

Expert Opinion

Pediatric Anesthesia Advisory: What should we know as a pediatric anesthetist when a COVID-19 patient needs an operation?

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ABSTRACT

We are living in a developing country with limited resources in the context of PCR testing, personal protective equipment, and negative pressure operating room availability; so facing a serious challenge for the continuation of surgical services especially in the context of anesthesia services and personnel safety during this COVID pandemic. As anesthesia provision is highly aerosol-generating thus predisposes both surgical and anesthesia teams to COVID. This demands a change in our anesthesia practice to provide a safe and comfortable atmosphere for the continuation of surgical services, as anesthesia is the backbone of surgery. We have developed this advisory for pediatric anesthetists especially relating to developing countries to guide them for providing safe anesthesia services keeping in mind the limited resources based on our practices and experiences gained during this pandemic along with reviewing national and international literature.

INTRODUCTION

Covid-19 has emerged as a global pandemic that has magnified the risk of viral spread while performing surgical procedures in the OR and if not taken seriously can lead to widespread transmission of virus among health care workers. Anesthesiologists are particularly exposed because of aerosol generation in nearly every procedure like mask ventilation, endotracheal intubation, positive pressure ventilation, and suction of airways.[1][2] Although the harmful effects of virus are well established in adults but children are not exceptions. It has been documented that regional anesthesia is associated with decreased risk of viral spread as it avoids the airway manipulation. Therefore we should consider regional anesthesia in pediatrics during the pandemic whenever possible.

Majority of anesthesia procedures require use of supplemental oxygen either by face mask during general

anesthesia or via nasal cannula during regional anesthesia. All these procedures can lead to aerosol generation which increases the risk of viral spread.[3] The risk is particularly higher at times of induction and extubation. All necessary measures should be taken during these high risk times to minimize aerosolization and this applies to regional anesthesia as well.[2] As an anesthesia providing safe anesthesia to the patient. In order to implement this, we have made a clear advisory/plan for the entire perioperative period. Here we discuss a stepwise approach to anesthetic management of a pediatric patient with COVID 19 disease at a tertiary care hospital in a low middle-income country.

Preoperative PCR Testing

Due to the limited COVID testing facility in a resource-constrained poor country like ours; it is very difficult to have HR-PCR testing before every elective surgery and usually impossible in emergency surgery. The COVID

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HR-PCR testing done so far before major surgeries in suspected patients, have already shown that one in every 10 patients is having positive testing. As a consequence we are bound to consider every patient as COVID suspected patient keeping in mind the very high prevalence of the disease if not tested.[4] So routine at our set up is to wear proper PPE not only during the procedure but also while doing preoperative evaluation. On one hand, it gives us a sense of security but at the same time, it leads to wastage of already scarce resources so expanding HR-PCR is the need of the day to enhance healthcare workers' safety.

Team Management

The senior anesthesiologist should take up the leadership role to organize a team for anesthetic management of COVID-19 patients. Any team member with comorbid conditions should not be included in care of COVID-19 patients. They can be assigned non-clinical tasks. Team should include an experienced anesthesiologist, an anesthesia technician/anesthesia nurse and a runner outside the OR. His/her additional duty is to check for all equipment required in the OR, for safe transport as well as PPE availability for the team. He/she should also inform and ensure proper PPE use by all the staff members present in the OR during COVID-19 patient management.

Dedicated Anesthesia Trolley Outside OR

It is important to keep minimum essential equipment inside the OR to avoid viral contamination and spread. To achieve this goal, we have shifted the anesthesia trolley in the clean corridor outside OR.



Figure 1: Dedicated anesthesia trolley with runner outside OR.

Runner

There is a runner (Fig.1) either nurse or doctor outside the OR in the clean corridor who assists an anesthesiologist working in the OR. The runner must also wear a gown, gloves and surgical mask /N95 mask (if available) at a minimum.

Donning

There should be a designated donning area in the OR. We have converted one of our sitting rooms into donning area. A labeled trolley (Fig.2) with all essential items is placed in the room. There is another person who ensures proper donning. All personnel involved in induction and intubation within 2 meters of the patient should use PAPRs (powered air-purifying respirators).[5] Since no PAPRs are available at our setup, so it is mandatory for all our team members to wear proper PPE which includes N95 masks protected by a surgical mask, goggles, face shields and double gloves in addition to impermeable gowns.[6][7][8] Only then they are allowed to proceed.



Figure 2: Donning trolley.

Preparation

The anesthesiologist and technician responsible for the case, prepares the required drugs and equipment and takes them in a zip-locked bag. It is advisable for all workers to leave their cell phones and keys outside the OR. There should be a phone in a plastic bag for effective communication outside the OR. If no phone is available, runner can help in communication.

Designated COVID-19 ORs

Ideally there should be an OR with a negative pressure environment to decrease viral dispersion beyond the OR. If there are ORs with a positive pressure environment, then at least air handling units with 25 air changes per hour should be there, so that viral load within the OR can be reduced.[8] We do not have any negative pressure rooms although we are working on it but have properly functioning air handling units with HEPA filtration facility in our 6 operating rooms. We have designated one OR for COVID-19 patient. It is our practice to apply 2 HME/HEPA filters, one at patient airway and other at expiratory limb [9][10] in all of our anesthesia machines. Proper scavenging is available. In addition we take every precaution to minimize spread.

