AIRWAY MANAGEMENT IN THE OPERATING ROOM DURING THE COVID-19 PANDEMIC: THE AUBMC EXPERIENCE

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Abstract

Severe Acute Respiratory Syndrome-CoronaVirus-2 (SARS-CoV-2), the virus responsible for the novel Coronavirus disease (COVID-19) is highly contagious. Anesthesiologists, critical care physicians and inhalation therapists, often responsible for managing the airway of patients in respiratory distress or presenting for surgery, are subjected to a high viral load and an increased risk of contracting the virus. Since airway instrumentation is a highly aerosol generating procedure, countries that were first and mostly affected by the novel coronavirus have used their personal experience to establish recommendation guidelines for airway management in order to decrease the disease burden. Moreover, as the pandemic evolved and became a global health emergency, the classical practice of anesthesiology needed to be modified and adequate preparation of all involved healthcare workers became essential.

This review describes the stepwise approach to airway management in the known or suspected COVID-19 patient presenting to the operating room. It illustrates the practice modifications that were implemented at the American University of Beirut Medical Center to accommodate the challenges imposed by the pandemic. Adequate anticipation and proper training, emerged as key factors in mitigating the risks in a resource strained country.

Keywords: COVID-19, Aerosol generating procedures, adult airway management, pediatric airway management, difficult airway.

Introduction

Severe Acute Respiratory Syndrome-CoronaVirus-2 (SARS-CoV-2), an encapsulated, positive single stranded ribonucleic acid, the causing agent of the novel Coronavirus disease 2019 (COVID-19), first reported in Wuhan China, is highly contagious.[1] The virus is transmitted predominantly by droplet spread or direct contact with contaminated patients or surfaces rather than airborne spread.[2,3] Healthcare workers (HCWs) like anesthesiologists, intensivists and inhalation therapists, who are directly involved in airway management were found to be subjected to a higher viral load with an increased risk of contracting the virus and a more severe clinical illness.[4-6] That led countries that were first and mostly affected by the novel coronavirus to develop principles and establish recommendation guidelines for airway management in order to provide adequate training and selection of HCWs, to encourage a safe, accurate and swift performance and minimize contamination.[5] In a systematic review of infection risk to HCWs, Tang

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et al ranked airway procedures in descending order of aerosol generation risk as follows: tracheal intubation, tracheostomy, non-invasive mechanical ventilation (NIV) and mask ventilation.[7] Other procedures like tracheal extubation, circuit disconnections, cardiopulmonary resuscitation in the absence of a secure airway, bronchoscopy and endotracheal suctioning were also classified as aerosol generating procedures (AGPs).[2,8]

As the pandemic progresses, airway management will not be only reserved for COVID-19 patients having respiratory distress and requiring ventilatory support but also for patients who will present to the operating room (OR) for non-related procedures. The virus has shown variable clinical manifestations ranging from mild symptoms to severe respiratory distress. In the absence of a vaccine and a definitive treatment, institution specific guidelines needed to be implemented in order to ensure patients and HCWs safety.

In this review, we discuss the practice modifications that were adopted by the Department of Anesthesiology at the American University of Beirut Medical Center (AUBMC) to care for the COVID-19 patient and any other patient presenting to the OR. These protocols were developed after reviewing the international recommendations for COVID-19 patients and were modified and implemented with regard to local workplace policies as well as equipment, resources and personal protective equipment (PPE) availability.

Preparation for intubation of the COVID-19 patient

As the pandemic evolved and overwhelmed healthcare systems worldwide, the operating room, a very dynamic environment was faced with unique challenges while caring for patients with confirmed or suspected COVID-19.[9,10] The usual practice of anesthesiology needed to be modified to maintain the safety of patients and HCWs perioperatively; from transport to the operating room, to intraoperative management to postoperative care. Since many teams were involved, adequate team communication was essential in ensuring that roles and responsibilities were clearly allocated among team members.[7,9,10] For instance, clearing the elevators and the route from the ward to the operating room was the task of the hospital security. Transport teams wearing full PPE were responsible for accompanying and monitoring the patient, and communicating with the OR nursing and anesthesiology teams to ensure a safe and a swift transport.[7,9]

At AUBMC, we aimed to prepare the teams to adopt these new practice modifications in perioperative care by providing simulation videos that demonstrate the multifaceted approach to patient care.

