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CLINICAL REVIEW

Reinvention of an academic anaesthesiology department during pandemic times: lessons learnt and adapting to a "new normal"

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Conditions created by the COVID-19 pandemic have impacted many aspects of medical practice. Responding to this crisis has required health systems to rapidly address a multitude of concerns, including workforce safety, staff redeployment, supply shortages and physical space restructuring. The pace of change created by new information and evolving conditions has proven challenging for traditionally-structured academic departments in medicine. Pandemic medicine requires a nimbleness in decision-making, clarity of communication and comprehensiveness of services that may demand a temporary rearrangement of leadership structure and clinical service delivery. Furthermore, the uncertain nature of a pandemic may require reinstitution and dissolution of services as demand sporadically either rises or falls. As the global medical community continues to respond to what may be multiple COVID-19 peaks stretching over months or years, it is important that approaches to preparation and management of the pandemic are shared to enable the identification of best practices and an effective response. With the availability of open access and free communication technologies, these strategies can be easily shared among the global anaesthesia community. The approach outlined here represents one way to organise leadership and streamline communication in order to reinvent an academic department to match the dynamic requirements of crisis conditions. We describe our experience in offering new services such as an airway team, COVID-19 simulation training and personal protective equipment testing, as well as our approach to evaluating the rapid flow of research findings related to SARS-CoV-2 and COVID-19. We summarise lessons learnt and our adaptation to what may be a "new normal" in anaesthesiology practice.

Keywords: COVID-19, SARS-CoV-2, coronavirus, pandemic medicine, academic department, leadership structure, communication

Introduction

The COVID-19 pandemic has pushed medical systems beyond their capacity around the world.[1-3] Conditions resulting from the pandemic require health systems to rapidly address a multitude of concerns, including workforce safety, staff redeployment, supply shortages and physical space restructuring.[4] As the global medical community continues to prepare for what may be multiple COVID-19 peaks stretching over months or years,[5] it is important that approaches to preparation are shared to allow adoption of best practices and an effective ongoing response to the pandemic.

This paper describes the reinvention of our moderately-sized academic department of anaesthesiology in the Western United States in order to meet the threat of the COVID-19 pandemic. Most of the high-impact interventions implemented in our department focused on changes in communication structure and resource allocation in the face of resource scarcity and ever-changing pandemic conditions. These changes are relevant to the global anaesthesia community as we all confront the universal challenges of limited personal protective equipment (PPE) and critical care medical supplies, rapidly changing information, as well as the need to provide healthcare services to both the general population and those suffering from COVID-19. With open access and free communication technologies, strategies can be shared, increasing the availability to our colleagues in low-resource settings. In this paper, we provide uniform resource locators (URLs) and supplements describing the changes we have made to address some of the difficulties presented to anaesthesia groups thus far during this pandemic. As we all continue to learn from each other, the sharing of resources is essential to maximise the effectiveness of anaesthesia providers for the ongoing pandemic and future challenges.

Restructuring department governance

The threat of a pandemic is destabilising to traditionally-structured departments in medicine because of the pace of change and the level of anxiety that it produces among practitioners. The particular characteristics of the COVID-19 pandemic, including aerosolised spread of the virus with tracheal intubation and extubation, the possibility of asymptomatic spread and a predominantly respiratory pathophysiology and transmission route, put anaesthesia providers at the forefront of the conversation. This is not only because of their vulnerability to the virus but also their skill set to care for affected patients. To adequately manage the deluge of new information and demands on anaesthesiologists, it became apparent to the leaders of our department that our success in responding to the pandemic would be a function of our ability to rapidly make decisions and disseminate those decisions through clear communication. Fundamental changes were made in the first few days of our department's response to the pandemic, which are summarised here.

