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PERSPECTIVE PIECE

Anesthesia Services in the Time of COVID

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Abstract

Our hospital is a 400-bed Level-1 trauma center with 78 ICU beds serving the greater Louisville metropolitan area. The COVID-19 pandemic forced our hospital to re-evaluate our core business operations and to develop a coherent response to a fluid situation. Between March 15 and May 15, 2020, the University of Louisville Hospital admitted more than 100 COVID-19 inpatients, approximately 30 were admitted to the intensive care unit (ICU) and most required endotracheal intubation. The following review describes our Department of Anesthesiology & Perioperative Medicine foci, actions and rationale during the COVID-19 pandemic. While we hope not to experience another pandemic in the near future, this review may be a helpful starting point for preparing for future respiratory spread pandemics.

Introduction

Our Anesthesiology & Perioperative Medicine Department services the Main Operating Room (OR), Regional Pain Service, Outpatient Surgery Center (OSC), Intensive Care Unit (ICU), Labor & Delivery (L&D), and Pain Management Center. We also support the Robley Rex VA Medical Center. On March 18, 2020 pursuant to Kentucky Order 2020-215, we ceased performing elective operating room procedures to help prevent SARS CoV-2 viral spread. [1] We also ceased operations in the OSC and Pain Management Center as well as suspended all academic meetings including Grand Rounds, resident-fellow lectures, and Journal Clubs as per University of Louisville directive. Our overall daily OR volume diminished to ~50% of pre-COVID levels in the month of April compared to prior year; however, we continued to operate urgent cases and Level-1 trauma. It appears as the Level-1 trauma volumes were nationally diminished for the same period.

Approach

The first part of this review will focus on general preparation and organization of our day-to-day operations. The second part will review the impact of the COVID-19 crisis on our Anesthesia Service Lines as depicted in **Table 1**.

Getting Organized

Assembling Personal Protection Equipment (PPE) – "COVID Airway Bag"

At pandemic onset, little was known on how SARS-CoV-2 virus spread, consequently plans were developed to protect anesthesia providers against airborne, aerosolized, droplet, and contact methods of spread. [2] These plans encompassed finding the highest level of personal protective equipment (PPE) available to our hospital. These PPE were assembled into grab-and-carry plastic bags (**Figure 1**) and provided protection to the respiratory tract, face-head-neck, body, and legs for most intubation scenarios.

Given well-publicized shortages of PPE, our institution rationed N95 masks, and we projected how long our PPE stockpiles would last given PPE burn rates on early COVID-19 ICU patients. We participated in mask sterilization to extend the life of N95 masks by approximately 10 times. As a contingency to insufficient N95 mask stockpiles, we also

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Table 1. Anesthesia Service Lines: Services Provided & Major COVID-19 Pandemic Changes

Anesthesia Service Line	Services Provided	Major Changes
Main Operating Room	General and monitored anesthesia to ensure patient safety and stability during operating room procedures Elective, urgent and emergent surgeries	PPE to protect anesthesia providers Intubation process changes (RSI, increase distance between provider & patient) Barrier devices to protect OR staff Negative pressure room for intubation / extubation "Clean" procedures to conserve equipment & medications
Regional Pain Service	Acute / perioperative pain management Peripheral and neuraxial blocks including catheter placement Longitudinal patient care via consult service	PPE to protect anesthesia providers "Clean" procedures to conserve equipment & medications
Intensive Care Unit (ICU)	Perioperative and longitudinal critical care for neurosurgery, stroke, neurology, obstetrics / gynecology / oncology, orthopedics, urology, ear / nose / throat. Critical care for outside hospital transfers when MICU team is "capped" at 20 patients Respond to emergent airways and codes	Actively contribute to cross-functional core team Cross-functional simulations & training linking MICU, nurses, respiratory therapists on new process PPE to protect anesthesia providers Practice donning & doffing Minimize aerosolizing procedures Run code blues w/o existing airway; urgent intubations Intubation process changes (RSI, increase distance between provider & patient) Contingency planning to onboard COVID patients "Clean" procedures to conserve equipment & medications
Obstetrics (OB)	Neuraxial (eg: spinal, epidural), general anesthesia and other management for vaginal and C-section delivery Patient stabilization for urgent / emergent surgeries	PPE to protect anesthesia providers Practice donning & doffing Prefer early epidural Intubation process changes (RSI, increase distance between provider & patient) Barrier devices to protect OR staff Negative pressure room for intubation / extubation "Clean" procedures to conserve equipment & medications
Chronic Pain Management	Interventional procedures for chronic pain done on outpatient basis	This line of service was shut down due to COVID-19 pandemic; service was resumed after April 27th, 2020
Outpatient Surgery Center (OSC)	Moderate sedation, monitored and general anesthesia for purely elective outpatient surgery	This line of service was shut down due to COVID-19 pandemic; service was resumed after April 27th, 2020

