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Virtual Surgical Subinternships: Course Objectives and a Proposed Curriculum

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Background: Due to the recent COVID-19 pandemic, patient care and medical education have faced many significant changes. The Association of American Medical Colleges and the American Council of Academic Plastic Surgery officially recommended halting all student rotations and interviews for the year. This change has unfortunately fallen squarely at the onset of a vital season for education and recruitment of plastic surgery subinterns. This article presents a curriculum for a single institution's virtual surgical subinternship to help inspire ideas and inspiration for programs developing their own virtual subinternships. **Methods:** The goals for the virtual surgical subinternship are focused on student preparation for residency and remain similar to those outlined by the core competencies for in-person rotations. The first virtual subinternship in plastic surgery modeled after the curriculum presented was offered as a 2-week course starting May of 2020.

Results: The components of the curriculum include a self-study syllabus, virtual case reviews, virtual suture laboratory, educational teleconferences, participation in research, and mentorship meetings. The 2-week course has approximately 25 hours of conferences and teaching, involving direct interaction with residents and faculty, and approximately 15 hours of self-directed learning.

Conclusions: To the authors' knowledge, this was the first virtual subinternship offered for rising fourth-year medical students. They strongly encourage other residency training programs to offer similar virtual learning opportunities for medical students, particularly for those without access to a home plastic surgery training program. The curriculum presented in this article is simply to provide ideas, inspiration, and a potential framework for programs wishing to create similar virtual learning opportunities. (*Plast. Reconstr. Surg.* 149: 1032e, 2022.)

As a result of the COVID-19 pandemic, the medical community has faced many recent changes, both in patient care and graduate medical education. The Association of American Medical Colleges and the American Council of Academic Plastic Surgery recommended halting all in-person student rotations and interviews for the 2020/2021 academic year.^{1,2} This change has unfortunately fallen squarely at the onset of a vital season for education and recruitment of plastic surgery subinterns and is likely to critically affect students and programs alike.

Within plastic surgery, 40 percent of matched students match into a program where they completed a subinternship.³ Program directors will have fewer data points to assess the fit and

character of a prospective resident; program directors value away rotation performance as one of the most important factors in resident selection.^{4,5} Furthermore, the transition from medical student to surgical intern is undoubtedly a crucial step in surgical training,⁶ and students who complete subinternships are likely to gain valuable skills preparing them to enter their intern year with the confidence needed for success.⁷ Subinternships are particularly crucial for students without a home program, who rely on away rotations as their only clinical experiences in plastic surgery. Programs and students mutually benefit during these rotations by determining

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compatibility with one another.⁶ In the wake of the COVID-19 pandemic, we see the need to drastically adapt our current educational programs to meet the needs of our students, especially those without a home plastic surgery program. Dean et al. briefly introduce the idea of a virtual surgical subinternship and some curricular components and urge other programs to consider virtual learning.⁸ In this article, we present detailed course objectives and discuss the resources and steps for implementing every component of the proposed curriculum for a virtual surgical subinternship, to help inspire ideas and provide a step-by-step guide for programs working to create a similar program.

METHODS

Designing the Virtual Subinternship

Video conferencing has become more widespread for medical education and is the most viable solution to overcome the inability to interact with students in-person.^{9–11} Using the video conferencing platform Zoom (Zoom Video Communications, Inc., San Jose, Calif.), as provided by our institution, we developed the virtual subinternship as a pathway to bridge the gap for both programs and medical students. The virtual subinternship was designed by the Division of Plastic Surgery at the University of California, San Diego. The content of the curriculum (Fig. 1) and the schedule of activities (Table 1) were designed to achieve the goals and objectives described in Table 2. A length of 2 weeks was chosen to balance having enough time to get to know and educate the subintern and minimize the overall time commitment given that many students are unable to receive course credit. Feedback from faculty, residents, and participating subinterns allowed for the evolution and improvement of the subinternship curriculum. Participants were recruited by survey (soliciting name, email, institution, statement of interest, and curriculum vitae) linked to the @ucsdplasticsurgery Instagram page and the University of California, San Diego Division of Plastic Surgery's website. A total of 38 applications were received before the survey was closed, and 26 participants were chosen from this group in order to limit participation to two to three subinterns per 2-week session. Students were selected based on review by multiple faculty and residents, with consideration given to their statement of interest and curriculum vitae and presence or absence of a home program. The first virtual subinternship in plastic surgery was offered as a 2-week course starting May of 2020. A total of 26 students are