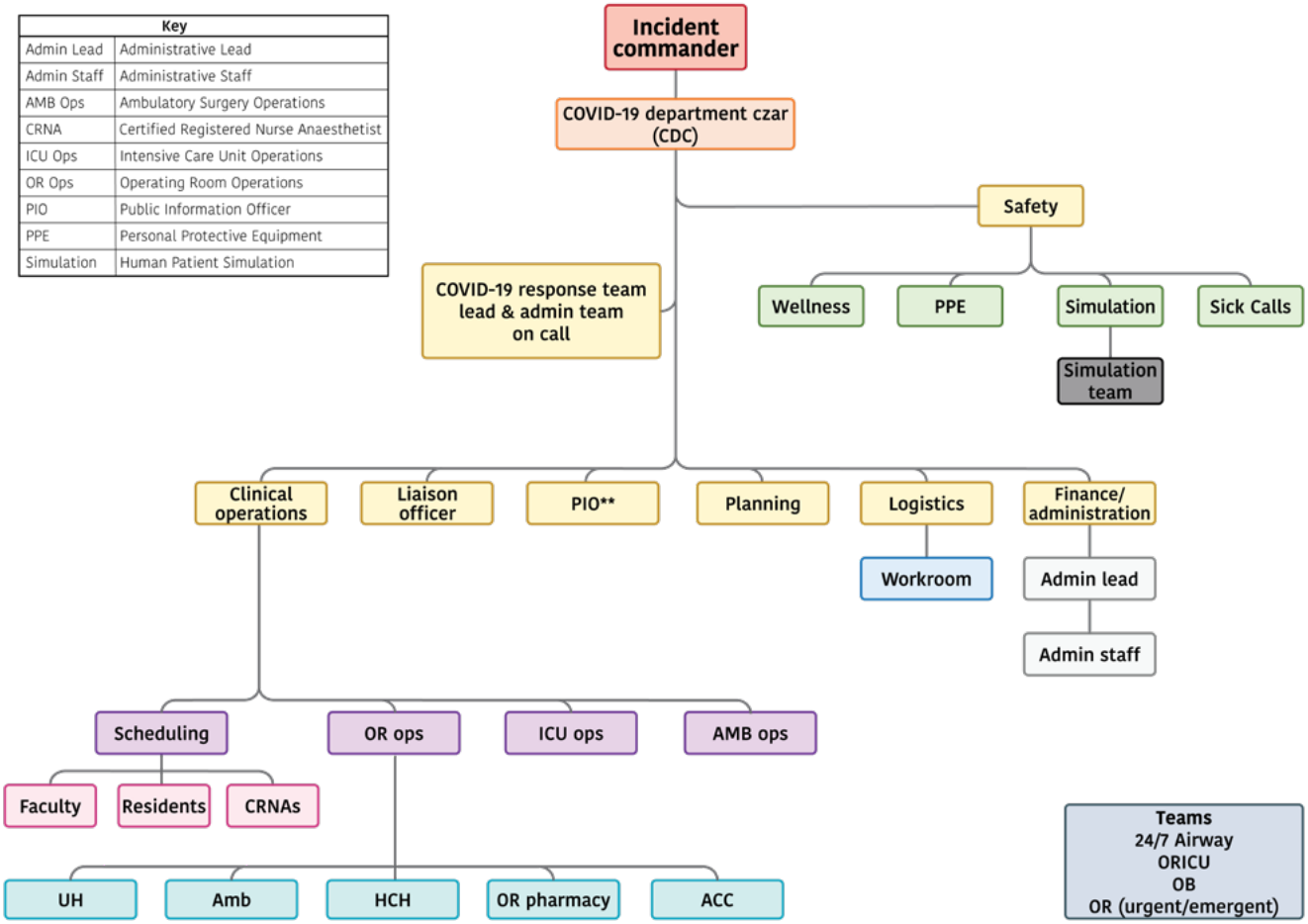

Figure 1: Adapted Incident Command System (ICS) integrated into the University of Utah, Department of Anesthesiology's leadership structure during the COVID-19 crisis
Adapted from the Federal Incident Command System (https://www.fema.gov/incident-command-system-resources).
ORICU – operating room intensive care unit, OB – obstetrics, OR – operating room, CRNA – certified registered nurse anaesthetist, UH – university health, PIO – public information officer, CDC – COVID-19 department czar, ICU ops – intensive care unit operations, AMB ops – ambulatory surgery operations, ACC – ambulatory care centre, HCH – Huntsman Cancer Hospital, UH – university hospital, OR ops – operating room operations, Admin lead – administrative lead, Sim – simulation, amb – ambulatory, CRTL – COVID-19 incident response team leaders

Incident Command System

The Federal Emergency Management Agency's (FEMA) Incident Command System (ICS)[6] has been adopted and adapted into medical practices to coordinate emergency response.[7-9] The ICS helps to organise a network structure into a hierarchical form of governance.[10] The goal of integrating the ICS was to support streamlined communication, to create a clear delineation of responsibilities and to facilitate rapid and decisive action when necessary. We found the ICS to be especially useful as our COVID-19 response became more complex (Figure 1).

COVID-19 response team leaders

The COVID-19 response team leaders (CRTL) comprised a small group of leaders within the department with an understanding of hospital operations and disaster response. Daily CRTL huddles allowed for fast and informed decision-making, clear messaging and coordinated communication with other stakeholders within the hospital including nursing, surgery, epidemiology, infectious disease, critical care and wellness.

COVID-19 department czar

We established a new position to head the COVID-19 response, coordinating all aspects of the effort. The COVID-19 department czar (CDC) was responsible for delivering daily email and periodic live videoconference updates. The CDC also served as a liaison to hospital administration regarding COVID-19.

On-call COVID-19 response leader

The CRTL implemented a schedule during which one CRTL leader would be on call to answer COVID-19-related questions (e.g. clinical protocols, PPE use or after-hours sick calls). This schedule ensured that a leader was on call on a rotating basis during any given 24-hour day.

Information dissemination

Clear and accurate dissemination of information is critical for the stability of a department during a crisis. Our goals were to provide simple and clear communication from a single source, to prevent the spread of misinformation (e.g. rumours proliferating through department-wide email blasts) and to develop a well-informed and unified voice from department leadership to