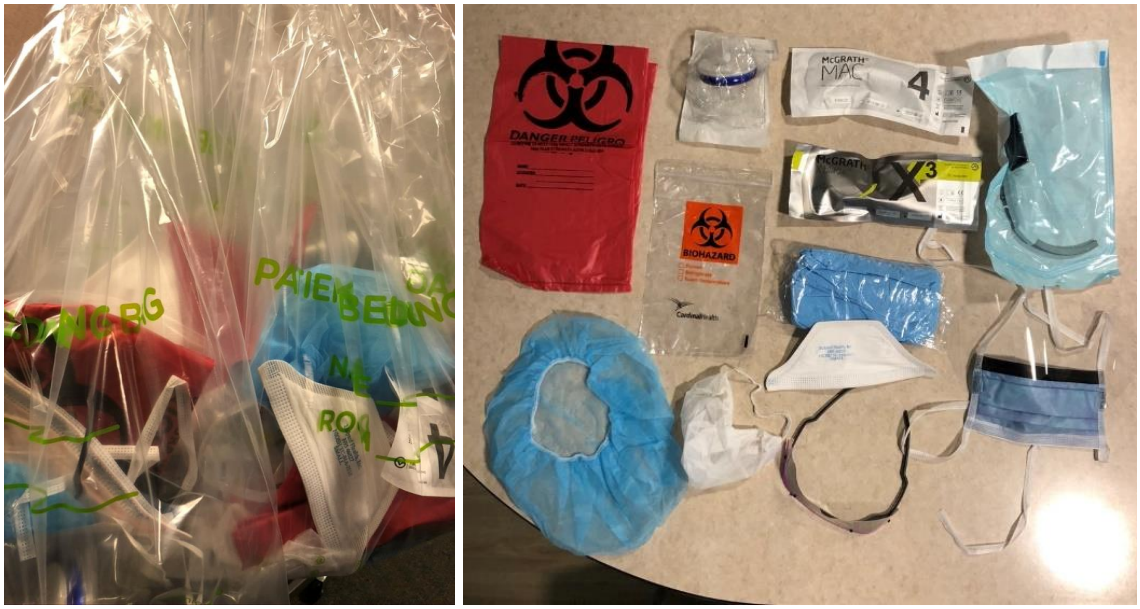


Figure 1. COVID Airway Bag: a) Respiratory Tract Protection—small and large N95 masks; b) Eye-Face-Head Protection—eye shield, surgical mask with face shield, bouffant cap, beard cover [Intubators would generally have own welder masks or goggles.]; c) Body Protection—waterproof and non-waterproof gowns; d) Intubating Equipment—McGrath video-laryngoscope, MAC4 and X3 blades; e) HEPA filter; f) Biohazard bags for used McGrath video-laryngoscope

evaluated makeshift elastomeric masks made from anesthesia facemasks attached to HEPA filter; our employee health services confirmed that these makeshift masks were equivalent to a fitted N95 mask. (**Figure 2**) Fortunately, we possessed sufficient N95 stockpiles and never resorted to makeshift elastomeric masks.

Anesthesia providers participating in Critical Care Anesthesia teams and Obstetrics Anesthesia (OB Anesthesia) also maintained a limited number of Powered Air Purifier Respirators (PAPR) and hoods. [3-5] Due to their very limited supply, PAPRs and hoods were used primarily for urgent/emergent airway situations in conjunction with COVID airway bag PPE, shared amongst multiple residents and attending personnel, cleaned after each use, and reused amongst multiple attending personnel and residents. To our knowledge, no University of Louisville anesthesia providers have tested positive for COVID19, and we will soon learn the immunity profile of our first responders. [6]