participating in the virtual subinternship, with the last session offered in the beginning of October of 2020, of whom 12 (46 percent) do not have a home integrated or independent plastic surgery program. Twelve (46 percent) of the participants are female. There is one participant enrolled in a D.O. (osteopathic medicine) program, and there are no international students.

Goals and Objectives

The goals and objectives for a surgical subinternship are focused on student preparation for residency and are similar to those outlined by the core competencies for in-person rotations with adjustments accommodating to a virtual medium.⁶ Specialized education regarding foundational plastic surgery knowledge remains at the core of our curriculum while also structuring student/faculty interactions to provide formative evaluation of the student's performance and assessment of fit for the residency program. The subinternship interactions are focused on patient cases and surgical teaching as recommended by the Association for Surgical Education.⁶ Objectives are created to be useful to both students and programs alike. Figure 1 and Table 2 outline the course objectives and course components each guided by the Accreditation Council for Graduate Medical Education core competencies for subinternships.

RECOMMENDATIONS

The curriculum for the surgical virtual subinternship is a combination of a directed self-study, virtual case reviews, virtual suture laboratory, virtual happy hour, divisional/departmental educational conferences, participation in research, and mentorship meetings. The 2-week course contains approximately 25 hours of conferences and teaching, involving direct interaction between students, residents, and faculty, and an additional 15 hours of self-directed learning. Each component is described below with elaboration of the methods used for evaluating subinternship performance. The case resources used in the curriculum presented here are outlined in Table 3.

Self-Study Curriculum

Rotating students are able to access the American Society of Plastic Surgeons Plastic Surgery Education Network (EdNet) platform by obtaining membership to the society's Medical Students Forum for a nominal fee.¹² This resource mitigates the need to develop a

