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Featured Article

The lasting footprint of COVID-19 on surgical education: A resident and attending perspective on the global pandemic

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ABSTRACT

Background: The COVID-19 pandemic has impacted surgical training nationwide. Our former curricula will likely not return, and training will need to adapt, so we are able to graduate residents of the same caliber as prior to the pandemic.

Methods: A survey evaluating perceptions of changes made in surgical training was conducted on surgery residents and attendings.

Results: Disaster medicine training has become more relevant and 85% residents and 75% attendings agreed it should be incorporated into the curriculum. Safety of family was the most significant concern of residents. Virtual curriculum was perceived to be acceptable by 82% residents and only 22% attendings ($p < 0.01$). Residents (37%) were less concerned than attendings (61%) of falling behind on their overall training ($p = 0.04$). Both groups agreed operative skills would be adversely affected (56%vs72%; $p = 0.37$).

Conclusions: To maintain an effective surgical curriculum, programs will need to implement new educational components to better prepare residents to become surgeons of the future.

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Introduction

The COVID-19 pandemic has impacted general surgery residency programs nationwide. Residents and faculty experienced abrupt changes in their normal daily routines as elective surgeries were cancelled, conferences were transitioned to virtual platforms, and programs prioritized the need to educate on personal protective equipment (PPE) and hospital COVID policies.^{1–3} Additionally, clinical rotation schedules were suspended to accommodate re-deployment and staggering of the workforce.⁴ As the pandemic continues on, including the possibility of future surges in COVID-19 patients, we are adjusting to the “new normal” and reconfiguring surgical training to adapt to our ever-changing landscape. Programs are challenged with providing a safe working environment, accommodate acutely changing clinical demands of the pandemic, and maintain a robust training curriculum that graduates residents of the same caliber as prior to the pandemic.

The long-term outcomes of surgical training during the pandemic remain unpredictable. In addition, the best mechanisms and platforms in restructuring a surgical curriculum continue to be investigated. Despite experiencing uncertainty, we have realized in the past few months that residents have had to adjust the manner in which they learn, and faculty have had to alter their approaches to teaching. Our former training curricula will likely not return, rather it will likely be replaced with a curriculum that encompasses new requisite components. By evaluating the perspectives of both residents and faculty, we aim to comprehensively appraise the curriculum changes made during the initial stages of the pandemic and evaluate new methods to maintain a robust surgical training experience during the COVID-19 era.

Methods

This study was approved by the Cedars-Sinai Medical Center Institutional Review Board. A voluntary and anonymous web-based survey was distributed to residents in our Accreditation Council for Graduate Medical Education (ACGME) approved general surgery residency program and attendings on teaching services within the Department of Surgery. The survey was conducted during the peak of California's initial surge of the COVID-19 pandemic from April 20,

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2020 to May 1, 2020. During this time, 3 reminder emails were sent to residents and attendings to optimize response rates.

For surgical training to persist during the initial stages of the pandemic, our program was required to abruptly improvise clinical coverage schedules, implement COVID-19 related education, and modify our traditional curriculum. Survey items were developed to evaluate resident and attending perceptions of these unprecedented changes so that we could understand how to adapt our surgical education and maintain a robust training experience within the pandemic environment. A combination of binary (yes-no), multiple choice, and ranking questions were utilized, in addition to statements with 5-point Likert scales (1-indicating strong agreement, 3- neutrality, 5- strong disagreement). Survey questions specifically queried demographics, program preparedness, interest in disaster medicine training, willingness to participate in the hospital's response efforts, psychological wellness, perceived adequacy of surgical education and identification of gaps in training during the pandemic.

Survey development

Survey items querying resident and attending perspectives on pandemic preparedness and their clinical response to the pandemic were based on previous surveys used to assess the perceptions of healthcare workers in response to infectious disease disasters.^{5–7} Survey items querying perspectives on surgical education during the pandemic, including transitioning to a virtual curriculum, were based on content from informal interviews with residents and attendings. Pretesting of the survey was conducted by using focus groups comprised of both residents and attendings. Through these focus groups we ensured that important issues associated with the pandemic were included in the survey. In addition, focus groups were used to test drafts of the survey.