Minimum Staffing

There should be one consultant anesthesiologist and a trained anesthesia technician in OR for induction of

case. If any difficulty arises in case of intubation, another anesthesiologist should be readily available.[11] If help is needed, the runner comes in who is also wearing PPE. None of the surgical team members is allowed to stay in the operating room during induction.

Protection of Anesthesia Equipment

Anesthesia workstations, ultrasound machines and other trolleys are wrapped up in clear plastic sheets to reduce contact contamination of equipment and other environmental surfaces. The trash bins and sharps containers are readily available and open to avoid floor contamination from viral particles.

Preoperative Evaluation and Patient Shifting Into OR

In order to facilitate the process, the anesthesiologist and technician after preparing the room goes to the isolation ward /ICU in PPE and completes the preoperative evaluation of COVID-19 patient before shifting directly to the designated OR. A day before, a senior anesthesiologist reviews all laboratory investigations, X-rays, CT scans etc. on WhatsApp. The hospital security is responsible for clearing the route for the COVID-19 patient to and from the OR. At our institution, the corona ward, ICU, the corridor and the elevator for shifting the COVID-19 patient are totally isolated from the rest of the hospital. It is equally important to ensure that patient is covering his/her face with N-95 Mask or minimally a surgical mask. [11] If a patient needs oxygen, it can be given either by nasal cannula under the surgical mask or face mask can be applied above the surgical mask. It is removed only after all monitors are applied and the anesthesia mask with a breathing circuit is ready for induction. If the patient is intubated, a transport ventilator is used for the Mapleson D circuit with HME filters at the tracheal tube.

Premedication

Since there is a change in practice from inhalational to IV induction in COVID-19 patients so importance of premedication is further increased. Vigorous crying can increase risk by aerosol generation. Only a calm child will allow for IV induction. We usually use IV midazolam alone or in combination with IV ketamine.

Induction and Intubation

Following are the key points to decrease aerosol generation:

- Adequate preoxygenation should be practiced as it decreases the number of attempts at endotracheal intubation.
- If IV is already in place, we do intravenous induction, preferably modified rapid sequence induction. The modified technique allows mask ventilation with

small tidal volumes in children as they can't tolerate hypoxia for long intervals.[8][9][11]

- Rapid sequence induction decreases the risk of reflex airway stimulation during intubation and thus reduces aerosolization.
- The importance of lowest possible flow rates and a tight mask seal cannot be overemphasized to prevent viral spread.
- Our practice is to wear double gloves during intubation. Left outer glove is removed to hold and hand-over the used laryngoscope blade after intubation. This limits the viral dissemination further.
- Use of antiemetics is encouraged because vomiting can also lead to aerosol generation.
- The most experienced anesthesia provider performs intubations along with anesthesia technician/nurse.
- After intubation our practice is to avoid auscultation and confirms adequate ventilation by looking at ETCO₂ and adequate chest rise.
- Video laryngoscope if available is ideal as it avoids direct exposure to the patient airway during intubation and increases the first attempt pass rate. If not available, DL can be used but preferably should be done under clear plastic drapes. Using VL for nearly all intubations is a common practice at our institution.
- Awake fiberoptic intubation is best avoided unless specifically indicated. Droplets containing viral pathogens may become aerosolized during this procedure. At our institution it is used only twice during the pandemic. Both patients were with limited mouth opening and presented for emergency surgeries. Hence preoperative COVID testing could not be done. All measures were taken to protect the OR team.
- A good seal with cuffed endotracheal tube is required to avoid further exposure to aerosols. To achieve this goal, cuffed ETT is preferred and the cuff is inflated before starting controlled ventilation.
- In case of failed attempt at endotracheal intubation supraglottic devices should be used as a rescue measure in order to avoid multiple attempts. These are never the first choice because of the poor seal and risk of viral spread.

Use of Clear Plastic Drapes

The purpose is to create a shield that may contain aerosol generation thus reducing exposure to OR personnel. Although we are not certain about their effectiveness but still they are used in different forms like intubation boxes, plastic sheets alone or over a mayo stand. Some may add suction under the drapes.[12] We use clear plastic-bags converted into sheets (Fig.3) that cover the patient fully during intubation and extubation. We also use two sheets, one over the patient and another over a screen thus providing double protection.



Figure 3: Induction under clear plastic drapes.

Use of HME/HEPA Filters

HME or HEPA filters are the devices which maintain humidification and filter 99.995 % of viral particles about 0.3 microns or greater in size.[9] They must be placed between the patient mask/ETT/LMA and the Y-piece of the breathing circuit.[8][9][10] If the filter is clogged it needs to be replaced or preferably after each patient. HME filters can increase dead space in small children so it's important to use appropriate sized filters with an acceptable dead space of 10 mls in a 5 kg patient.



Figure 3: Induction under clear plastic drapes.