Protecting Anesthesia Providers – Donning & Doffing
Numerous articles and protocols on donning and doffing were readily available electronically via the Centers for Disease Control (CDC), American Society of Anesthesiologists (ASA), Anesthesia Patient Safety Foundation (APSF), Society of Critical Care Medicine (SCCM), and the New England Journal of Medicine. [**Table 2**] These different protocols used slightly different PPE, and we modified our process to fit available PPE. (**Figure 1 and Figure 3**) This process was taken seriously as breaches in donning and/or doffing could contaminate the provider and cause downstream infections. [7,8] Critical Care Anesthesia team members were informed of our available PPE and donning & doffing process and engaged in hands-on individual training followed by cross functional simulations with MICU, respiratory therapists and nursing staff. Given the increased time spent during donning/doffing, we made others aware of the need for early notification should an intubation be required. After intubations/codes, anesthesia attending personnel functioned as trained observers to help ensure the doffing process was followed.

Anesthesia Practices in the Operating Room
As mentioned previously, urgent and emergent cases continued at the University of Louisville Hospital. Because our early COVID testing took up to 5 days to result, the COVID status of most of our operating room cases was unknown at the time of surgery. Consequently, the anesthesia providers wore fitted N95 masks along with a face shield and full PPE protection found in the COVID airway bag. We covered our fitted N95 mask with a regular surgical mask to preserve the outer layer of N95 clean. We attempted to minimize OR staff exposure to SARS-CoV-2 by having non-essential staff either step out of the room or wear N95 mask and ancillary protective equipment until the patient was intubated. We performed rapid sequence intubation to help minimize aerosolization and barrier devices were made available to help limit the spread of droplet/aerosolization. Extubations of COVID-positive or COVID-likely patients were performed in a negative pressure environment. Regular extubations were done in the operating rooms under essential personnel's supervision.

Critical Care COVID-19 Core Team
March 18, 2020 marked the gathering of essential critical care core team members, consisting of our Chief Medical Officer; representative attending personnel from the Medical, Surgical, and Anesthesia Intensive Care Units; nursing; and respiratory therapy. Also present were counterparts representing MICU and Cardiothoracic ICU from Jewish Hospital. The key deliverable from this meeting was to organize our institutional COVID-19 responsibilities and response: Medical Intensive Care team (MICU) would take lead role in on boarding and management of COVID-19 patients and persons under investigation (PUI). After the MICU team reached at twenty patients, Critical Care Anesthesia would receive MICU patients. If MICU and Critical Care Anesthesia teams became overwhelmed with COVID-19 patients, Surgical Intensive Care (SICU) and then Cardiac Critical Unit (CCU) would begin ICU management for COVID-19 patients. It was estimated our maximum institutional capacity for COVID patients was 178 ICU beds in non-optimal settings, however our ventilator capacity would fall well short of our maximum capacity.

Critical Care Anesthesia team would continue having primary responsibility for intubating all floor and ICU patients as well as difficult COVID airways experienced by the ED Team. In case of code blue, where the patient did not have a pre-existing secured airway, Critical Care Anesthesia Team would secure the airway and then run the code. For patients that had a pre-existing secured airway, MICU would run the code. Each team would be available for each other as an immediate back up in case help needed. Unless it is very likely back up teams would not be donned, but just be available. As stated, we continued to respond to all difficult airways in the Emergency Department as a part of our routine responsibilities.

Anesthesia in Obstetrics / Labor & Delivery (OB L&D or L&D)

The University of Louisville operates a seven bed, 2-operating room Labor & Delivery Unit (L&D) which provides a full range of obstetrics services to a high-risk population. In accordance to Kentucky Order 2020-215, L&D ceased purely

Table 2. COVID-19 Preparedness Resources Relevant to Anesthesia, Perioperative Medicine, and Critical Care Services.

Society / Organization	Type of Recommendations	Web Source
American Society of Anesthesiologists (ASA)	Donning, Doffing, Intubation, Perioperative Services, Anesthesia machines as ventilators	https://www.asahq.org/in-the-spotlight/coronavirus-covid-19-information
Anesthesia Patient Safety Foundation (APSF)	Donning, Doffing, Intubation, Perioperative Services, Anesthesia machines as ventilators	https://www.apsf.org/novel-coronavirus-covid-19-resource-center/
Society of Critical Care Medicine (SCCM)	Educational resources for critical care & patient management, COVID-19 discussion groups, mechanical ventilation strategies	https://www.sccm.org/Disaster/COVID19
Society of Critical Care Anesthesiologists (SOCCA)	Donning, Doffing, Intubation	https://socca.org/covid-19/
Society for Obstetric Anesthesia & Perinatology (SOAP)	Considerations for L&D, Staff training & Equipment, OB Anesthesia specific considerations	https://soap.org/education/provider-education/expert-summaries/interim-considerations-for-obstetric-anesthesia-care-related-to-covid19/
International Anesthesia Research Society (IARS)		https://iars.org/coronavirus-resources/
Centers for Disease Control (CDC)	Data surveillance & analytics, healthcare professional guidance, contact tracing	https://www.cdc.gov/coronavirus/2019-nCoV/index.html
World Health Organization (WHO)	Public advice, technical guidance,	https://www.who.int/emergencies/diseases/novel-coronavirus-2019

