aerosol.

Prior to induction, one HEPA filter at the patient end of the breathing circuit, and another between the expiratory limb and the anaesthesia machine should be connected.<sup>31,33</sup>

**Table 1:** Practical recommendations for safety of patient and healthcare workers and prevention of infection during COVID-19 scenario.

Pre-Operative phase	Intra-operative phase	Post- Operative phase
Proper counselling of the patient.	Intubation to be performed by senior most experienced anaesthetist.	Complete recovery in the OR itself.
Specific allotment of ORs for COVID-19.	Regional anaesthesia to be performed by most experience person on team.	Proper disinfection of equipment inside OR.
Pre-specified route for transportation.	Monitoring of hemodynamic and vitals.	Proper disposal of waste according to protocol.
Prior Preparation of minimum necessary equipment for anaesthesia and surgery.	Lung protective mechanical ventilation strategies.	Plastic covering used on equipment or patient to be disposed properly.
Proper donning of PPE.		
Assessment of general condition and vitals.		
Use of digital format for consent		

**Fig. 2:** Layout for designated COVID-19 OR

Circuit extensions should be attached before start of surgery and there should be no circuit disconnections in between surgery. An endotracheal tube should be used to secure the airway instead of a supraglottic airway device. Use of video-laryngoscope is preferred over conventional laryngoscopes because hood, goggles and face shield diminishes the vision during direct laryngoscopy as well as the anaesthetist is further away from patient while using video-laryngoscope.<sup>26</sup>

Adequate pre-oxygenation should be done. Rapid sequence induction (RSI) is recommended to decrease the time for bag-mask ventilation and small tidal volumes should be given. The plane of anaesthesia should be deep with complete neuromuscular blockade (assessed by train-

of-four monitoring) before intubation can be attempted by the most experienced anaesthetist. The correct placement of endotracheal tube must be confirmed with detection of end-tidal carbon dioxide. After intubation, the cuff should be inflated and patient should be kept on intermittent positive pressure ventilation. Lung protective mechanical ventilation strategies are recommended i.e. target tidal volume  $6 \text{ mL} \cdot \text{kg}^{-1}$  predicted body weight, plateau pressure  $\leq 30 \text{ cm H}_2\text{O}$ , target  $\text{SaO}_2$  88–95% and  $\text{pH} \geq 7.25$ .<sup>34</sup> Closed, in-line tracheal suction can be utilised and open suction must be avoided.<sup>33</sup> If circuit disconnections is unavoidable, positive pressure ventilation must be stopped, adjustable pressure limiting valve should be set to zero, and endotracheal tube should be clamped before disconnecting the circuit.<sup>32</sup> Both

HEPA filters and soda lime must be changed after each case.

Extubation of the patient is a high-risk procedure for aerosol generation. As such, extubating should be done only by the anaesthetist and the assistant after all other staff have gone out of the OR. By placing a plastic cover over the patient's face and upper body generated aerosol spread can be minimized.<sup>35</sup>

Anti-emetics should be given to decrease postoperative vomiting and retching. All equipment e.g. suction catheters, endotracheal tubes, nasogastric tubes, eye covers etc. which comes in contact of patient secretions should be carefully manipulated and properly disposed after recovery from anaesthesia. The patient should wear a surgical face mask after extubation. Supplemental oxygen can be given via nasal prongs and we must avoid using Venturi masks as they pose a risk for May aerosolization of the virus. Recovery and post-operative monitoring should be done in OR itself.

## 8. Consideration for Regional Anaesthesia

The ultrasound machine used for peripheral nerve blocks has a large surface area that makes it more prone for contamination via droplets and serve as a reservoir for the virus spread. In order to avoid this contamination the screen, control panel and the probe which comes in patients contact should be covered completely with a single use plastic cover, which should be disposed properly after use. Additional probes of the ultrasound machine, not needed for the block should be removed and kept separately.<sup>36</sup>

Peripheral nerve blocks have been observed to cause fewer physiological complications consequences or haemodynamic side-effects than neuraxial anaesthesia, as it does not result in systemic hypotension caused by sympathectomy.

Preparation of patient for the block should be done and all the aseptic precautions should be followed. A block which has least chances of interfering with the diaphragmatic function which in turn might hamper respiration, should be preferred. For example, axillary or infraclavicular brachial plexus block may be selected over supraclavicular brachial plexus block or superior trunk block may be chosen over interscalene block.

