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Resident Education and Redeployment During a Disaster



Vanessa Mazandi, MD^{a,*}, Emily Gordon, MD, MSED^b

KEYWORDS

- Resident education • Anesthesia residency • COVID-19 • Housestaff
- Resident staffing model

KEY POINTS

- Redefining roles for anesthesia residents in a pandemic.
- Preparing residents to take on new roles during a time of limited health care resources.
- Balancing clinical service and education during a time of limited health care resources.
- Providing emotional support for residents during a health care crisis.

INTRODUCTION

In the United States, there are more than 140,000 physician residents training in more than 20 specialties.¹ Many are in US cities with more than 8000 people per square mile; locations with population densities that make them more susceptible to spread of a pathogen via droplet or airborne methods. When a virulent microorganism with high communicability hits regions of high population density, there exists the potential for an epidemic, which can pose a threat to the stability of the health system in these communities. As the spread of the novel severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2; Coronavirus Disease 2019 [COVID-19]) has demonstrated, our global economy provides the runway, so to speak, for an epidemic to enter the category of pandemic, with the ability to disrupt health care systems worldwide.

In the US health care system, resident physicians make up more than 10% of the physician work force,² a proportion that grows larger if you compare resident physicians with inpatient-based attending physicians. Furthermore, as larger hospitals can accommodate a higher number of trainees in residency programs, most resident physicians practice at tertiary medical centers that assume care for the sickest, most

^a Department of Anesthesiology and Critical Care, Children's Hospital of Philadelphia, 3401 Civic Center Boulevard, Philadelphia, PA 19104, USA; ^b Department of Anesthesiology and Critical Care, Hospital of the University of Pennsylvania, 3400 Spruce Street, Philadelphia, PA 19104, USA

* Corresponding author.

E-mail address: mazandiv@email.chop.edu

complex patients; patients who are most vulnerable in a pandemic. Given their large footprint within the US health care system, the specialty-specific skill sets, ability to care for patients in novel environments, and educational requirements of residents are all factors that must be considered when determining how best to use these physicians-in-training to ensure outstanding patient care both in the short-term scope of a pandemic surge, and in the future as trainees assume the role of attending physicians.

At the same time, although it is true that a career in medicine entails lifelong learning, resident physicians have unique needs among learners in that they are building the necessary foundations of the educational base that will serve them for their careers. Not only is it important that their skillsets be redeployed in useful ways during a crisis that stresses the health care system, but it is equally as critical that their overall educational goals are met. COVID-19 created additional stress for resident education, forcing creative solutions to continue resident education during a time when the tug-of-war between clinical duties and didactics intensified. A highly communicable disease, COVID-19 required renewed commitment to ensure time for didactic learning, while also finding ways to keep it effective in a remote learning environment. The lessons learned during the COVID-19 outbreak in the spring of 2020 can be applied to any disaster that challenges the US health system.

Among resident physicians, those in anesthesia face unique challenges in a pandemic given their skillset. Anesthesia residents are well-suited to care for patients in a critical care environment as front-line ordering clinicians both from a medical management standpoint, and due to familiarity with ordering processes given their role as residents, and relatively recent roles as interns and medical students, within a large hospital structure. In addition, anesthesiology requires mastery of procedural skills, which can be more difficult to attain when elective surgical cases are canceled to enable better resource utilization within the hospital during a pandemic. Anesthesia residents serve as a fluid work force that can quickly adapt to a critical care environment. The additional benefit of staffing anesthesia residents in the intensive care unit (ICU) is the educational value for the trainees in the setting of fewer operating room (OR) cases. As will be discussed further, clinical/"bedside" learning is challenging during a pandemic that requires socially distanced virtual learning; rotating through the ICU provides an opportunity for anesthesia residents to use and improve on their procedural and critical thinking skills.