Figure 2. Mask-Shift Elastomeric Masks w/ HEPA Filter.

Figure 3. Critical Care Anesthesia team members wearing PPE.

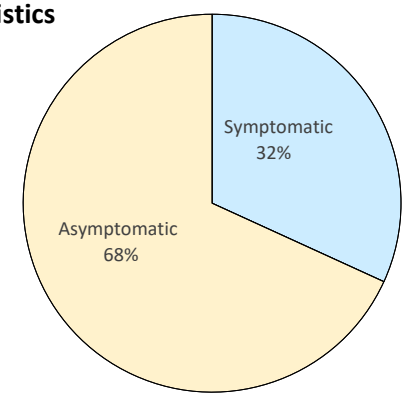
elective procedures, however delivery and Cesarean section (C-section) rates continued at pre-COVID levels. Anesthesia continued to perform neuraxial anesthesia (epidurals and spinals) and general anesthesia support (also known as OB Anesthesia); our total number of procedures continued unabated.

The COVID pandemic challenged the L&D unit to re-evaluate its workflow and process in order to prevent SARS-CoV-2 viral transmission amongst patients and healthcare providers while maintaining a patient-centric care. Cross-functional teams consisting of obstetrics, nursing, OB Anesthesia and maternal fetal medicine (MFM) developed protocols consistent with guidance from the American College of Obstetricians and Gynecologists (ACOG) and CDC. All admitted L&D patients were tested for SARS-CoV-2; patients testing positive for SARS-CoV-2 received a corresponding MICU consult. All term patients not needing ICU level of care would remain the L&D area in a negative pressure room. All SARS-CoV-2 positive antepartum patients would be cared for in a COVID-specific floor or unit. Between April 15 and June 6, 2020, L&D cared for 22 COVID-19 positive patients. Our COVID-19 L&D summary data and statistics may be found in **Figure 4**. Whether in patient labor & delivery or in operating rooms, OB Anesthesia followed PPE/donning and doffing precautions already documented in this review. One PAPR and hood was made available for residents though it has not been used for OB Anesthesia.

University of Louisville Labor & Delivery Statistics

April 15 - June 6, 2020

Pregnant COVID-19 Positive Patients	Number	Percentage
Symptomatic	7	32%
Asymptomatic	15	68%
Total	22	100%



Oxygen Treatment In Symptomatic Mothers	
Nasal Cannula	3
Face Mask	1
High Flow Nasal Cannula	2

Choice of Delivery - Term Mothers	Nothing	Epidural	Spinal	GA*	Total
Vaginal	4	11	-	-	15
C-Section	-	1	2	-	3
Subtotal	4	12	2	-	18

*GA = General Anesthesia

Figure 4. UofL Labor & Delivery Anesthesia Services' COVID-19 Care Statistics

Although there is no clear proof of vertical transmission of virus, direct contact after immediate delivery and nursing periods would place the newborn under high risk of exposure. None of the newborn babies, even those born to COVID positive mothers, tested positive for COVID. Breast-feeding and use of breast pump was encouraged. COVID specific education was provided to the mothers who did not want to separate from baby. They were educated on personal hygiene and social distancing between baby and mother once they were discharged.