Statistical analysis

Statistical analysis was performed with SPSS for Windows version 25.0 (IBM Corp., NY, USA). Descriptive statistical methods were used to calculate frequencies and percentages of the survey response data. Mann-Whitney *U* test was used to compare the responses of residents and attendings.

Results

The survey was distributed to 33 general surgery residents and 64 attending surgeons. Twenty-seven residents and 36 attendings participated, with a response rate of 82% and 56%, respectively. **Table 1** depicts the demographics of responders including the postgraduate year (PGY) level of residents and surgical subspecialty, age, and years of experience of attendings.

In preparation for COVID-19, residents strongly agreed more often that it was important for the department to provide pre-event training for infectious disease outbreaks, compared to attendings (78% vs 47%; *U* = 337.5, *p* = 0.02). Majority of both groups believed they were being provided adequate preparation for the COVID-19 pandemic (*U* = 408, *p* = 0.25). Accordingly, 85% of residents and 75% of attendings reported receiving information on PPE, viral testing, and quarantine guidelines (*U* = 435, *p* = 0.45). Additionally, 82% of residents and 64% of attendings had undergone training for donning and doffing PPE, including the powered air-purifying respirator (PAPR) (*U* = 392.5, *p* = 0.17). Overall, three-fourths felt they were sufficiently prepared to respond to the COVID-19 pandemic (*U* = 414.5, *p* = 0.28). Most also reported feeling safe at work while taking care of patients (*U* = 480.5, *p* = 0.94) (**Table 2**).

Disaster medicine training is often not included in surgical

Table 1
Demographics of residents and attendings.

	%	n
RESIDENTS		27
PGY-1	11%	3
PGY-2	26%	7
PGY-3	19%	5
PGY-4	22%	6
PGY-5	22%	6
FACULTY		36
Specialty		
Trauma/Acute Care	11%	4
Cardiothoracic	17%	6
Colorectal	11%	4
Plastic Surgery	6%	2
Surgical Oncology/Breast	17%	6
Transplant	8%	3
Vascular	11%	4
General Surgery	19%	7
Age		
<45 years old	31%	11
45–55 years old	42%	15
>55 years old	28%	10
Years of Experience		
≤5 years	22%	8
6–10 years	14%	5
>10 years	64%	23

Table 2
Resident and attending perspectives on pandemic preparation.

Statement	Residents n = 27		Attendings N = 36		p-value
	%	n	%	n	
It is important for the department to provide pre-event training for infectious disease outbreaks					0.02
Strongly agree	78	21	47	17	
Agree	18	5	44	16	
Neutral	4	1	6	2	
Disagree	0	0	0	0	
Strongly disagree	0	0	3	1	
The department provided adequate preparation and training for infectious disease outbreaks					0.25
Strongly agree	37	10	28	10	
Agree	48	13	42	15	
Neutral	4	1	19	7	
Disagree	7	2	8	3	
Strongly disagree	4	1	3	1	
I received information on PPE usage, viral testing, and self-quarantine guidelines					0.45
Strongly agree	41	11	33	12	
Agree	44	12	42	15	
Neutral	4	1	17	6	
Disagree	7	2	8	3	
Strongly disagree	4	1	0	0	
I received training for donning and doffing PPE including the PAPR					0.17
Strongly agree	41	11	31	11	
Agree	41	11	33	12	
Neutral	11	3	22	8	
Disagree	7	2	6	2	
Strongly disagree	0	0	8	3	
I feel sufficiently prepared to respond to the pandemic					0.28
Strongly agree	33	9	14	5	
Agree	41	11	61	22	
Neutral	22	6	17	6	
Disagree	0	0	8	3	
Strongly disagree	4	1	0	0	
I am safe in my work caring for patients during the pandemic					0.94
Strongly agree	29	8	22	8	
Agree	41	11	53	19	
Neutral	15	4	14	5	
Disagree	11	3	11	4	
Strongly disagree	4	1	0	0	

curricula. However, its relevance became apparent as surgery programs hustled to educate residents and attendings. Only 11% of residents and 28% of attendings reported having any experience in disaster medicine ($U = 405, p = 0.11$). When asked if the program should incorporate routine disaster medicine training, 85% of residents agreed it should be included into the training curriculum and 75% of attendings felt it should be a part of continuing medical education requirements. The ideal frequency of disaster medicine training was reported to be annually by both groups ($U = 450.5, p = 0.58$) (Fig. 1A). Residents preferred simulation-based training, whereas attendings preferred lecture ($U = 434.5, p = 0.44$) (Fig. 1B).