DISCUSSION: REDEPLOYMENT OF RESIDENTS

Anesthesia residents are uniquely suited to redeployment during a pandemic that requires specialists in critical care. The more than 6700 anesthesia residents¹ in the United States provide valuable staffing during times when the resources of the health care system are challenged. Not only do anesthesia residents have high exposure to equipment and procedures used to care for critically ill patients (including ventilators, advanced airways, and advanced monitoring devices, as well as arterial and central line placement) but they have more recent exposure to different areas of the hospital, including specific ICU rotations, and potentially even different electronic medical record systems given their proximity to medical school rotations. As such, they are distinctively qualified to serve as front-line care providers in the ICU as they are both familiar with the ICU environment, and have recent exposure to a variety of medical environments and electronic medical records.

In fact, because anesthesia residents possess a skillset that makes them adaptable to working in non-OR locations caring for critically ill patients, their absence from other

rotations must be weighed in the setting of limited resources. For example, during a pandemic-driven surge in hospital admissions, it may be more appropriate to have a junior medicine resident help with the duties of the pain service or perioperative clinic so that anesthesia residents can be prioritized for staffing needs in the ICU. In addition, senior anesthesia residents can be relied on to serve, alongside advanced practice practitioners (APPs), as supervisors within the front-line ordering clinician hierarchy given the exposure to ICU monitoring and life-sustaining interventions that are encountered in daily OR assignments. This ability for supervision and service as educators becomes especially important when hospitals are forced to shift to a pandemic/mass casualty event model of staffing, where residents are pulled from normal assignments to cover areas of the hospital with which they may have less familiarity.

During the initial COVID-19 outbreak in the spring of 2020, elective surgical cases were canceled, leaving an abundance of surgical residents with decreased clinical duties, available to fill other roles in the hospital (Figs. 1 and 2). Even on nonsurgical floors, the spring of 2020 COVID-19 experience demonstrated how quickly all hospital services can have a decrease in other types of admissions during a pandemic, increasing the number of trainees available to work in an ICU setting.^{3–5} In addition, as was seen in New York City and London during the spring of 2020 COVID-19 outbreak, pediatric ICUs can provide valuable beds during a surge in illness that affects adults more severely than children.⁶ In settings in which adult patients were cared for in a pediatric setting, front-line ordering clinicians included general pediatrics residents. Although surge spaces, whether in a pediatric ICU, OR, or medical or surgical floor, provide critical bed capacity, it is important that the providers caring for patients are equipped to care for these, at times, unfamiliar patient populations in an equitable fashion. This is just as important at the attending physician and nursing levels as it is for the front-line ordering clinicians. Although redistribution of health care resources can create increased staffing in a pandemic surge model, residents and APPs with limited critical care experience will benefit from being on teams with anesthesia colleagues as well as ICU-trained APPs.

Another key component to “uptraining” faculty, trainees, and other providers during the pandemic was Penn’s creation of a front-facing, public Web site with curriculums developed based on the provider’s prior knowledge and area of redeployment.⁷ During a time when ICU fellows and attending physicians may be following as many as 50 patients at a time, anesthesia residents and APPs, as both colleagues and

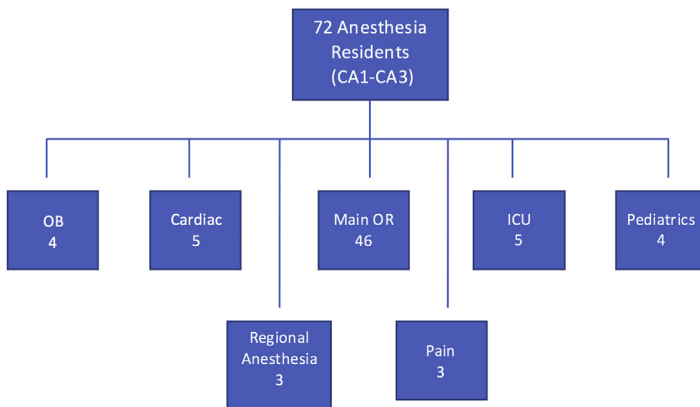


Fig. 1. Pre-COVID anesthesia resident staffing model.