Room setup

Patients with or suspected COVID-19 should directly be placed in an airborne isolation room, a single negative pressure room with frequent air exchanges of at least 12 air changes per hour.[5] Positive pressure and air conditioning systems need to be turned off if negative pressure rooms are not available.[10] It is recommended to use negative pressure rooms for airway management on the ward or in the operating room when a COVID-19 patient needs airway instrumentation.[7] It is also preferred to have an anteroom with enough space to don and doff PPE.[11,12]

In addition to operating in a negative pressure room, careful considerations to minimize contamination of equipment, hallways and HCWs should be considered. For instance, a dedicated room should be reserved for the COVID-19 patient where the anesthesia machine is covered with a plastic impermeable barrier, additional heat and moisture exchanger (HME) filters are placed on the expiratory limb and between the circuit and the patient, the soda lime and HME filters are changed between cases. Also, the anesthesia trolley is kept in a clean area outside the OR, with only the necessary drugs and airway equipment taken inside the room.[12]

At AUBMC, international practice guidelines recommending extending preoperative testing for COVID-19 were adopted. All patients presenting to the OR were screened within 24 to 48 hours of their scheduled procedure using the gold standard polymerase chain reaction (PCR) test.[13] Since turning all operating rooms into negative pressure rooms was not feasible, only patients that presented for emergency

or lifesaving procedures with unknown test results, and patients with a high suspicion for COVID-19 were taken into the dedicated negative pressure OR where all safety measures were ensured. For instance, the designated OR was located at the corner of the operating room complex and was granted a separate access. It has an anteroom, where a clean trolley containing extra medications and airway equipment is kept. It also has its own induction room, that is reserved for donning and doffing of PPE and serves as a communication area between teams in case additional equipment or drugs are needed during the case.

Before patient's arrival, all personnel directly involved in patient care will meet to debrief, formulate a clear plan, wear full PPE and go over a checklist. That includes machine checking, covering equipment with plastic drapes (Figure 1), applying HME filers on the circuit, expiratory and inspiratory limbs and changing the capnography line, the D-Fend and the Soda lime. The team will prepare the induction, maintenance and emergency drugs to be taken inside the OR while keeping the rest in a clean area outside the room. Finally, they will check the availability and functionality of all airway equipment and determine the location of the disposal bins.

Personal protective equipment (PPE)

Although contact and droplet spread of respiratory secretions were the predominant mechanism of transmission of the novel coronavirus; anesthesiologists and critical care clinicians are thought to be at a higher risk of contracting the virus through their daily involvement in AGPs like intubation and extubation.[11] Providing adequate PPE to ensure HCWs safety became a priority.

In concordance with the infection control committee, institution specific consensus on the essential PPE required to care for a COVID-19 were implemented. These included the use of a long sleeved waterproof Tyvek suit, disposable shoe covers and head caps, a well fitted N95 respirator or a powered air purifying respirators (PAPRs), an eye protective shield and appropriately sized double gloves.[7,10,11]

Fig. 1
Anesthesia machine covered with an impermeable plastic drape

At our institution, all anesthesiology personnel were educated on the appropriate level of PPE required to care for a COVID-19 patient presenting to the OR. An additional layer of protection was added whereby an impermeable gown is worn above the Tyvek suit during AGPs. All our induction rooms were reserved as clean areas for donning PPE following a clear protocol. Similarly, waste bins were placed inside the room for doffing of contaminated equipment like gloves, impermeable gowns, surgical masks and goggles, and outside the room for the removal and disposal of N95 respirators and Tyvek suits.