Depending on the severity of the pandemic, surgery residents and attendings were aware of the possibility of joining the workforce in the care of COVID-19 patients. Most agreed that attending physicians have an obligation in the planning, response, and recovery efforts during the pandemic (85% vs 86% $U = 376.5, p = 0.09$). In regard to residents sharing the same obligation, more residents (89%) compared to attendings (78%) reported agreement ($U = 352.5, p = 0.04$). Surgery residents and attendings could be relied upon to aid in the pandemic response, as the majority of residents and attendings were willing to participate in the workforce (89% vs. 89%; $U = 466, p = 0.76$). When asked about the roles they were willing to perform, more residents (56%) compared to attendings (33%) were willing to respond in any capacity, including performing non-medical tasks, such as transporting patients or providing updates to families. A third of both residents (33%) and attendings (39%) would respond in a medical capacity only, including re-deployment to other specialty teams. More attendings (25%) compared to residents (7%) would respond if their responsibilities were providing surgical services only ($U = 357.5, p = 0.05$) (Table 3).

The survey contained statements to investigate the psychological well-being of residents and attendings during the COVID-19 pandemic. Most residents (70%) and attendings (81%) reported being psychologically prepared to respond to the pandemic ($U = 454, p = 0.63$). Furthermore, 74% of residents and 83% of attendings were confident they had access to psychological support and counseling ($U = 476, p = 0.88$). To effectively target program support to residents, we evaluated their perceptions on various concerns relevant to the COVID-19 pandemic. Residents and attendings were given a list of 8 possible concerns and asked to rank them in order of importance. They ranked their family's health, safety, and preparedness as their most significant concern (Fig. 2).

Multiple aspects of surgery training were impacted by social distancing, cancelation of elective surgeries, and preparation for COVID-19 surges. Prior to the pandemic, our surgery program included approximately 3 h per week of mandatory didactics and 2 h per week of simulation and skills labs. During the pandemic, our program transitioned to a virtual curriculum, which included virtual didactics, such as grand rounds, morbidity and mortality conferences, and in-service training exam review sessions, in addition to access to suture boards and laparoscopic trainers for residents to practice their skills at home. Surgery simulation and skills labs were initially suspended during the first peak of the pandemic. Since then, we have resumed the simulation and skills curriculum limiting attendance to only 8 residents per session to accommodate for social distancing.

Residents and attendings differed in their perceptions of the overall virtual curriculum (Table 4). More residents perceived the program was prepared and transitioned smoothly to virtual education, in comparison to attending perceptions (70% vs 47%; $U = 287.5, p < 0.01$). Additionally, most residents believed the virtual curriculum would train them as well as the in-person curriculum, whereas most attendings did not agree (82% vs 22%; $U = 134.5, p < 0.01$). We asked both groups to identify the most essential components of a virtual curriculum. Web-based didactics (WebEx [Cisco Systems; Milpitas,CA], Zoom [Zoom Video Communications Inc; San Jose,CA]) and access to surgical procedure videos were the most important curricular components reported by both residents and attendings (Fig. 3).

When asked if residents would fall behind on their overall (clinical and surgical) training this year due to the pandemic, residents reported less concern with the sentiment compared to attendings (38% vs 61%; $U = 343, p = 0.04$). Additionally, only 19% of residents were concerned that the development of their clinical skills would be impaired, in contrast to 56% of attendings ($U = 219.5, p < 0.01$). Both residents (56%) and attendings (72%) were in agreement that the procedural or operative skills of residents would be adversely affected this year due to cancelations of surgery ($U = 424.5, p = 0.37$).