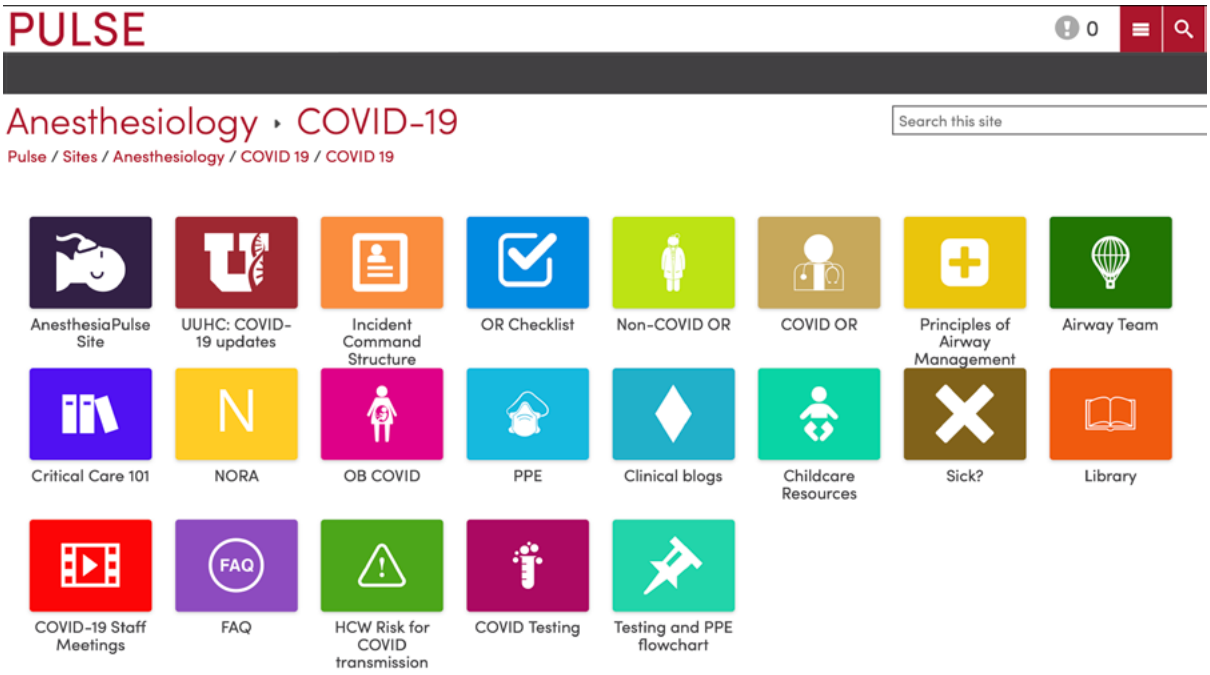

Figure 2: University of Utah Department of Anesthesiology COVID-19 website screenshot representing the main categories of daily curated material available for clinicians
Source: Department of Anesthesiology, University of Utah
PPE – personal protective equipment, UUHC – University of Utah healthcare, OR – operating room, OB – obstetrics, NORA – non-operating room anaesthesia, FAQ – frequently asked questions, HCW – healthcare workers

HEALTH UNIVERSITY OF UTAH

PPE Supply Summary
Purchased and Issued

Data as of: May 28, 2020
▲ ▼ : Variance from Previous Week

		Daily Average Use (Averages based on previous week's data)		Quantity Available		Days On Hand	
N-95	N-95 3M Fold	26	▲0%	4,503	▼-2%	173	▼-2%
	N-95 Haylard Duckbill Reg	60	▼-48%	56,238	▼-1%	928	▲89%
	N-95 Haylard Duckbill Small	21	▼-66%	25,326	▲ 7%	1,166	▲203%
	N-95 Total	108	▼-47%	86,067	▲ 1%		
MASK	Mask Earloop- Procedure	4,663	▼-9%	546,819	▲8%	117	▲19%
PAPR	PAPR Hood MD/LG-Reusable	N/A	N/A	832	▼-1%	N/A	N/A
	PAPR Hood SM/MD-Reusable	N/A	N/A	181	▼-10%	N/A	N/A
	PAPR Total			1,013	▼-3%		
GOWN	Gown- Blue	2,367	▼-22%	81,844	▼-17%	35	▲7%
	Gown- Yellow	70	▼-46%	42,372	▲2%	605	▲88%
	Gown Total	2,437	▼-23%	124,216	▼-11%		
EYE PROTECTION	Safety Glasses	62	▼-21%	1,486	▼-15%	24	▲7%
	Safety Glasses- Hard-sided	11	▼-84%	2,763	▼-2%	233	▲469%
	Visor-Full Face	9	▼-87%	18,857	▼-1%	1,941	▲606%
	Eye Protection Total	84	▼-61%	23,106	▼-2%		

Figure 3: *PPE supply summary* is a dashboard provided by the hospital to inform hospital staff of PPE availability and use on a daily basis
PPE – personal protective equipment, PAPR – powered air purifying respirator, N-95 – negativity at approximately 95 milliseconds, MD/LG – medium/large

inform practice. In order to accomplish this, we developed numerous communications and reference and education tools (summarised in Supplement 1).

COVID-19 departmental intranet

Content for the intranet was curated daily by the CRTL and links to updated protocols and information were highlighted in the CDC's daily email. Content included clinical protocols, recommended practices when caring for COVID-19 patients in the operating room, COVID-19 cardiac arrest recommendations, COVID-19 airway procedure recommendations, PPE guidelines, and wellness resources, including childcare, sick call policies and a library of selected COVID-19 literature (Figure 2).

COVID-19 mobile application

This mobile reference guide provided infographics on the principles of COVID-19 airway management, PPE donning and doffing procedures, COVID-19 infection prevention principles for operating room cases and an interactive checklist for operating room cases with suspected/confirmed COVID-19 patients. The intent of the mobile application (app) was to provide key information that was always accessible to practitioners on their smartphones. See the following URL for COVID-19 mobile content and instructions on how to download the app: https://medicine.utah.edu/anesthesiology/covid-19-app.php.