Induction and Intubation

Airway management carries a high risk of viral transmission, and should be performed while ensuring the safety of all involved healthcare personnel. Therefore, the number of medical providers in the room at the time of the intubation should be limited to an experienced laryngoscopist, a skilled assistant and a team leader, all wearing full PPE.[14,15]

Before intubation, the team prepares the airway kit that contains all the necessary equipment including a video laryngoscope, the adequate endotracheal tube (ETT) and oral airway sizes, a fixation device and a closed airway suction system (Figure 2).[5] A second generation supraglottic airway (SGA) offers a higher pressure laryngeal seal than first generation SGA and should be available as a rescue device in the event of a difficult ventilation or intubation.[5,16]

Intubation should be performed by the most experienced laryngoscopist in order to optimize first attempt success.[11,14] There has been an international consensus regarding the benefit of using video laryngoscopy on the first attempt, as it improves both the view at laryngoscopy and the success rate when intubation is difficult.[5,10,11] Also, it facilitates help from the assistant and ensures an adequate distance between the patient and the intubator.[5,10,11]

At AUBMC, we have followed the international recommendations for intubation, whereby a rapid sequence induction (RSI) technique was adopted for all cases presenting to the OR.[7,10]

A hood was built by our technician and was connected to a negative pressure suctioning system to serve as intubation barrier (Figure 3). Many barriers have been used and described in the literature despite a controversy regarding their efficiency.[17,18] All the patients were required to present to the operating room with a surgical facemask.[14]

In preparation for induction, full monitors are applied and intravenous access is established. Preoxygenation is performed with a well-fitting facemask with 100% oxygen for at least 5 minutes using low gas flows (3-5 L/min). When deemed necessary, ventilation was performed using a two hand V-E grip, an oral airway, low flow and low pressure ventilation and a wet gauze applied to the patient's mouth and nose to minimize virus spreading.[5,10] In the event of a difficult ventilation, a second-generation SGA was reserved for rescue ventilation with less aerosol generation than facemask ventilation.[5] Propofol or ketamine (1-2 mg/

Fig. 2
Airway Kit used at AUBMC

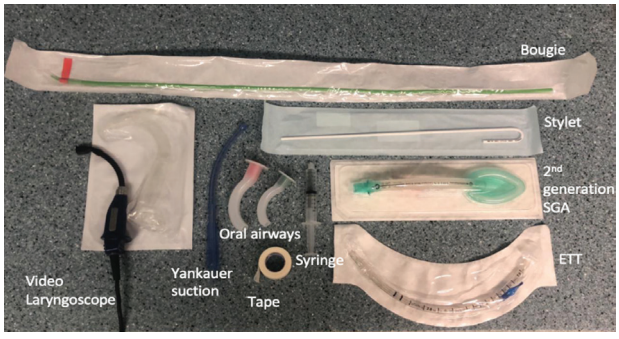


Fig. 3
Negative pressure intubating/extubating hood used at AUBMC

kg) depending on the patient's cardiovascular status, rocuronium (1.2 mg/kg) or succinylcholine (1.5 mg/kg) and lidocaine (1.5 mg/kg) were used for RSI. Opioids were preferably given after neuromuscular blockade to prevent the potential cough reflex, and a vasopressor to treat induction induced hypotension was always available. Intubation was performed after ensuring full neuromuscular blockade following the below described steps (Figure 4). Circuit disconnections should be avoided, if necessary, they shall be done beyond the filter after pausing the gas flow and clamping the ETT to minimize viral contamination. ETT confirmation by capnography, bilateral chest wall expansion or by ultrasound guidance has been recommended over chest auscultation.[9,11]

The Difficult Airway

The unexpected difficult airway

In the event of an unexpected difficult airway, the basic algorithm for difficult airway management has been modified and adapted for COVID-19 patients.[19,20] It is crucial to declare difficulty to the team at each step and ask for additional support. A difficult airway cart including front of neck airway (FONA) equipment should be readily available.[5,10] Mask ventilation, initially deferred, can be used for rescue oxygenation when intubation is deemed difficult. Alternatively, a second-generation SGA can be used for oxygenation between laryngoscopy attempts. It is important to minimize the number of attempts at each technique to reduce exposure and consider changing the device and/or the operator during each attempt.[5]