Discussion

To adapt to the COVID-19 pandemic, surgical programs modified their curricula and implemented changes that were initially thought to be temporary. Now four months into the pandemic, with

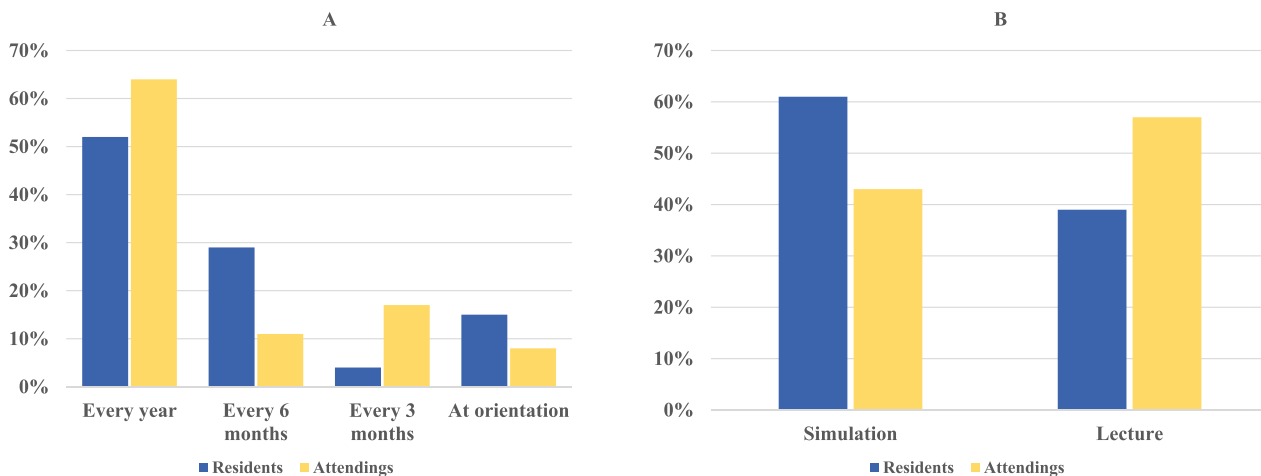


Fig. 1. Resident and attendings perspectives on disaster medicine training.

Table 3
Resident and attending clinical response to the pandemic.

Statement	Residents n = 27		Attendings N = 36		p-value
	%	n	%	n	
Attending physicians share an obligation in the planning, response and recovery efforts during the pandemic					0.09
Strongly agree	70	19	44	16	
Agree	15	4	42	15	
Neutral	11	3	6	2	
Disagree	4	1	8	3	
Strongly disagree	0	0	0	0	
Resident physicians share an obligation in the planning, response and recovery efforts during the pandemic					0.04
Strongly agree	70	19	42	15	
Agree	19	5	36	13	
Neutral	4	1	14	5	
Disagree	0	0	8	3	
Strongly disagree	7	2	0	0	
I would be willing to respond to the COVID-19 pandemic regardless of severity					0.76
Strongly agree	41	11	36	13	
Agree	48	13	52	19	
Neutral	7	2	6	2	
Disagree	0	0	6	2	
Strongly disagree	4	1	0	0	
What capacity would you be willing to respond in the current pandemic?					0.05
Any capacity including non-medical capacities	56	15	33	12	
Any medical capacity including re-deployment to other specialty teams	33	9	39	14	
Only if my primary responsibilities were providing surgical services	7	2	25	9	
If I were given the option, I would prefer to stay home and not respond	4	1	3	1	

continued surges, a predicted second wave in the fall, and the risk of potential annual outbreaks, the future remains unpredictable. Program leadership and faculty have recognized that our traditional teaching methods and curriculum may now be obsolete. By evaluating the perspectives of both residents and faculty, our study identified requisite components that programs may consider incorporating to maintain a robust surgical training curriculum that is resilient to the rapidly evolving pandemic environment.

Disaster medicine training

Disaster medicine education, including preparation for infectious disease pandemics, is not a requirement of the ACGME’s Residency Review Committee (RRC) for general surgery, as it is in the Emergency Medicine RRC. Therefore, surgery residents have significantly less to possibly no disaster medicine education.^{8,9}

Experience in disaster medicine amongst surgery attendings is also lacking with less than 30% of surgeons, including trauma surgeons, participating in disaster-specific training courses.¹⁰ Prior to the pandemic, its relevance may have been overlooked. However, our residents and attendings now realize the importance of incorporating routine disaster medicine training into the curriculum and continuing medical education, as demonstrated in our study.