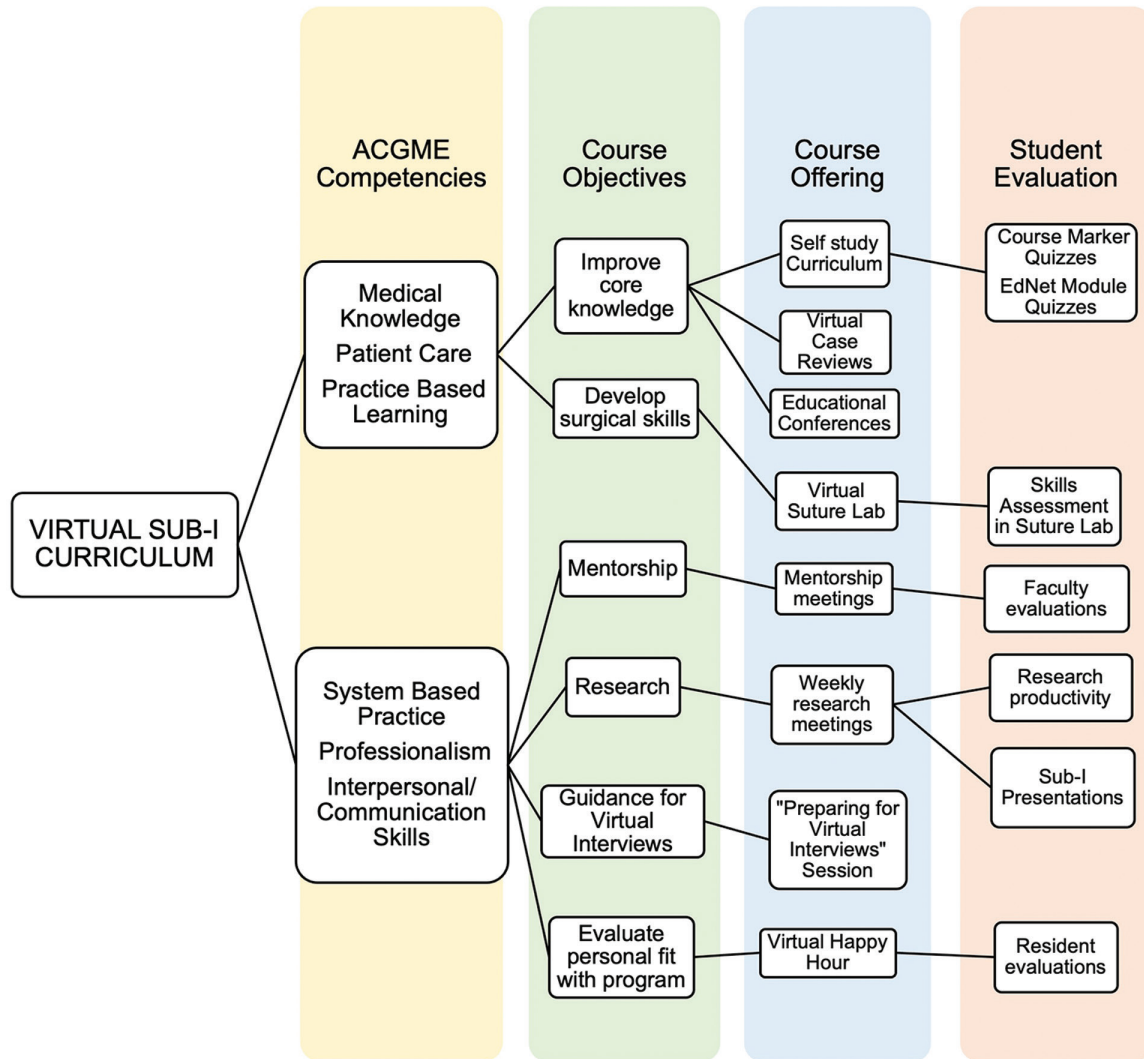


Fig. 1. Course objectives and curriculum. The objectives of the virtual subinternship (*Sub-I*) and correlated Accreditation Council for Graduate Medical Education (*ACGME*) competencies, course components, and methods of student evaluation in accomplishing these objectives.

topical curriculum de novo for the virtual subinternship. Given the broad range of topics and high level of discussion provided by the EdNet curriculum, a list was curated that recommends modules focused on topics most critical to the functions of a plastic surgery intern, namely, facial trauma, hand trauma, and the fundamentals of clinical care. The EdNet modules used in the curriculum include “Facial and Mandibular Fractures,” “Hand Fractures and Dislocations,” “Extensor Tendon,” “Flexor Tendon,” and “Critical Care” as the core curriculum. Other EdNet modules relevant to upcoming plastic surgery case reviews, included as part of the virtual curriculum, are also recommended for review on a case-by-case basis and allow for more in-depth case discussions.

Case Reviews: Optimizing Use of the Virtual Interface

Virtual learning has been a rising tool in medical education with significant positive benefits namely in anatomic and diagnostic teaching.^{13,14} These benefits have further been expanded to include clinical case scenarios used to evaluate a learner’s clinical reasoning in a simulated, interactive environment.¹⁰ Given the absence of face-to-face interactions in this current pandemic, many programs and learners have become facile with video interactions using standardized resources.