For instance, after an initial failed attempt at laryngoscopy, technique modification, use of additional airway equipment (bougie or a stylet), and external laryngeal manipulation should be performed to optimize the success of a subsequent attempt. Rescue oxygenation is necessary when the airway is declared difficult or if the patient becomes hypoxemic. In the event of "cannot intubate, cannot oxygenate", an airway expert should be readily available to perform a FONA. The scalpel-bougie-tube technique have been preferred over the cannula technique in COVID-19 patients as it is associated with a lower risk of aerosolization.[5]

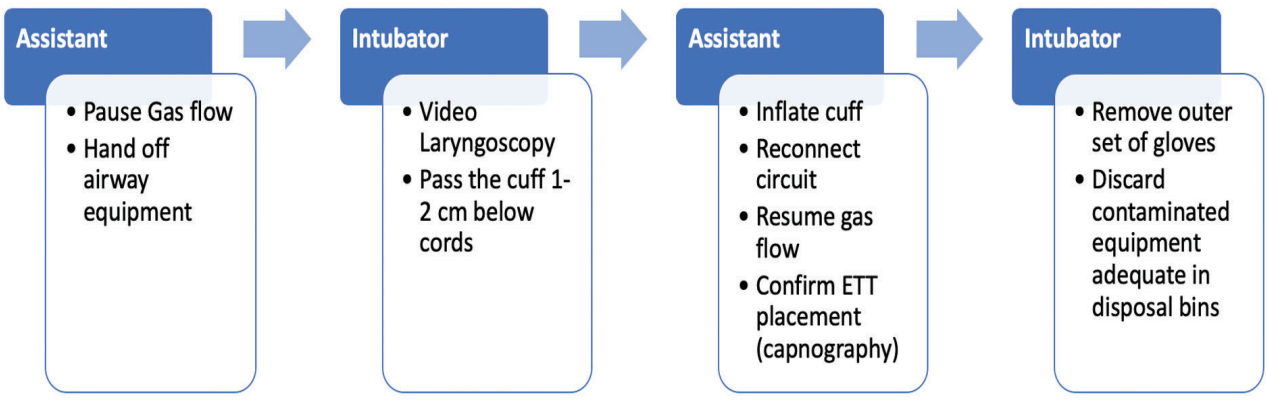
At each step of the algorithm, the plan should be clearly communicated between the surgical and anesthesiology teams to make an informed decision on how to proceed. Moreover, when rocuronium is used as a paralytic, sugammadex should be readily available in case a decision to wake up the patient has been made.[10]

The anticipated difficult airway

Some patients may present to the OR with an already known difficult airway. Under normal circumstances, anesthesiologists might opt for an awake flexible fiberoptic intubation.

Flexible fiberoptic intubation is an aerosol generating procedure and should not be the technique

Fig. 4
Intubation steps of a COVID-19 patient presenting to the OR



of choice during a difficult intubation.[5,21] Similarly, airway topicalization with a local anesthetic might induce coughing and virus aerosolization,[14] In the absence of an alternative and in the presence of an experienced operator, flexible video assisted bronchoscopic intubation can be performed, after ensuring adequate paralysis and anesthetic depth, with the display placed as far away from the patient as possible.[11]

Video laryngoscopy with a hyperangulated blade was suggested to be the method of choice on the first attempt at intubation.[5,14] Alternatively, intubation through a SGA can be performed either blindly, flexible bronchoscopy assisted, or using a guided Aintree tube exchanger.[5]