Dashboards

Dashboards were developed and updated daily, and included, among others, information on medication shortages, PPE supplies, hospital capacity and COVID-19 case burden. Figure 3 shows a real-time dashboard tracking the supply of PPE based on the reported daily use rates as an example of a relevant dashboard from the early days of the pandemic.

COVID-19 reference handbook

This clinical reference was created as a pocket-sized, wipeable booklet with infographics on COVID-19 airway management and PPE donning and doffing procedures. It was intended as a supplement to the app, making key information available to clinicians in a convenient, portable format. The content and instructions on how to print the content into a booklet is available at the following URL: https://medicine.utah.edu/anesthesiology/files/covid19-for-anesthesiologists-ppe-and-airway-management-03.21.2020.pdf.

Lectures and education supplements

This material on evidence-based guidelines for the care of COVID-19 patients was developed as concise, rapidly-digestible educational content, supplemented by lectures. The section on converting operating room resources to intensive care unit resources contains full details as well as the supplement URL.

Live COVID-19 weekly videoconferences

During the early weeks of the pandemic, it became clear that a live videoconference was the most effective way of communicating information on updates and faculty concerns. This format had the added benefit of increasing the human element in the process of information dissemination. Questions were texted to a designee during the meeting and all questions were addressed in a comprehensive email using a frequently asked questions (FAQs) format, which was sent out after the videoconference.

Daily COVID-19 email

This daily email for department-wide distribution was prepared by the CDC as a high-level summary for the time-starved and overwhelmed clinical audience. The email included relevant updates with links to protocol changes, dashboards and hospital communications.

Simulation course

A simulation course consisting of four simulations was developed to address knowledge gaps on COVID-19 clinical care and PPE use. (See the section on the COVID-19 simulation course for more details.)

COVID-19 library

The information deluge during the early stages of the pandemic was overwhelming and anxiety producing. To promote clarity about the scientific foundation informing the clinical care of COVID-19 patients, a few departmental clinical scientists curated a set of high-quality publications from the scientific literature. This frequently-updated library of articles, which was placed on the website, was a convenient way for our clinicians to stay up to date on the latest thinking regarding the pandemic.

Personal protective equipment

Both the clinical and psychological benefits of access to adequate PPE during a pandemic cannot be overemphasised. The three main themes to our approach toward addressing PPE use and supply were (i) widespread respirator mask fit testing, (ii) widespread training on donning and doffing PPE and (iii) PPE conservation.

At the onset of the pandemic, only a minority of our providers had been fit tested for N95 masks and it was apparent that the typical process of fit testing at our institution would be quickly overwhelmed. To address this need, a number of our administrative staff undertook training to become qualified fit testers which dramatically expanded our capacity.

Furthermore, worldwide PPE supply shortages demanded an approach to conserving N95 respirators. In addition to clear messaging on the appropriate use of N95 respirators (Figure 3) and the development of a hospital ultraviolet mask sterilisation programme, our department was able to acquire elastomeric respirators (also known as P100 masks) from an online source.

These reusable respirators protected our providers while not depleting the stock of N95 masks. These respirators provided additional challenges, however, as we had to work with industry representatives, our department's bioengineers, as well as our institution's environmental health and safety group to ensure that the masks were genuine, would provide the appropriate protection,[13] and could be cleaned appropriately.

COVID-19 simulation course

The anaesthesiology department's simulation centre developed a 2.5-hour high-fidelity simulation course addressing the unique requirements of delivering care in the midst of a respiratory virus pandemic. The main thrust of this simulation course was to address the logistics of maximising patient and provider safety, and reducing contamination of the environment and equipment during airway events and "code blue" episodes.

A needs assessment identified four knowledge gaps: (i) familiarity with PPE, (ii) environmental protection of the anaesthesia

Table I: Four simulation stations using both low- and high-fidelity techniques to train personnel to care for the COVID-19 patient

Stations	Learning objectives	Time
PPE	• Identification of the level of PPE needed for aerosolising procedures and non-aerosolising procedures • Correct donning and doffing protocols	15 minutes
Anaesthesia machine	• Location of HEPA/HME filters on the anaesthesia circuit • Anaesthesia machine turnover • OR cleaning	15 minutes
OR airway	• Practice PPE donning and doffing order • Best practices during routine airway management • Best practices during difficult airway management	45 minutes
NORA airway and code blue	• Practice PPE donning and doffing order • Best practices of non-OR airway management • Best practices during CPR	45 minutes

PPE – personal protective equipment, HEPA/HME – high efficiency particulate air/heat and moisture exchanger, OR – operating room, NORA – non-operating room anaesthesia, non-OR – non-operating room, CPR – cardiopulmonary resuscitation

machine and the operating room, (iii) routine and difficult airway management in a COVID-19 patient in the operating room (OR) and (iv) emergent airway management and advanced cardiovascular life support (ACLS) protocols in non-OR locations in a COVID-19 patient. A set of four simulations were thus developed to address these knowledge gaps (Table I).

Airway team

The leadership team coordinating our response to the pandemic identified the need to establish a specialised COVID-19 airway team during the early days of the COVID-19 outbreak. A team dedicated to performing all tracheal intubations in the hospital during a respiratory virus pandemic has the following three functions: (i) to ensure that the most experienced providers are managing airways for the best patient outcome; (ii) to minimise the number of personnel exposed to virus; and (iii) to optimise the use of resources, including PPE and airway equipment.