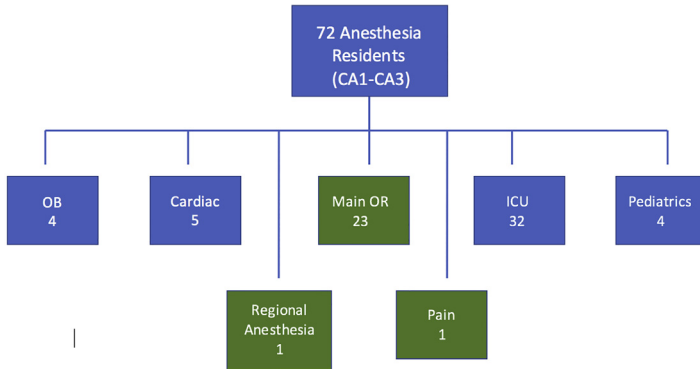


Fig. 2. COVID anesthesia resident staffing model.

supervisors, can provide education to those less familiar in critical care environments and help to ensure quality metrics are being met for all patients.

Efficacy within this ICU role is best met with preparation. The Department of Anesthesiology and Critical Care at the Hospital of the University of Pennsylvania (HUP) groomed the department's residents for their roles in the ICU by rotating small groups of residents for a brief time of 2 to 5 days through the ICUs. This served to both familiarize them with various ICU environments (including ICUs where they had not previously rotated), and develop camaraderie with the APPs and nurses. The time before a potential surge was the most valuable window in which to do this integration, as it ensured not only good care of patients with COVID-19, but also patients having urgent surgeries that required detailed, attentive care from practitioners familiar with their postoperative courses and possible complications.

As the surge intensified 100 miles north of Philadelphia, patients from New York and New Jersey were brought to University of Pennsylvania Health System hospitals, increasing the number of patients with COVID-19 and likewise the need for isolated units to care for the infected patients. Newer surge spaces were created, including a 36-bed negative-pressure unit in the postoperative care unit [PACU] of the HUP. Residents, APPs, and faculty who would work in this unit were notified ahead of time and participated in simulations within the unit before its opening. Although the PACU-turned-ICU was fortunately not needed in the spring of 2020 COVID-19 outbreak, the simulations were beneficial to establish the roles of anesthesia residents within this unit, and develop familiarity with the nurses and APPs who would work alongside them. In addition, an opportunity was leveraged for resident education with inclusion of the residents in virtual learning within the Division of Critical Care. There were also in-person demonstrations of different ventilators presented by critical care fellows, faculty, and respiratory therapists. During a time when OR cases were drastically reduced, resident learning and utilization continued in ways that prepared anesthesia trainees to be both board-certified anesthesiologists and front-line ordering clinicians in the event of a pandemic.

RESIDENT EDUCATION IN A PANDEMIC

The necessary cancellation of elective surgeries interrupted a critical component of clinical learning for anesthesia residents. At the same time, social distancing reduced the ability for didactic learning to continue in-person. The second problem was more easily addressed than the first.

Had COVID-19 presented itself 20 years ago, the ramifications on resident education could have been more damaging. However, within the anesthesia residency program at HUP, all the residents had access to the Internet and computers within their homes, making it possible to convert didactics to an online forum using the platforms BlueJeans and Zoom. Although the virtual learning environment cannot replace in-person learning, fortunately case conferences, board question reviews, and mock oral boards were able to continue with use of the chat function, selective muting of participants, and screen share for PowerPoint presentations.

The lack of in-person didactics combined with a less rigorous OR schedule allowed time to create a comprehensive resident educational Web site with video tutorials and didactics that will continue to be a resource, regardless of social distancing measures. A department-specific intranet that is updated in a timely fashion also can serve as a communication platform. The intranet can be a place to give updates, as well as post videos to demonstrate for all members of the department the skills necessary in the pandemic, such as proper donning and doffing of personal protective equipment, when to wear an N-95 mask and eye protection during intubations, and how to use filters with Ambu bags and the anesthesia machine when delivering care to infected patients. The residency leadership at HUP took advantage of a change in normal routines to enhance the available education resources. Building this type of infrastructure adds value to resident education in “normal times”; it becomes invaluable within the context of a pandemic. Real-time feedback was provided with regard to the new resident virtual curriculum in the form of weekly town halls with residency leadership.