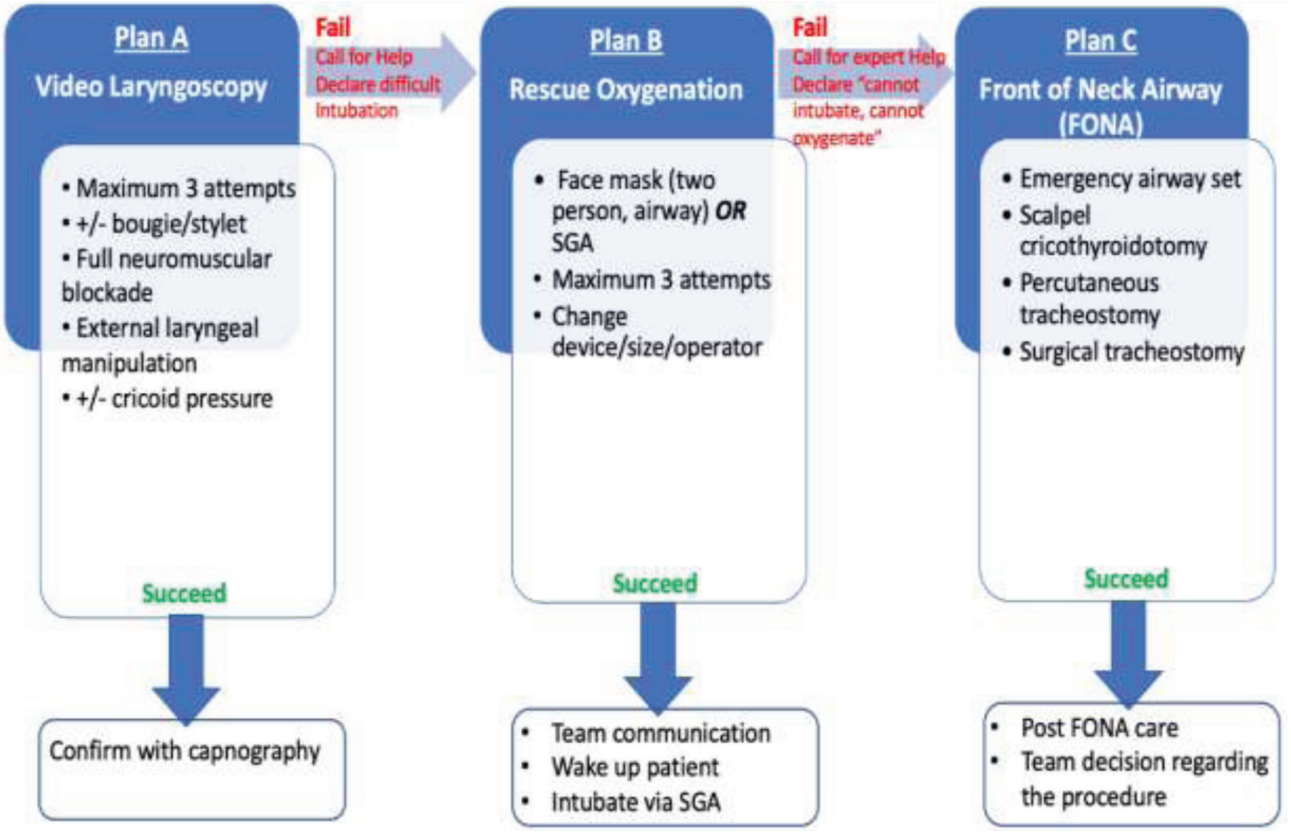
The stepwise approach to the difficult airway is summarized in Figure 5.

Cardiopulmonary resuscitation (CPR) might need to be performed before securing the airway in the event of a respiratory and a subsequent cardiovascular collapse. Early tracheal intubation with a cuffed tracheal tube is recommended. However, in the absence of an airway expert, a second-generation SGA can be used for rescue ventilation and the intubator is encouraged to use the technique he is most comfortable with.[5] In the presence of an airway expert, where intubation can be performed swiftly, holding chest compression to avoid aerosolization of the virus and room contamination during intubation is advised.[14]

Emergence from Anesthesia

Since extubation is considered an aerosol generating procedure, efforts should be made to limit the number of medical personnel in the room during emergence in order to minimize the risks[9]. Preparation for extubation should be planned throughout the procedure by using maintenance drugs that minimize coughing at emergence.[5,9] In a network meta-analysis using surface under the cumulative ranking curve

Fig. 5
Difficult airway algorithm of a COVID-19 patient



analysis (SUCRA), dexmedetomidine was found to have the highest cumulative rank for decreasing the incidence of moderate to severe peri-extubation cough, followed by intravenous remifentanil, fentanyl, tracheal and topical lidocaine, intracuff lidocaine and intravenous lidocaine respectively.[22] Total intravenous anesthesia using propofol and remifentanil has also been used to reduce post-extubation cough.[23]

It has been recommended to extubate the COVID-19 patient in a negative pressure room, using a protective extubation barrier; nylon drapes, plexiglass boxes and negative pressure hoods have been used.[9,24] As an additional layer of safety and to reduce the exposure to secretions, two layers of wet gauze can be used to cover the patient's nose and mouth during extubation.[7,10] The "mask over tube" is a safe and efficient technique that has been described by D'Silva et al, whereby an anesthesiologist and an assistant positioned behind the patient's head, extubate the patient in a stepwise manner.[25] The extubation protocol at AUBMC, has been clearly written and applied in order to ensure patients and HCWs safety (Figure 6).