Furthermore, we have learned in the past few months that routine schedules can be abruptly suspended and our roles as surgeons may transition to joining the medical workforce in the care of COVID-19 patients. Since surgery residents and attendings remain dedicated in helping with the pandemic, disaster medicine training is integral in increasing confidence and comfort levels when responding to a disaster.^{8,9,11} Despite a minority of residents and faculty being familiar with disaster medicine, three-fourths reported sufficient skills in responding to the COVID-19

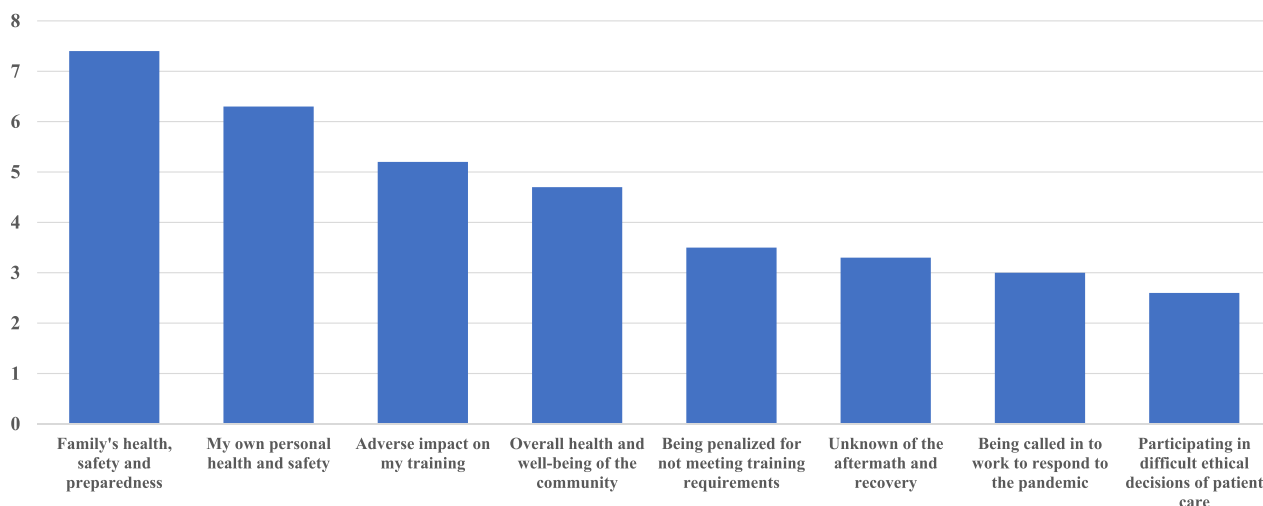


Fig. 2. Concerns of residents during the COVID-19 pandemic.

Table 4
Resident and attending perspectives of how surgical training was impacted this year during the pandemic.

Statement	Residents n = 27		Attendings N = 36		p-value
	%	n	%	n	
The residency program was prepared and transitioned well to a virtual curriculum					<0.01
Strongly agree	44	12	8	3	
Agree	26	7	39	14	
Neutral	22	6	28	10	
Disagree	4	1	25	9	
Strongly disagree	4	1	0	0	
The virtual curriculum will train residents as well as the in-person curriculum					<0.01
Strongly agree	56	15	5	2	
Agree	26	7	17	6	
Neutral	11	3	25	9	
Disagree	7	2	36	13	
Strongly disagree	0	0	17	6	
I am concerned the residents will not be as well trained or fall behind in their overall training this year due to the pandemic					0.04
Strongly agree	19	5	14	5	
Agree	19	5	47	17	
Neutral	11	3	22	8	
Disagree	40	11	17	6	
Strongly disagree	11	3	0	0	
I am concerned that the development of the residents' clinical skills, both inpatient and outpatient, will be impaired this year					<0.01
Strongly agree	4	1	14	5	
Agree	15	4	42	15	
Neutral	15	4	22	8	
Disagree	40	11	22	8	
Strongly disagree	26	7	0	0	
I am concerned that the procedural or operative skills of residents will be adversely affected this year					0.37
Strongly agree	26	7	19	7	
Agree	30	8	53	19	
Neutral	22	6	22	8	
Disagree	18	5	6	2	
Strongly disagree	4	1	0	0	

pandemic. This may have been due to the survey being distributed after residents and attendings received education regarding PPE and COVID-19 policies, which therefore demonstrates the positive effects of disaster training on respondents.