Clinical learning is one of the most important aspects of resident education, especially for anesthesia. Although the ICU environment is a natural place for residents to expand their knowledge and skills in the use of vasoactive medications, sedatives, resuscitation pathophysiology, and vascular access, certain aspects of clinical knowledge are difficult to replicate during a pandemic. Regional anesthesia is one such specialty that requires clinical exposure and was adversely affected during the pandemic. Most blocks performed during a regional anesthesia rotation are done for elective orthopedic surgeries, which are often the first types of cases to be canceled when a crisis hits the health care system. Even with flexibility allowed by the American College of Graduate Medical Education (ACGME) for minimum number of blocks performed required to graduate from residency, acquiring proficiency in a time of limited elective cases is still a concern.

In times where resident presence is prioritized in other areas of the hospital, a more creative and personalized scheduling strategy is required. During a time when less regional anesthesia is done, it can be beneficial to have fewer residents on the rotation for less time; thus, cycling more residents through during, say, a 3-month stretch while allowing a single resident to handle the reduced volume of blocks during their rotation time. Prioritizing residents who have a strong interest in regional anesthesia, or who need more numbers of regional pain blocks, can also help to create an equitable system during a time of reduced learning opportunities. During the peak of COVID-19 cases in Philadelphia, the regional anesthesia rotation that normally has 2 residents, had only 1 assigned for usually a week at a time. When elective cases resumed, priority for the rotation was given to those who needed block numbers, and to those who had indicated a strong interest in regional anesthesia.

In addition to specialty rotations that are adversely impacted during a pandemic, foundational knowledge can be adversely affected. A mainstay of learning anesthesia is the introduction to the specialty through “one to ones.” At HUP, clinical anesthesia-1 (CA-1) residents are assigned to an attending in a 1-to-1 ratio during the month of July during a rotation called “1:1s.” In preparation for the springtime COVID-19 surge, there was concern that 1:1s may not be able to continue in traditional fashion if there was

still cessation of elective cases during the summer. Fortunately, the HUP ORs were at nearly full capacity in July 2020, and 1:1s proceeded as planned. However, COVID-19 provided an opportunity to reflect on how 1:1s could occur during a health care crisis with reduced surgical volume. Our 1:1s primarily consist of OR time and so with fewer elective cases, it may have required that the intensive training occur over a period of 2 to 3 months rather than 1 month. To allow some autonomy as well as flexibility for resident staffing, a system of milestones could be used to allow some independent practice of residents (under attending medical direction) within this 2-month to 3-month timespan. For example, while a CA-1 having successfully completed 1:1s could be under the medical direction of an attending physician for a variety of cases, in a setting with reduced volume, the same CA-1 could be cleared to care for American Society of Anesthesiologists 1 and 2 patients in the outpatient surgery center under medical direction. This would allow for some autonomy and growth in the OR with the expectation that they would still have periods in which they shift back to the 1:1 model during this 2-month to 3-month training period to gain competency in a variety of cases. This benchmark-driven approach to completion of 1:1s would enable safe patient care to continue, while making the most of lower case volumes and allowing attending physicians to be more available to medically direct and work in the ICUs rather than having a full class of 1:1s to instruct at any one time.

During times of especially low OR case volume, it is possible that even with a rotation system with oscillation between 1:1 instruction and medically directed practice, there may not be enough OR cases to provide learning opportunities for all the new CA-1s at the same time. In this scenario, an alternative could be to have some of the new CA-1 residents work with senior anesthesia residents in the ICUs where they can be prioritized to place vascular access lines, intubate (when appropriate for COVID-19–negative patients or times when there is no increased risk of transmission with aerosol-generating procedures) and learn more about medications that are used with frequency in the ICU and OR. To ensure quality and some measure of standardization in the curriculum, senior residents in the ICU could have a list of skills and topics to cover with CA-1s, just as attending anesthesiologists currently have in the OR setting. During a time when there are not enough elective OR cases for all CA-1s to learn at the same time, although not ideal, increasing the time of 1:1s and pairing CA-1s with senior residents who have been pulled to the ICUs can mitigate the loss of learning that occurs for future critical workers in the health care system.