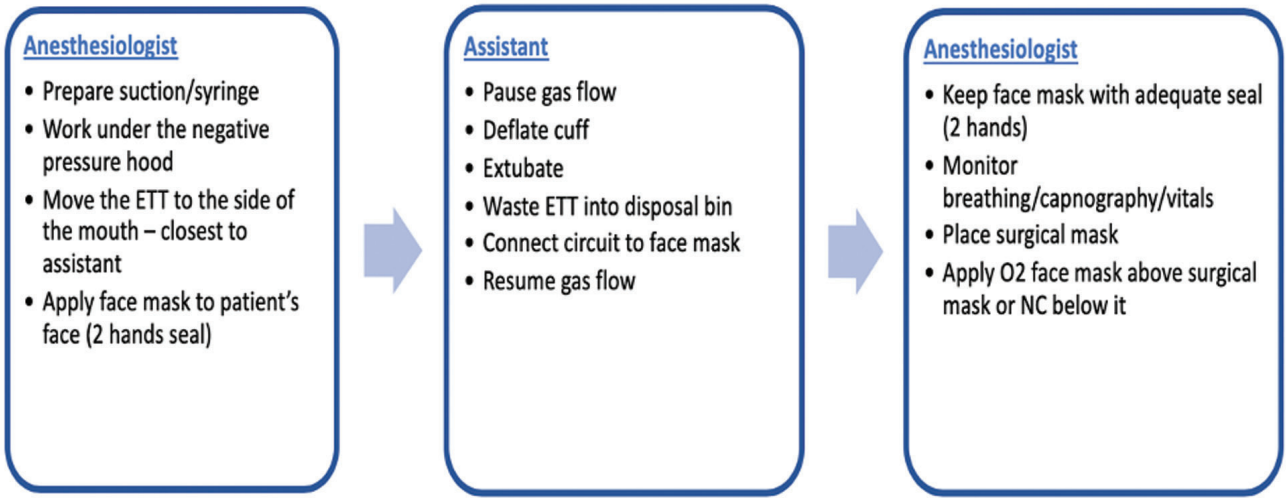
After extubation and after ensuring hemodynamic stability and regular breathing patterns, the patient shall be monitored either in an airborne isolation room, or in the negative pressure operating room itself. At our institution, and in an attempt to minimize contamination of patient's areas, the Post-Anesthesia Care Unit (PACU) team assists in patient's recovery inside the designated operating room. For patients requiring intensive care unit (ICU) monitoring, a specialized COVID-19 team ensures a safe and a secure transport from the operating room to the COVID-19 unit's ICU. Once the procedure is over and the teams are ready to leave the room, they are required to doff their PPE in the appropriate areas designated for contaminated equipment.[7]

At the end of the procedure, a minimum of an hour is allocated between cases to allow the OR staff to send the patient back to the ward, conduct thorough decontamination of all surfaces and equipment. All unused items are assumed to be contaminated and are discarded, and all staff are required to shower before resuming their regular duties.