Proactive approach to well-being

Prior to the pandemic, the health and wellness of surgery residents and attendings were emphasized on national platforms. A national survey of general surgery residents reported 38.5% of residents had weekly burnout symptoms with 4.5% reporting suicidal thoughts.¹² Additionally, the ACGME has made it a common program requirement, regardless of specialty, to address well-being more directly and comprehensively. Burnout has also been an issue amongst surgery attendings. A survey of almost 8000 surgeons sponsored by the American College of Surgeons reported a 53% rate of burnout, which is much higher than the 28% rate of the general population.¹³ The pandemic has only magnified these psychological challenges, as demonstrated by a survey of healthcare workers in Wuhan reporting incidences of 50% depression, 44% anxiety, 34% insomnia, and 71% distress.¹⁴ The data mirrors prior published reports on the psychological impact from the SARS outbreak in 2003.¹⁵

Most of our residents and attendings felt they were psychologically prepared to respond to the pandemic, with the survey distributed approximately a month after our first wave of COVID-positive patients. We now have realized that the pandemic is ongoing, with no clear end in sight. In addition to burnout, the pandemic has brought on new issues that have psychological impact, such as the fear of transmitting the virus to others, witnessing patients succumb to the disease in isolation, reductions in productivity, and the dynamic day-to-day needs within health-care.¹⁶ There have also been limitations in pursuing wellness due to stay-at-home orders, social distancing and unplanned shut-downs within the community.²

Programs must investigate methods on how to maintain resiliency and psychological endurance of their residents and attendings. We should not feel at ease simply because a majority of our residents and attendings were confident they had access to psychological support and counseling. Providing these resources is a passive strategy and published reports have demonstrated only 26% of surgeons will seek out psychiatric care.¹⁷ Therefore, programs may need to be more proactive in their approaches in maintaining the mental wellness of their residents and attendings. In addition to ensuring adequate time off work, program leadership may need to routinely conduct “check-in” sessions to address concerns, target support, arrange social web-based group events to mitigate

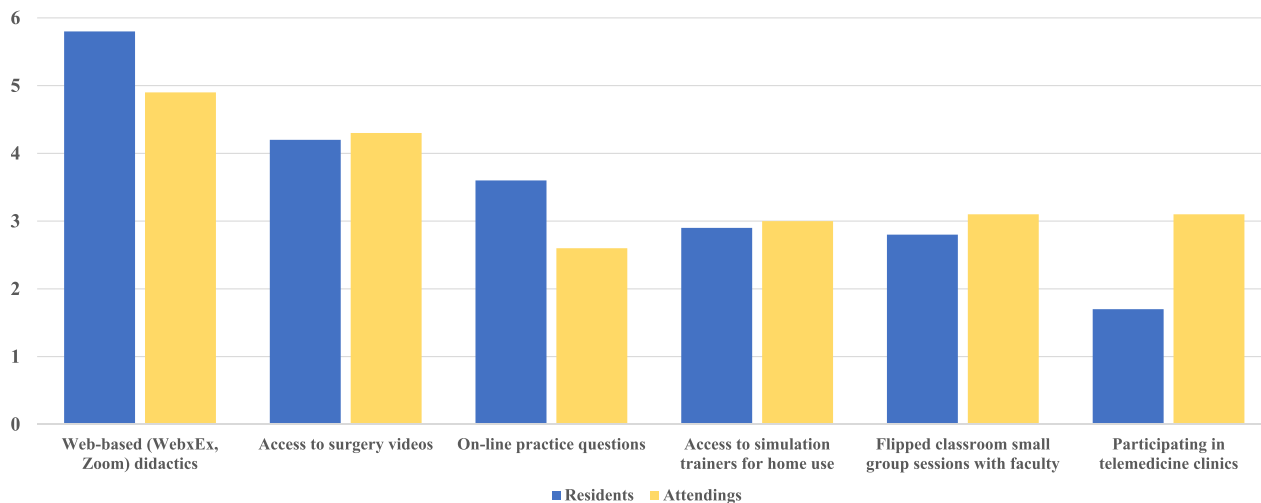


Fig. 3. Requisite virtual curriculum components.

isolation, and increase the frequency of mentorship amongst all academic levels to promote productivity.