Elimination of elective surgery freed up anaesthesia providers to staff an in-house, 24/7 airway team consisting of two attending anaesthesiologists. The airway team offered immediate access to attending physicians in high-level PPE with the ability to manage airways, initiate mechanical ventilation, perform invasive procedures and treat haemodynamic instability. While the primary role of the airway team was to manage all tracheal intubations in the hospital, the team was asked to fill additional critical roles in the hospital, including responding to and directing care for all "rapid response" calls and cardiac arrests, as well as being "on-call" critical care extenders in the respiratory unit of the emergency department.

Converting operating room resources to intensive care unit resources

The sudden reduction in surgical volume and the anticipated need for a dramatic increase in intensive care unit (ICU) ventilator beds created an opportunity to transform newly underused operating rooms into much-needed critical care beds using the anaesthesia machine ventilators. Anticipating a surge of critically ill COVID-19 patients, we set out to rapidly reallocate the perioperative physical spaces, material resources and personnel. To meet this need, education on evidence-based guidelines for care of acute respiratory distress syndrome (ARDS) and sepsis patients was combined with evolving consensus-based COVID-19 care guidelines. These guidelines were put into concise, rapidly digestible content, supplemented with video lectures. (See the following URL for lectures and educational content: https://medicine.utah.edu/anesthesiology/covid-19.php.) In addition, ICU shadowing experiences were created for our anaesthesiology faculty in order to refresh their ICU practice knowledge and skill, and to prepare them to join a multi-tiered, expanded critical care team. This staffing flexibility provided by anaesthesiologists allowed for the offloading of ICU physician tasks to the team of anaesthesia critical care extenders.

Bioengineering research

In response to the pandemic, the department's bioengineering research group (which has a long history of developing respiratory equipment) re-oriented their focus to address an expected significant shortage of ventilator capacity.[11] Breathing circuit modifications were designed and tested to allow home bilevel positive airway pressure (BiPAP) ventilators to be used for intubated patients as a last resort. In addition, guidance for using anaesthesia machines for long-term ventilation were developed (Supplement 2).

In collaboration with a bioengineering group at Stanford University, a simple ventilator was developed, designed to be rapidly manufactured with components from outside of the fragile medical supply chain.[12] This collaboration has since been expanded upon to include more than 35 researchers and a number of major industrial partners. This effort is partly directed at low-resource settings where ventilator capacity may be severely limited. This collaborative group is preparing the design for the US Food and Drug Administration (FDA) Emergency Use Authorization (EUA) and open source distribution to the international community (https://www.pez-globo.org/). Numerous prototypes of the ventilator have been manufactured and have been deployed clinically in low resource countries.

Response to pharmacy constraints

The COVID-19 pandemic significantly disrupted medication supply by decreasing production at the source.[14] In addition, COVID-19 patients who are mechanically ventilated require higher levels of sedative medications that are in limited supply.[15] This reality, coupled with the unpredictable volume of critically ill COVID-19 patients, required significant changes to adequately manage the limited inventory of these critically important medications.

To meet this challenge, a medication dashboard was created showing daily use of sedatives, opioids and muscle relaxants in OR anaesthesia, non-operating room anaesthesia (NORA), nurse sedation and ICU sedation (Table II). The dashboard supplied additional information including how long the current supply would last given different volumes of mechanically-ventilated COVID-19 patients. To guide consumption practices of these critical medications, we published an internal dashboard that was updated daily and made available to our clinicians, to provide the information needed to prioritise and alter their medication regimens in the perioperative setting (Table II).

Wellness

The physical and mental health of anaesthesiologists is a critical resource during an organised response to a pandemic.[16] In addition to the intrinsic stresses of the everyday practice of physicians,[17] a pandemic adds, among others, the stress of expansion of clinical duties to areas outside their usual scope of practice,[18] the stress of caring for multiple critically ill patients,[16] second victim effects,[19] concerns for preventing infection in oneself and one's family, financial concerns, child care and homeschooling needs. Physician burnout has been a well-documented and growing problem prior to the pandemic,[20,21] so it is clear that increased wellness efforts are necessary to support providers.[22]

To meet an anticipated increase in the need for wellness services, a wellness champion was designated within our department to identify providers in need and to work with the hospital resiliency centre to facilitate assistance. The wellness champion provided live videoconference updates, relevant scholarly articles and a collection of community resources that offered services for healthcare providers. Perhaps the greatest impact of the wellness champion was derived from personal communication with every practitioner on a periodic basis. These personal conversations enabled individual physicians to voice their concerns and to engage in peer support feedback.[23,24] On occasion, these interactions resulted in referral to the resources available at the hospital's resiliency centre.