The gas sampling tubing should also be protected by a HME filter, and gases exiting the gas analyzer should be scavenged and not allowed to return to the room air.

Another viral filter must be placed at the expiratory end of the breathing circuit to protect the anesthesia machine from viral exposure. (Fig.4) The filter at the end of the expiratory limb has no effect on dead space. If filters are available in sufficient number then it's advisable to change filter for every patient. Otherwise it can be re-used and simply wiped. In addition these filters protect water trap from contamination and it needs not to be changed in between the patients. It also needs to be wiped at the end of each case. The gas sampling tubing needs to be changed if a COVID positive patient is done.

If the filter in the water trap is confirmed to have an effective VFE, gases sampled from the airway do not require additional filtering. Otherwise placing a 0.2-micron

Drug Injection Filter at the entry to the water trap will provide an added measure of protection.

During the COVID-19 pandemic, our routine practice is to use two HME filters, one between the patient and the Y connector and the other at the expiratory limb of the breathing circuit. If dead space is a concern in pediatric patients, we use only one at the expiratory limb.

Scavenging

Anesthesia machines may or may not have proper scavenging system. To facilitate scavenging, a corrugated tubing can be attached to the scavenging port and dipped in a bucket or a chest drain bottle under water seal with a 1 % hypochlorite solution.[10] Scavenging is available and functional at our designated COVID-19 OR.

Maintenance of Anesthesia

Strict compliance to wearing PPE is observed throughout the procedure. No one is allowed to leave the OR before doffing is completed and hand hygiene is performed.

Airway Suctioning

To limit aerosol generation closed suction system should preferably be used. The closed suction system is usually placed between ETT and the HME filter after ETT insertion. The inline nebulizers in ICU are similarly placed on the patient side of the HME filter. The ventilator should be stopped and ETT must be clamped if breathing circuit requires to be changed to avoid risk to OR personnel. The water trap needs to be replaced if used in a COVID positive patient.



Figure 5: Suctioning under the clear plastic drapes

Since we don't have a closed suction system so we ensure airway suctioning is done under clear plastic drapes and strict compliance to ETT clamping is practiced while changing the circuit (Fig. 5).

Extubation and Recovery

As an additional precaution, extubation must be done in a negative pressure room whenever possible.[8] Since we lack a negative pressure room so after extubation the

patient is fully recovered in the operating room. Immediately after extubation, put a surgical mask over the patient's face. If oxygen is required either administer it through nasal prongs under the surgical mask or through an oxygen mask placed over the surgical mask and keep the patient under the clear plastic drapes.

Shifting and Transport to Isolation Ward/ICU

After extubation, the patient is not shifted to the recovery room but directly to the isolation ward/ICU. Again hospital security is responsible for clearing the route to the corona isolation ward /ICU. The same anesthesiologist and technician in full PPE are responsible for shifting. Make sure the patient wears an N-95/surgical mask if not intubated. If the patient is on mechanical ventilation, then we can use a transport ventilator and two viral filters on the patient side of the Y piece and the expiratory limb of the breathing circuit. If transport ventilator is not available, we shift on a Mapleson D breathing circuit with a HME filter placed on the tracheal tube. In order to avoid coughing and bucking, sedation and neuromuscular blocking agents can be administered, keeping in mind the risk-benefit ratio.

Doffing

Ideally there should be a designated doffing area as well. Since we lack such an area so we do doffing inside the OR after the case in a stepwise-recommended sequence and another person in the OR ensures proper doffing. This is our practice during this pandemic. Since the COVID-19 patients are directly shifted to isolation ward/ICU so doffing takes place in their doffing area. After removing protective equipment, the person takes care not to touch hair or face and performs hand hygiene. It is mandatory to take a bath after doffing before leaving the isolation area.

Cleaning and Disinfection

It is important to discard breathing circuits, mask, tracheal tube, HME filters, gas sampling line, soda lime, and change water trap. All used airway equipment is sealed in a double zip-locked plastic bag. It is then removed for decontamination and disinfection. Adequate

time should be given for cleaning and disinfection to decontaminate all surfaces, screens, keyboard, cables, monitors and anesthesia machine with 62–71% ethanol, 0.5% hydrogen peroxide or 0.1% sodium hypochlorite, or other biocidal agents such as 0.05–0.2% benzalkonium chloride or 0.02% chlorhexidine digluconate [13][14]. At our setup, 75 % alcohol is kept in a spray bottle for disinfection of all equipment surfaces, and the disinfection of walls and floor is carried out with 17.5 g didecyl dimethyl ammonium chloride and 4.0 g polyhexanide. All used and unused drugs are discarded.

CONCLUSION

Whenever there is a pandemic, the first and foremost step is the preparation. This involves changes not only in the infrastructure but also in the mindset and practices. Setting up COVID OR, providing PPEs, explaining all steps with regular teachings, PPE drills and simulations are one aspect. The other most challenging aspect is implementation and strict compliance with the protocols. Bringing a change is always difficult even if it is risking lives. As Pediatric anesthesiologists, we should play our part in collaboration with the surgical team. The more our team is organized, the better it performs in terms of patient management and the protection of health care workers.

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