Process Changes

Induction / Intubation

Literature on timing of induction has been unanimously in favor of rapid sequence induction/intubation to help limit coughing episodes prior to intubation, which could spread SARS-CoV-2 virus via droplet and aerosolization. [9] For ICU patients, the preference was also rapid sequence intubation, however COVID patients may be hemodynamically too unstable for rapid sequence intubation and therefore type of induction, induction agents, and intubation plan was left to clinician judgment. Because video-laryngoscopes increased the distance between the intubator and aerosolization source, video-laryngoscopes were used preferentially in nearly all intubations. [10,11]

Intubation Barrier Devices

Despite the proper use of N95 mask, face shield and other PPE by anesthesia providers, there still was concern whether these precautions were sufficient for both the anesthesia provider as well as operating room/ICU staff. Barrier devices such as the plexiglass box (**Figure 5**) and clear plastic sheets were deployed to help prevent droplet spread during intubation. [12] There is no clinical evidence showing the effectiveness of reducing viral transmission nor are there studies comparing the superiority of plexiglass versus plastic sheet barrier devices. Heavy and cumbersome, the plexiglass restricts the degrees of freedom of movement for the anesthesia provider, further increasing the difficulty of intubation. During difficult intubations, it may be necessary to remove the device during difficult intubations but plexiglass offers better visibility compared to clear plastic sheets. Nonetheless, barrier devices appear to be a common-sense intervention given our need to help prevent droplet/aerosolization viral spread to healthcare workers. At the Louisville Veterans Administration Hospital, it is mandatory to use barrier devices (either plexiglass box or plastic sheet) during intubation and extubation.

Emergent airways

Our anesthesia ICU teams have always had the primary responsibility for securing airways during codes and emergent airways for floor and ICU patients. Due to the timeframe for airway team's transit, preparation of equipment and drugs, and donning PPE during an emergent airway or code, it was conceivable that time from calling the code/emergent airway to securing the airway could be up to 20-to-30 minutes. The initial recommendations were to not bag mask the patient for risk of COVID virus aerosolization. The logical conclusion was that emergent airways/codes would likely

a. Intubation barrier device in simulation model

b. Intubation barrier device display

Figure 5. Intubation Barrier Devices

not survive under these conditions and that Critical Care Anesthesia team recommended 30-minute warning before the airway became "emergent." This required close coordination & cooperation between MICU and Anesthesia teams, and this collaboration resulted in an excellent teamwork. These joint efforts prevented many emergency intubations.

Codes
MICU team has been the primary team for running codes in our hospital. Typically, Critical Care Anesthesia responded to the airway component, and SICU obtained vascular access if necessary. However, during the COVID-19 pandemic, Critical Care Anesthesia Team assumed primary code responsibilities if patients did not have a secure airway. This approach helped to limit the exposure of unnecessary medical personnel to the virus. In situations where the patient already possessed a secured airway, the MICU team was still the primary response team to the code.

Game Changers

Testing
At the start of the pandemic, testing at University Hospital was severely limited and took up to 3-5 days to result. Consequently, we initially tested only patients that had a very high clinical suspicion for COVID-19; those patients were admitted to a mixed COVID floor/ICU until their tests resulted. As the pandemic evolved, total number of tests increased – every patient admitted into the hospital received a COVID PCR test. The result became available within a 3-hour period. Consequently, we were able to more accurately assign patients to the appropriate floor or ICU.

Intubation Timing
Early in the pandemic, data indicated that COVID patients could rapidly decompensate and so the focus was to intubate non-emergently and apply lung protective strategies for Acute Respiratory Distress Syndrome (ARDS). As the pandemic evolved, data indicated that intubated COVID patients did not do well and had a more difficult time coming off the ventilator. WHO guidelines for management of respiratory failure in COVID-19 advocated use of CPAP or NIV [13] and consequently more centers delayed intubations in favor of non-invasive ventilation (CPAP and high flow nasal cannula). This unexpected transition alleviated the stress on our Critical Care Anesthesia teams in terms of volume of intubations, however never eliminated the pressures once an intubation decision was made.

Discussion

At time of manuscript submission, much is still unknown about SARS-CoV-2. Though transmission is widely believed to be respiratory spread, the mechanism of spread may involve other means such as fecal-oral. After several weeks of decline, COVID-19 cases may be resurging in parts of Southeastern and Western United States but it is also unclear whether this is due to increased testing versus actual spread due to loosening of lockdowns versus some other reason(s). In addition, despite multiple clinical trials, it will take at least several more months before a treatment and/or vaccine are available. One thing is certain: SARS-CoV-2 will be in the population for the foreseeable future; and our Department of Anesthesiology & Perioperative Medicine will continue to modify and improve upon our processes to serve the patients that come into our hospital and we will endeavor to limit the spread to other patients and healthcare workers.

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