Table II: An example of our internally published medication supply dashboard showing the "days on hand" of medications likely to be in short supply if our institution was to accommodate a sudden rise in the number of patients needing to be sedated for ventilation in the ICU

Ventilated COVID-19 patients	Operating room interventions	Medication supply dashboard								
				20 + days		10–20 days		< 10 days		
		Fentanyl	Hydromorphone	Midazolam	Lorazepam	Cisatracurium	Rocuronium	Succinylcholine	Vecuronium	Propofol
200 patients	Restricted cases only (emergent or time-sensitive)	Yellow	Green	Yellow	Yellow	Orange	Green	Green	Orange	Yellow
	Historic caseload with new medication saving anaesthesia regimens	Yellow	Green	Yellow	Yellow	Orange	Green	Green	Orange	Yellow
	Historic caseload with routine anaesthesia	Orange	Green	Orange	Orange	Orange	Green	Green	Orange	Orange
100 patients	Restricted cases only (emergent or time-sensitive)	Green	Green	Green	Green	Yellow	Green	Green	Yellow	Green
	Historic caseload with new medication saving anaesthesia regimens	Green	Green	Green	Green	Yellow	Green	Green	Yellow	Green
	Historic caseload with routine anaesthesia	Yellow	Green	Yellow	Yellow	Yellow	Green	Green	Yellow	Yellow

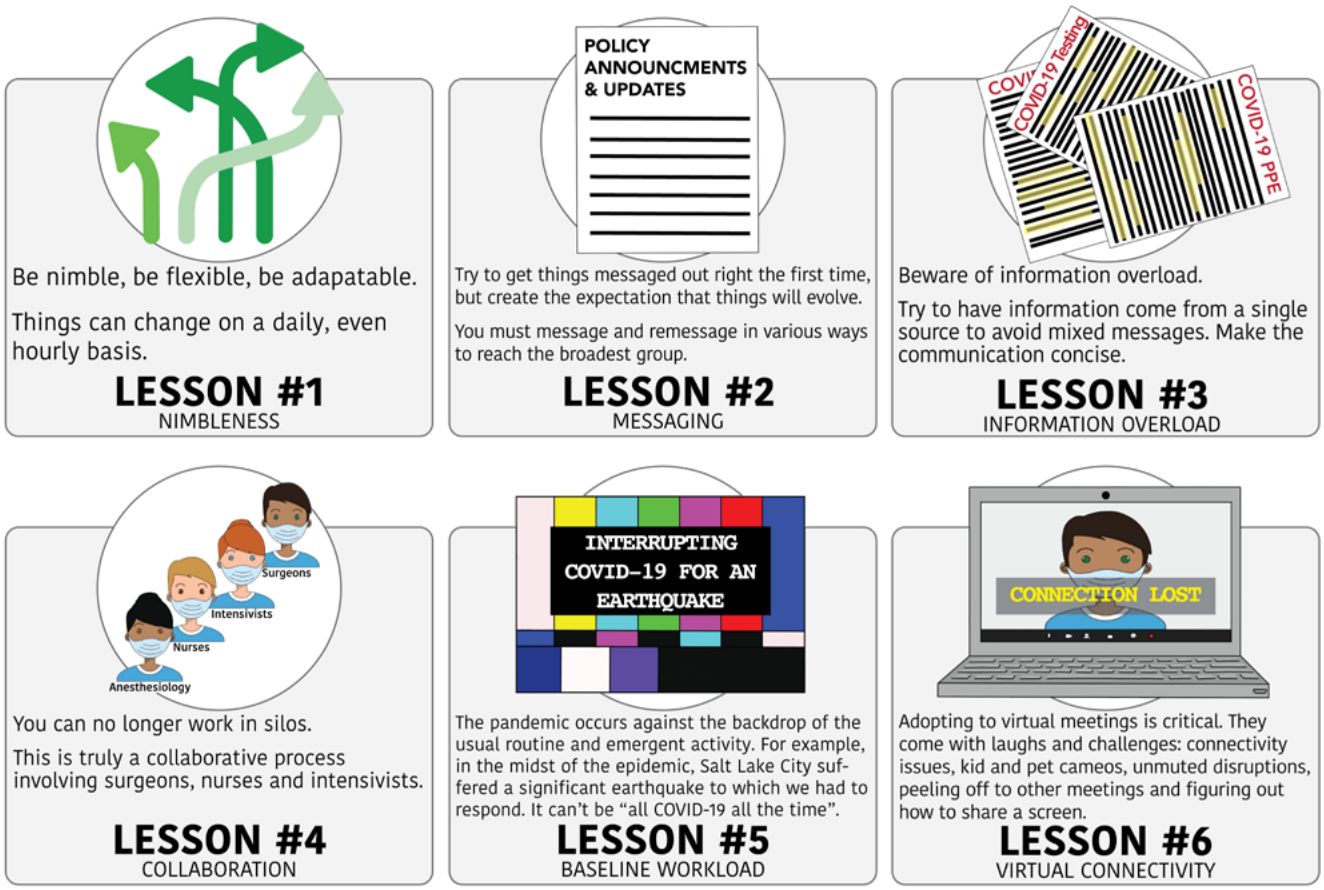

Figure 4: Selected lessons learnt during the University of Utah, Department of Anesthesiology's response to the COVID-19 pandemic
Source: Department of Anesthesiology, University of Utah
Lesson 1 – The rapid pace of change in the early days of the pandemic required a nimble leadership team that could efficiently make decisions based on up-to-date information. Instituting the COVID-19 response team leaders (CRTL) and daily huddles helped to meet this demand.
Lesson 2 – People lose confidence if there is a lot of backtracking of information. The COVID-19 department czar (CDC) was a liaison to the hospital epidemiologist and other parties responsible for giving vital information that shaped departmental policy. All information went to the CDC, who was the single source of COVID-19 information to the department, thereby reducing the need to message different information. Nonetheless, messaging multiple times in multiples ways was found to be necessary to acculturate change quickly.
Lesson 3 – The deluge of information sent internally and externally to the department, both to leaders and to front line providers, is vast, often contradictory, and anxiety producing. To limit this, we instituted a requirement that all COVID-19 information was to be sent to the CDC, who would then coordinate messaging with the CRTL and then send out a daily COVID-19 email.
Lesson 4 – Changes in policies and procedures takes time to acculturate with all the different perioperative staff. Getting all stakeholders involved in discussions early and messaging from a single source helps to avoid confusion.
Lesson 5 – The department continued to experience non-COVID-19 related needs and even emergencies during the COVID-19 crisis. Having a secondary leadership structure in place, the adapted Incident Command Structure (Figure 2), allowed COVID-19 needs to be addressed as other operational needs were also addressed.
Lesson 6 – In order to limit possible exposure to SARS-CoV-2, all non-essential face-to-face contact ceased and many virtual meetings were required in its place. This presented many challenges and was best met with increased patience and kindness towards one's colleagues and tolerance of this different method of operating meetings.