The PCR negative patient presenting to the OR

As the pandemic evolves, many patients will be presenting to the OR for elective procedures, many of whom will be asymptomatic and might be carriers of SARS-CoV-2. In the presence of sufficient resources, there has been a clear benefit to extending testing for COVID-19 as widely as possible to include all patients presenting to the OR.[15] At our institution, PCR testing within 24 to 48 hours of the scheduled

Fig. 6
Extubation steps of COVID-19 patients followed at AUBMC



surgical procedure has been required. Since the clinical sensitivity of PCR testing is unknown, precautions during AGPs have been taken even in the PCR negative patient.[26]

For instance, minimizing the number of personnel in the room during intubation and extubation is currently routinely performed at AUBMC. The involved teams wear PPE consisting of an N95 respirator covered with a surgical mask, an eye protective shield and an impermeable gown during these two procedures. Given the risk of accidental circuit disconnection and unquantified aerosolization, it has been recommended to keep full PPE throughout the procedure in the event of a high clinical suspicion for COVID-19 or during AGPs.[15]

Most patients are intubated by video laryngoscopy, after which at least one air cycle equivalent to a four minutes waiting time is required before the rest of the personnel re-enter the room. The same process applies for extubation. After ensuring that the patient is hemodynamically stable, a surgical face mask is applied to the patient's face above the nasal cannula (NC) or below an oxygen face mask in preparation for transport to the PACU.[9]

Management of the Pediatric Airway

Children infected with SARS-CoV-2 might have a milder clinical course and could shed the virus asymptomatically even in stools, and infect others.[27] In the Chinese experience, asymptomatic transmission of the virus from children to HCWs emerged as a significant risk.[28,29] Modifications in the management of the pediatric airway in order to decrease viral transmission became essential.

Most children present to the OR without an intravenous (IV) access and require inhalational induction which might carry an increased risk of virus aerosolization in an agitated child.[30] It has been recommended against parent present induction in order to minimize exposure and conserve PPE.[30,31] Intravenous, oral or intramuscular premedication is a safe alternative to parent present induction and helps in soothing an anxious child presenting to the OR.[32] Nasal administration of medications should however be avoided as it might trigger coughing or sneezing.[30] Although IV induction is preferred, the child's disposition for IV placement should be assessed as struggling to place a catheter might result in more droplets shedding in a crying child. Alternatively, mask induction should be carried cautiously by using low gas flows and ensuring an adequate mask seal.[30]

At AUBMC, all children presenting to the OR are premedicated with a benzodiazepine, the most commonly used being midazolam, orally (0.5-1 mg/kg up to 20mg), intravenously (0.05-0.1 mg/kg) or intramuscularly (0.1-0.2 mg/kg). However, under certain circumstances, and when necessary one parent wearing full PPE accompanies the child to the OR and leaves before airway instrumentation.

Rapid sequence induction is recommended. However, since some children might not tolerate periods of apnea without developing hypoxemia, a modified RSI with gentle positive pressure ventilation using enough tidal volumes to achieve chest rise is acceptable. Full neuromuscular blockade should be ensured before airway instrumentation and cuffed endotracheal tubes are always used. While checking for a leak is not recommended, ETT cuff pressures should be adequately measured to prevent post-extubation croup.[30]

A second-generation SGA device should be readily available in case of a difficult airway for rescue oxygenation and ventilation.[30] Direct neuromuscular blockade reversal with sugammadex should be considered in case of a difficult ventilation and difficult intubation.[33] Similar to adults, video laryngoscopy has been adopted for intubation, while intubation through an SGA device was reserved for cases of difficult intubations.[30]

Extubation of a child should be carried cautiously, while minimizing post extubation cough, laryngospasm and emergence agitation.[30] Multiple strategies like using total intravenous anesthesia or maintenance drugs like dexmedetomidine infusions has been recommended to decrease emergence agitation.[34]

Conclusion

During the COVID-19 pandemic, specific considerations and practice modifications needed to be implemented to ensure patients and staff's

safety. Airway management of patients with known or suspected COVID-19 became challenging and necessitated the establishment of new practice guidelines. The classical practice of anesthesiology needed to be modified and adequate preparation of all involved HCWs became essential to decrease the disease burden.

At AUBMC, international guidelines were adopted and modified with regards to the local workplace policies, as well as equipment and resources availability.

While this review focuses on the airway management of adult and pediatric patients presenting to the operating room, many other protocols were also implemented with regards to infection control, team preparation and coordination, and the establishment of a COVID-19 specialized unit. As challenges arose with the evolving pandemic, adequate anticipation, healthcare workers determination and collaborative efforts appeared to be the key elements in successfully attenuating the disease burden in a resource strained country.

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