Consideration of residents' families

As surgical educators, we often perceive residents as individual entities and not within the context of their personal lives or families. However, as we have experienced training during the pandemic, we have realized that residents may be distracted by conflicts between professional obligations and family responsibilities, similar to other reports of healthcare workers during past disasters.¹⁸ The biggest concern of our surgical residents was their family's health, safety and preparedness, which was also reported by a qualitative study performed in the early phases of this pandemic.¹⁹ Surgical educators and program leadership may need to also ensure care of residents' families to alleviate their concerns. Strategies to address the well-being of families may include being more considerate in giving residents time away from work during the daylight hours to take care of family responsibilities, especially since community resources have limited operational hours during the pandemic. Programs may also need to evaluate the feasibility of families receiving priority in testing, vaccination and treatment when available.²⁰ Additionally, residents exhibit anxiety in the risk of transmitting the virus to family members. As Adams and Walls suggested, programs may need facility experts to provide information on home decontamination, protective planning for the home, potential separation of living spaces, and guidance on routines upon their arrival home after duty.²⁰ Availability of on-site shower facilities and institution sponsored housing accommodations for healthcare workers caring for COVID-19 patients, may also alleviate resident stress surrounding potential virus transmission to their families.

Hybrid learning and faculty development

The majority of residents believed the program was providing a virtual curriculum that would educate them just as well as the in-person curriculum, whereas the majority of attendings did not agree. This difference in perception may be due to generational differences and exposure to technology of residents and attendings. Our current residents are members of Generation Y or the Millennial Generation. They have grown up in the technological era and widely apply technology to function more efficiently in their daily lives.^{21,22} Therefore, virtual curricula are more aligned with their learning styles than traditional formats. Virtual platforms also complement their generational characteristics, such as enabling them to be mobile, allowing for multitasking and the ability to record virtual conferences allows them to review and access education material at their convenience.^{23–25} Although the transition to a virtual curriculum was forced by the pandemic, we may have stumbled on to an improved method that increases learner satisfaction amongst the current generation of residents. Future studies may be necessary to explore differences in learner satisfaction in the pre-pandemic, in-person curriculum era to the current pandemic virtual curriculum.

Hybrid or blended learning, using a combination of traditional and virtual instruction, may be the future of surgical training. While residents have easily mastered web-based platforms, our attendings may not be as facile or familiar.²⁶ This may be an opportunity for faculty development in virtual instructional strategies. Programs may need to provide resources where attendings can learn to use web-based conference platforms to its full potential and make sessions more interactive, such as breakout rooms, screen shares, reactions, chats, and polling. Furthermore, training in E-learning components may be useful for faculty to acquire skills in content or

module development, utilizing content management systems, such as Blackboard (Providence Equity Partners; Washington, DC) and WebCT (Providence Equity Partners; Washington, DC), and appropriate applications of synchronous or asynchronous content delivery.²⁵

Didactic collaboration

Web-based video conferences, lectures and journal clubs were considered to be the most requisite component in a virtual curriculum by both residents and faculty. Although in the past few months we have realized many benefits of this transition, such as increased attendance due to the ability to participate remotely,^{24,27} the most productive advantages of web-based video conferences may extend beyond the institutional walls.^{28,29} Instead of working in silos, programs can knowledge share through web-based technology and collaborate in their didactics.³⁰ Therefore, as we continue to train residents in a pandemic environment, the time constraints of surgical faculty and magnitude of clinical demands remain uncertain. A multi-institutional initiative of didactic education contributes to maintaining a consistent, resilient and robust training experience.

Video-based education

As expected, both residents and attendings were concerned that procedural and operative skills would be adversely affected this year. The cancelation of elective surgeries, slow recovery of surgical volume and potential future cancelations due to ongoing COVID-19 surges may threaten our ability to graduate surgeons ready for independent practice. Although the American Board of Surgery has modified training requirements for graduating chief residents this year, we are uncertain of the permanence of these modifications and whether decreasing clinical time and case logs is a reasonable long-term solution.³¹ To maintain the operative competence of our residents, programs may need to investigate alternative strategies for operative training.