Scientific guidance

With the outbreak of COVID-19, important issues within our department and institution emerged that required scientific guidance to address. One of the most significant issues was how to implement several therapeutic trials and requests for off-label or non-conventional treatments for patients with COVID-19. With no well-established interventions to treat SARS-CoV-2 infections or its complications, a consensus among physician leaders at our institution and elsewhere was that most patients would benefit from participation in well-designed clinical trials. To that end, a multidisciplinary therapeutics panel was established to evaluate institutional review board (IRB)-approved trials in order to provide guidance to providers caring for COVID-19 patients with regard to priority of individual trials for specific patient groups.

Table III: A summary of services offered during crisis and "new normal" modes

	Crisis services	New normal services
Airway team	√	Paused
CDC	√	√
CRTL	√	√
ICS	√	Paused
Daily huddle	√	Weekly huddle
Weekly live online faculty updates	√	As needed
Daily email	√	Weekly email
On-call CRTL	√	Paused

CDC – COVID-19 department czar, CRTL – COVID-19 response team leaders, ICS – Incident Command Structure

The panel has also provided information about specific agents (such as remdesivir, hydroxychloroquine, azithromycin, etc.) which have been approved in other contexts, and are now under consideration for off-label or FDA-approved emergency use for COVID-19.

Chair's perspective – the Dunkirk analogy

To mount an effective response to the pandemic, we unveiled a theme early in the crisis as a symbol of our commitment to engage all of our department members in the fight against the SARS-CoV-2 virus. Alluding to the well-known evacuation at Dunkirk in the late spring of 1940, in which the rescue of hundreds of thousands of soldiers from the western coast of France was made possible by throngs of "little ships" manned by civilians, we named our department response to the pandemic "Operation COVID-19 Anesthesia Dunkirk". In developing the theme, a recurring motif at our department meetings was that all department members were called to come to the rescue in their respective roles, making sacrifices as necessary.

The organisation of our response to the pandemic taught us many lessons that we leveraged when the surge of COVID-19 patients eventually materialised in our region (it will also be useful when some other crisis arises). These lessons relate to a wide variety of issues, including decision-making and governance, communication, collaboration and resilience (Figure 4). There are certainly more lessons to be learnt in the days to come.

As the pandemic continues to unfold, the Dunkirk analogy is obviously apropos. A department's response to a crisis is akin to a military operation in that things do not usually proceed according to plan, necessitating continuous adaptation to failure. It is inspiring to see healthcare workers the world over courageously boarding their individual boats and coming to the rescue at a time of great societal need, despite personal danger.

Transitioning to a "new normal" with our global anaesthesia community

The global anaesthesia community continues to adapt their various approaches to the pandemic. As we transition from crisis mode to a "new normal" (Table III) and prepare for additional COVID-19 peaks stretching over months or years, it is important that approaches to preparation are shared to allow adoption of best practices and an effective ongoing response to the pandemic.

With open access and free communication technologies, we have the advantage of easily sharing resources throughout the world, including low-resource settings. We have outlined some of our approaches (all of which are available through the indicated URLs and supplements), including how we restructured communication, implemented education interventions and approached dealing with constrained anaesthesia resources. These interventions represent more of a way in which to structure communication, present information and adapt to changes in resources. Therefore, these are low-resource interventions and could be replicated in most anaesthesia departments. As we all continue to learn from each other, the sharing of resources is essential to maximise the effectiveness of anaesthesia providers for this ongoing pandemic as well as future challenges.

Conflict of interest

Drs Morrissey, Zimmerman, Bledsoe, Bott, Stuart, DeCou, Thackeray, Kuck, Dorsey, Chortkoff, Drennan, Smith, and Jackman, and Ms Chacin and Mr Paulsen have nothing to disclose. Dr Johnson reports grants from GE Healthcare, during the conduct of the study; other from Applied Medical Visualizations, LLC, outside the submitted work; and is an author on several published manuscripts that describe the models used in the drug display presented in this manuscript. Dr Egan reports other from Applied Medical Visualizations, during the conduct of the study; other from Paion, outside the submitted work; in addition, Dr Egan has a patent US8744779B2.