Although necessary deployment to the ICU in a pandemic can serve as an opportunity to expand the anesthesia skillset, there will still be compromise of resident learning when elective OR cases are canceled. Simulation is a valuable tool to improve learning and teamwork.^{8,9} Using simulation to mimic normal OR settings for CA-1s with abbreviated 1:1s can accelerate learning in an environment with low OR volumes. In addition, the same principles can be applied for other CA-2 and CA-3 specialties that have lower volumes during a pandemic. Simulations that provide opportunities to troubleshoot a double-lumen endotracheal tube in a thoracic case, or manage a Type 2 protamine reaction in a cardiac case, will never replace learning in the setting of direct patient care. Nonetheless, simulation has a role to strengthen critical thinking skills and supplement clinical learning in the ICU while opportunities for clinical learning in the OR are decreased. Well-planned simulations can provide a productive use of the extra time afforded by a slower OR schedule.

Resident Mental Health in a Pandemic

COVID-19 brought the issue of physician burnout to the public consciousness. In the medical arena, if it was not already discussed, it became a more prominent topic.

COVID-19 served to intensify issues the medical field had with mental health and well-being.¹⁰ Mental well-being in anesthesiology is especially significant because poor mental health can be a risk factor for drug abuse in a specialty where there is access to addictive medications. Anesthesiology residents are at particular risk of substance use/abuse, with an incidence of 1% to 2% per year.¹¹ Regardless of whether substance use is an endpoint, mental health of residents during particularly stressful times, such as a pandemic, must be addressed. At HUP, the chief residents held weekly town halls over a virtual platform with program leadership oftentimes joining for the last 10 to 15 minutes to answer questions from the residents that could not be addressed by the chiefs. In addition, fortuitously, at the beginning of the 2019 to 2020 academic year (AY), the chief residents had divided the residents into 3 groups of “families,” 1 for each chief resident to oversee. These groups spanned class years and provided a platform for residents to get to know each other across classes outside of work, and have a chief with whom they could always feel comfortable going to with concerns. COVID-19 began to surge in the United States just as the 2019 to 2020 AY anesthesia chiefs at Penn were transitioning duties to the newly selected 2020 to 2021 AY chiefs. This transition allowed each chief family to have 2 chiefs at the helm (both incoming and outgoing), which allowed each of the 6 chiefs to have 13 to 14 residents to reach out to individually on a weekly basis. Thus, the town halls allowed for weekly updates to schedule changes and provided a forum for concerns to be aired to the group. The weekly individual check-ins allowed the chiefs to assess which residents had notable challenges, fears, and/or concerns associated with the pandemic and assess which residents could use additional support. Dividing the residents among the 6 chiefs also allowed for rapid dissemination of news as it came in. The chief families provided the template for a phone tree; rather than wait for the weekly departmental town halls, chiefs could directly contact their 13 to 14 residents to deliver salient updates.

In addition to personalized check-ins, the department ensured that everyone (residents and faculty) was aware of the mental health resources available to them through the hospital system. However, although having information about these resources was important, during the COVID-19 surge, many of these resources were overwhelmed and unable to provide timely care to residents in need. The personalized check-ins allowed for better identification of residents who were struggling and for those who were, our department chair worked quickly to provide access to mental health services outside of the traditional resources. In addition, faculty who were in quarantine due to clinical exposure, were quick to offer their services if residents or faculty needed someone to speak with confidentially about their personal and professional difficulties during the COVID-19 surge. This had the dual effect of not only helping the residents, but also the side-lined faculty, who felt powerless to help their colleagues while quarantined at home for 14 days. The department ombudsmen continued to provide a space for residents to bring concerns. Although discussing mental health remains a stigma in medicine, the Department of Anesthesiology and Critical Care at Penn continued a tradition of emphasizing its importance during the COVID-19 pandemic and provided multiple outlets, including one-on-one conversations, for residents to be heard.