Viewing surgical videos was perceived by residents and faculty to be the second most important component of a virtual curriculum. Initial interest in video-based education began when the ACGME implemented the 80-h work week. At the time, surgical educators were concerned that residents had to acquire surgical skills in less time than their predecessors. Video-based education was a strategy that attempted to address this concern and allowed for training outside of the operating room. Although limitations in time are no different, the pandemic raises an issue of training residents with potentially less operative cases compared to prior years. Thus, video-based education may gain prominence in surgical training. Several studies have reported benefits of residents viewing videos prior to performing in the operating room, demonstrating improvement in overall performance and ability to complete the operation with less verbal guidance.^{32,33} Residents are more prepared for cases and exhibit deliberate practice in the operating room, instead of learning through discovery. Therefore, video-based education may shorten learning curves for procedures, which may help to equilibrate periods of low case volume.

Along with implementing video-based education, programs may need to develop their own libraries of faculty submitted videos to ensure residents are viewing material that show standardized evidence-based technique and step-by-step instruction. Of the 98.6% of residents using videos to prepare for cases, the majority are viewing publicly available material on the internet, which are unregulated.^{34–36} Society webpages and education portals offer peer-reviewed videos of higher quality, however, access may be limited due to cost or subscription requirements. Guidelines for

producing laparoscopic and robotic surgery videos for surgical education have been previously established and can be used by programs to uphold quality standards of the educational content.^{37,38}

Leadership curriculum

Due to a decline in operative volume and non-COVID-19 patients during the pandemic, attendings were concerned that surgical training would be adversely affected this year. Although the true impact of the pandemic on operative and patient care skills have yet to be assessed, the COVID-19 era presents an opportunity for residents to learn noncognitive skills sets.³⁹ Systems-based practice, resource management, organization, and leadership are skills that surgeons must have competency in. However, opportunities to learn and practice these skills during training are often limited, as most will hone these skills during their attending years. Training during the pandemic has offered a unique experience for our residents as they have participated in the restructuring of surgical teams, have had real-life lessons in managing limited resources, learned to adapt to a rapidly evolving environment and exhibited leadership skills in the hospital's COVID-19 response planning. This presents an extraordinary opportunity for programs to launch a structured leadership curriculum. Didactics in leadership theory, reflective practice facilitated by surgical educators, and the ability to apply concepts in real time during the pandemic, constitute a comprehensive learning experience for residents.⁴⁰ Therefore, despite deficits in traditional training this year, the opportunity to develop non-technical skills, may train residents more adeptly in becoming surgical leaders of the future.

This study has a number of limitations. These are perceptions of residents and attendings from a single institution and therefore, may not be generalizable. Future studies utilizing multi-institutional or national survey data will be necessary prior to developing a formal post-COVID surgical training curriculum. Additionally, the survey sought self-reported perceptions of how the pandemic affected surgical training and objective data is not yet available since we are only 4 months into the pandemic. Comparison of pre-COVID and post-COVID case volumes, American Board of Surgery In-Training Exam scores and rotation evaluation scores would objectively evaluate the effects of the pandemic on training on a longer-term scale. Survey responses in our study reflect perceptions reported during the peak of the first wave, which may have the potential to change as the pandemic environment rapidly evolves and surgery programs adapt. Since the timing of the survey was during the first couple of months of the pandemic, our survey is limited in querying the initial perceptions of changes made to surgical education. Future studies are needed to explore the perceived effectiveness and preference of interventions made during the pandemic. Despite these limitations, however, we demonstrate perspectives from both residents and attendings, which enable us to recommend new educational components that accommodate both groups.

Conclusion

The COVID-19 pandemic has changed surgical training and has taught us that our former methods may not be sufficient to train the next generation of surgeons. To maintain an effective surgical curriculum, programs will need to be innovative and implement new educational components. Implementation of disaster medicine training, promoting active initiatives of well-being, consideration of resident families, adoption of a hybrid curriculum with opportunities for faculty development, collaborative didactics amongst institutions, investigating video-based education and creating a

leadership curriculum, are amongst the components that may better prepare residents to become surgeons of the future.

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