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References

1. Grasselli G, Pesenti A, Cecconi M. Critical care utilization for the COVID-19 outbreak in Lombardy, Italy: early experience and forecast during an emergency response. JAMA. 2020;323(16):1545-46. https://doi.org/10.1001/jama.2020.4031.
2. Wu Z, McGoogan JM. Characteristics of and important lessons from the coronavirus disease 2019 (COVID-19) outbreak in China: summary of a report of 72 314 cases from the Chinese Center for Disease Control and Prevention. JAMA. 2020;323(13):1239-42. https://doi.org/10.1001/jama.2020.2648.
3. Ranny M, Griffeth V, Jha A. Critical supply shortages – the need for ventilators and personal protective equipment during the Covid-19 pandemic. N Engl J Med. 2020;382:e41. https://doi.org/10.1056/NEJMp2006141.
4. Hick J, Hanfling D, Wynia M, Pavia A. Duty to plan: health care, crisis standards of care and novel coronavirus SARS-CoV-2. NAM Perspectives. Discussion paper. Washington: National Academy of Medicine; 2020. https://doi.org/10.31478/202003b.
5. Anderson RM, Heesterbeek H, Klinkenberg D, Hollingsworth TD. How will country-based mitigation measures influence the course of the COVID-19 epidemic? Lancet. 2020;395(10228):931-34. https://doi.org/10.1016/S0140-6736(20)30567-5.
6. ICS Review Document [Internet]. Washington: FEMA; 2018. Available from: https://training.fema.gov/emiweb/is/icsresource/assets/ics%20review%20document.pdf. Accessed 10 May 2020.
7. Schmidt JM. Seeking evidence-based Covid-19 preparedness: a FEMA framework for clinic management. NEMJ Catalyst [Internet]. 2020 March. https://doi.org/10.1056/CAT.20.0079.
8. Zarzaur BL, Stahl CC, Greenberg JA, Savage SA, Minter RM. Blueprint for restructuring a department of surgery in concert with the health care system

during a pandemic: the University of Wisconsin experience. JAMA Surg. 2020;155(7):628-35. https://doi.org/10.1001/jamasurg.2020.1386.
9. Arnold J, Dembry L, Tsai M, et al. Recommended modifications and applications of the hospital emergency incident command system for hospital emergency management. Prehosp Disaster Med. 2005;20(5):290-300. https://doi.org/10.1017/S1049023X00002740.
10. Moynihan DP. Combining structural forms in the search for policy tools: incident command systems in U.S. crisis management. Governance. 2008;21:205-29. https://doi.org/10.1111/j.1468-0491.2008.00395.x.
11. Ferguson N, Laydon D, Nedjati-Gilani G, et al. Report 9: impact of non-pharmaceutical interventions (NPIs) to reduce COVID-19 mortality and healthcare demand [Internet]. London: Imperial College COVID-19 Response Team; 2020. https://doi.org/1025561/77482.
12. Li H, Li E, Krishnamurthy D, et al. Utah-Stanford ventilator (Vent4US): developing a rapidly scalable ventilator for COVID-19 patients with ARDS. medRxiv. 2020. https://doi.org/10.1101/2020.04.18.20070367.
13. Gardner PD, Eshbaugh JP, Harpest SD, Richardson AW, Hofacre KC. Viable viral efficiency of N-95 and P100 respirator filters at constant and cyclic flow. J Occup Environ Hyg. 2013;10(10):564-72. https://doi.org/10.1080/15459624.2013.818228.
14. Badreldin HA, Atallah B. Global drug shortages due to COVID-19: impact on patient care and mitigation strategies. Res Social Adm Pharm. 2021;17(1):1946-9. https://doi.org/10.1016/j.sapharm.2020.05.017.
15. Hanidziar D, Bittner E. Sedation of mechanically ventilated COVID-19 patients: challenges and special considerations. Anesth Analg. 2020;131(1):e40-e41. https://doi.org/10.1213/ANE.0000000000004887.
16. Shanafelt T. Burnout in anesthesiology: a call to action. Anesthesiology. 2011;114(1):1-2. https://doi.org/10.1097/ALN.0b013e318201cf92.
17. McCue J. The effects of stress on physicians and their medical practice. N Engl J Med. 1982;306:458-63. https://doi.org/10.1056/NEJM198202253060805.
18. Chuang CH, Tsing PC, Lin CY, Lin KH, Chen YY. Burnout in the intensive care unit professionals: a systematic review. Medicine (Baltimore). 2016:95(50):e5629. https://doi.org/10.1097/MD.0000000000005629.
19. Vincent C. Understanding and responding to adverse events. N Engl J Med. 2003;348:1051-6. https://doi.org/10.1056/NEJMhpr020760.
20. Shanafelt T, Sloan J, Habermann T. The well-being of physicians. Am J Med. 2003;114:513-59. https://doi.org/10.1016/s0002-9343(03)00117-7.
21. Hyman S, Michaels DR, Berry JM, et al. Risk of burnout in perioperative clinicians: a survey study and literature review. Anesthesiology. 2011;114:194-204. https://doi.org/10.1097/ALN.0b013e318201ce9a.
22. Dunn PM, Arnett BB, Christensen JF, Homer L. Meeting the imperative to improve physician well-being: assessment of an innovative program. J Gen Intern Med. 2007;22:1544-52. https://doi.org/10.1007/s11606-007-0363-5.
23. Gordon EK, Baranov DY, Fleisher LA. The role of feedback in ameliorating burnout. Curr Opinion Anaesthesiol. 2018;31(3):361-65. https://doi.org/10.1097/ACO.0000000000000583.
24. Vinson AE, Randel G. Peer support in anesthesia: turning war stories into wellness. Curr Opinion Anaesthesiol. 2018:31(3):382-87. https://doi.org/10.1097/ACO.0000000000000591.

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