Nerve Blocks should be done under ultrasound guidance to decrease the risk of complications as well as local anaesthetic toxicity.<sup>37</sup> The adjuvants to local anaesthetic should be selected after considering risk-benefit ratio e.g. dexamethasone has risk of immunosuppression; morphine and fentanyl can cause sedation; clonidine and dexmedetomidine might result in bradycardia and hypotension; and possible drug contamination.<sup>38</sup>

If Sedation has to be administered extra caution is advised in COVID-19 patients as they might have respiratory complications. Carbon dioxide (CO<sub>2</sub>) monitoring by end-tidal CO<sub>2</sub> is recommended for any patient which has been sedated.<sup>39</sup> However in COVID-19

suspected or confirmed cases we should avoid direct connection of CO<sub>2</sub> sampling line in order to avoid contamination of the monitor. A cut section of a suction catheter can be placed between the simple face mask and the endotracheal tube connector is attached to the catheter, followed by which a HEPA filter is attached to the connector. The carbon dioxide (CO<sub>2</sub>) sampling line is then connected to the HEPA filter, so that the sampled gas undergoes filtration and capnography is visible.<sup>36</sup>

Peripheral nerve blocks and fascial plane blocks for analgesia should be evaluated depending on the surgery. Under general anaesthesia it is preferred to perform a block that does not require patient repositioning as it may cause disconnection or dislodgement of endotracheal tube resulting in risk of contamination. For example, transversus abdominis plane blocks are preferred over erector spinae block. However nerve blocks for analgesia can be avoided altogether by achieving adequate systemic analgesia.<sup>40</sup> While performing a nerve block for upper limb procedures, plastic drapes can be used to cover the patient in order limit droplet spread to the anaesthetist.

The effect of peripheral nerve block should be checked thoroughly and extra time should be allowed for onset of block effect before starting surgery to reduce risk of conversion to general anaesthesia. If intra-operative conversion to general anaesthesia is necessary, the emergency airway procedure should be followed as per protocol.<sup>41</sup> If signs and symptoms of Local Anaesthetic Systemic Toxicity (LAST) are observed staff should be alerted as soon as possible as time is required for donning of PPE before entering the resuscitation.<sup>26</sup> Management of LAST should follow the currently established protocol.<sup>42</sup>

## 9. Consideration for Spinal Anaesthesia

For a case of suspected or confirmed COVID-19 infection, in the absence of any other risk factors or complications, there is no contra-indication for spinal or epidural anaesthesia in obstetric or non-obstetric patients.<sup>43</sup> Routine indications and contra-indications for neuraxial anaesthesia should be followed. There is evidence suggesting development of thrombocytopenia and lower platelet counts in COVID-19 patients, as compared to COVID-19 negative patients.<sup>44,45</sup> Hence it is recommended to rule out thrombocytopenia before performing the procedure.<sup>46</sup> It should be noted that presence of any pre-operative respiratory compromise may further worsen after giving spinal anaesthesia as result in loss of functional residual capacity. In a study conducted on parturient with COVID-19 infection, who received epidural labour analgesia or spinal anaesthesia for caesarean, none had a contra-indication for the same as well as no haemodynamic instability or neurological complications were observed.<sup>47</sup>

However, it isn't advisable to reduce the dose of spinal anaesthetic agent or use of using short-acting agents, as



it has a higher risk for conversion to general anaesthesia which isn't desired. Routine aseptic precautions must be followed in preparing the patient. It is advisable to put an epidural catheter in addition to spinal anaesthesia in case surgery could prolong. There is no recommendation at present for dose adjustment for spinal anaesthesia or adjuvants.<sup>40</sup> However, patient can be kept on the epidural infusion pump in order to remove additional top-up doses that results in frequent patient contact.

## 10. Discussion

SARS-CoV-2 is a highly infectious virus with Respiratory droplets and close contact as major routes of transmission with a high possibility of aerosol transmission as well. To address the safety concerns of health care personnel, all medical staff should be properly trained in infection control procedures and have a vivid understanding of mechanism of infection spread control and risk factors for COVID-19.

As the pandemic prolongs, there great chances of shortage of N95 respirators and it should be ensured to tackle the problem if it arises. There have been studies that show that wearing N95 respirators and PPE could be tolerated for up to eight hours.<sup>48</sup> However it is not feasible for most healthcare personnel to extend the use beyond 4 hours as they to take breaks drink, and for using the toilet. The Association for Professionals in Infection Control and Epidemiology position paper have recommended recommend extended use of N95 respirators rather than re-use. There must be single-use of N95 respirators For cases which are highly suspected or confirmed COVID-19 positive, as re-using poses a great risk of droplet contamination, reduction in filtration efficacy, improper mask fitting on re-use, cross-contamination in storage and contamination during doffing and donning of the respirators.<sup>31</sup> For proper PPE use, Training of staff at routine intervals is a must. It must be emphasised the importance of correct doffing technique and health care personnel should be reminded each time to not touch eyes or face.

Anaesthetist handling COVID-19 cases must be well-accustomed both General and Regional anaesthesia techniques. The protocol dictates that the senior-most member of the team is the primary anaesthesiologist for suspected or confirmed COVID-19 infected patients. The plan of anaesthesia is according to the general condition of the patient and type of surgery which has the minimum risk of transmission.

## 11. Conclusion

Anaesthesiologists are on frontlines for management of COVID-19 patients. Vigilant measures for prevention and control of infection, proper use of PPE and preparedness for management of infected patients are of great value. We must modify the existing infrastructure, implement the strategies

for infection prevention, and apply clinical recommendation in the OR setting. The containment measures are essential to provide optimum care for COVID-19 patients and to minimize the risk of viral transmission, especially to healthcare personnel. We expect a Clear and transparent form of communication from the government and healthcare organisations to the hospitals and general public as well.

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## 13. Conflict of Interest

The author declares no conflict of interest

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