SUMMARY

In summary, COVID-19 challenged the US health care system in a way that its predecessors (including SARS-CoV-1, Middle Eastern Respiratory Syndrome, and H1N1) had not. Not only did it strain the health care system and cause cancellation of elective

surgeries to accommodate increased numbers of patients, but it also threatened the work force.

In our global economy, it is unlikely that COVID-19 is an outlier. Whether it be future outbreaks of COVID-19 or a novel pathogen, it is almost a certainty that the US health care system will face another challenge to its resources, and most likely it will require those in anesthesiology and critical care to be at the forefront of the response. With a rapidly spreading disease like COVID-19, it is difficult to stay abreast as new knowledge about the novel pathogen evolves. With COVID-19, rapid shifts in our collective understanding of the disease, including the transmission mechanism, underscored the importance of having plans ready for future surges of COVID-19 or another pathogen. A silver lining of COVID-19 is it allowed residency programs and hospital systems to rethink resident roles and assignments in the setting of an event that causes major strain on the health care system. COVID-19 underlined the importance of regular communication and transparency from leadership, not only for mental health but also as safety mechanisms, such as patient isolation, testing, contact tracing, and critically, personal protective equipment recommendations changed. Early prevention of spread with quick transitions to remote education is key; early preparedness with reimagining and retraining residents to fill specific roles ahead of time is equally important.

It is critical that departments have plans in place for how to use and educate anesthesia residents during a stress equal to, or greater than, the magnitude of disruption caused by COVID-19. Anesthesia residents possess specific skills that allow them to be key parts of the teams caring for patients. For this reason, their continued education during a time of crisis is important because it will enable them to be part of the next wave of attending physicians and educators on which the health care system relies.

DISCLOSURE

The authors have nothing to disclose.

REFERENCES

1. Accreditation Council for Graduate Medical Education. Data resource book: academic year 2019-2020. Chicago: ACGME; 2020. p. 49.
2. Young A, Chaudhry HJ, Pei X, et al. FSMB census of licensed physicians in the United States, 2018. *J Med Regul* 2018;105(2):7–23.
3. Huynh K. Reduced hospital admissions for ACS – more collateral damage from COVID-19. *Nat Rev Cardiol* 2020;17(8):453.
4. Jeffery M, D'Onofrio G, Paek H, et al. Trends in emergency department visits and hospital admissions in health care systems in 5 states in the first months of the COVID-19 pandemic in the US. *JAMA Intern Med* 2020;180(10):1328–33.
5. Diegoli H, Magalhães PSC, Martins SCO, et al. Decrease in hospital admissions for transient ischemic attack, mild, and moderate stroke during the COVID-19 era. *Stroke* 2020;51(8):2315–21.
6. Remy KE, Verhoef PA, Malone JR, et al. Caring for critically ill adults with coronavirus disease 2019 in a PICU: recommendations by dual trained intensivists. *Pediatr Crit Care Med* 2020;21(7):607–19.
7. UPHS Covid-19 Learning Website. Available at: <https://www.med.upenn.edu/uphscovid19education/>.
8. Lorello GR, Cook DA, Johnson RL, et al. Simulation-based training in anaesthesiology: a systematic review and meta-analysis. *Br J Anaesth* 2019;112(2):231–45.

9. Kolawole H, Guttormsen AB, Hepner DL, et al. Use of simulation to improve management of perioperative anaphylaxis: a narrative review. *Br J Anaesth* 2019; 123(1):e104–9.
10. Stuijzand S, Deforges C, Sandoz V, et al. Psychological impact of an epidemic/pandemic on the mental health of healthcare professionals: a rapid review. *BMC Public Health* 2020;20(1):1230.
11. Fitzsimons MG, Baker K, Malhotra R, et al. Reducing the incidence of substance use disorders in anesthesiology residents: 13 years of comprehensive urine drug screening. *Anesthesiology* 2018;129(4):821–8.