Each subintern participates in at least three virtual case reviews per week. During each case review, the student prepares a guided discussion with a junior resident, a senior resident and/or faculty (faculty join for case reviews during the second week

Table 1. Example of Weekly Schedule*

		Monday	Tuesday	Wednesday	Thursday	Friday
Week 1	AM	-Weekly inpatient rounds (E) -Check-in with program director (PD)	Suture lab (R)	-Mentorship meeting or educational conference (E) -Educational conference/journal club (E) -Grand rounds (E)	Weekly research meeting (E)	
	PM	Case review #1 (R, R)	Case review #2 (R, R)	Mentorship meeting #1 (F)	Case review #3 (R, R)	
	Total hours	4	2	4	1	0
Week 2	AM	Weekly inpatient rounds (E)	Suture lab (R)	-Mentorship meeting or educational conference (E) -Subinternship presentation and educational conference (E) -Grand rounds (E)	Weekly research meeting (E)	Exit interview (PD)
	PM	Case review #4 (R, R, F)	Case review #5 (R, R, F)	-Mentorship meeting #2 (F) -Check in with chief (C)	Case review #6 (R, R, F)	Happy hour (R, R, R, R)
	Total hours	3	2	4	1	2

E, everyone in the division; R, a single resident; A, a single attending; PD, program director; C, division chief.
 *Schedule for each virtual subinternship, excluding the self-study curriculum. Each noted activity is around an hour long. Note that the total hours exclude time spent preparing for case reviews and the time spent on the self-study curriculum. **Bolded** activities designate those that are not routinely offered throughout the year in the regular divisional education curriculum. Those involved in each session are designated with initial E, R, A, PD, or C.

of each subinternship) to discuss the indications for surgery, relevant anatomy, preoperative planning, clinical relevance, and surgical techniques for de-identified cases occurring at the institution that week. The three cases chosen for the week would be assigned to one of three resident teams and assigned to the subinterns with one of them designated as the “case leader.” The subintern case leader would have the role of preparing a few slides and moderating the case discussion, as described in Appendix 1 (see **Appendix, Supplemental Digital Content 1**, which shows instructions for virtual case review. This is a copy of the instructions that were given to virtual subinterns regarding the format of case reviews and their expectations, <http://links.lww.com/PRS/F36>). The *Color Atlas of Anatomy: A Photographic Study of the Human Body*, by Rohen et al., is one tool used to guide discussion of the relevant surgical anatomy.¹⁵ The resident and/or the attending surgeon who will be performing the case at our institution provide clinical insight

to augment the discussion of the particular case topic. This frequently includes reviews of anatomy and relevant radiographic imaging, which other groups have shown efficacy in teaching via virtual environments.^{13,14} After initial feedback that the case reviews were scheduled too “last minute” or too late given a time difference for several students, the scheduling process was changed to coordinate assignment and timing of reviews prior to the start of the respective week.

Craniofacial cases provided a unique opportunity to augment anatomic learning by applying technologies to the virtual teaching setting. These discussions are facilitated by use of the Craniofacial Interactive Virtual Assistant (myFace, New York, N.Y.) developed by Roberto Flores and Joseph McCarthy.¹⁶ This software allows for detailed anatomic presentation of craniofacial approaches and can be easily presented over a virtual discussion format.

Virtual Suture Laboratory

Surgical technical skills are difficult to teach without in-person interaction. In addition to demonstrating technique, an instructor must observe learners in action, and provide error correction in real time.¹⁷ To overcome this, we have created a suture skills laboratory format utilizing a standardized, inexpensive box trainer setup that allows for students to practice their suturing technique while also receiving real-time coaching, feedback, and assessment. [See **Video (online)**, which describes in detail the creation and implementation of the box trainer for virtual suture laboratory.] Students are required to own a video conference

Table 2. Detailed Virtual Subinternship Course Objectives in Detail

	Course Objective
1	Improve core plastic surgery knowledge necessary for success as a plastic surgery intern.
2	Develop early surgical skills, including suturing and tissue handling.
3	Gain one-on-one mentorship from faculty to students in preparation for application to plastic surgery.
4	Participate in research and obtain opportunities for research mentorship.
5	Gain guidance in preparing for virtual interviews.
6	Interact with program residents and evaluate personal fit with residency program.

Table 3. Course Resources and Associated Costs for All Portions of the Clerkship

Cost	Resource
\$25	Plastic Surgery Education Network (EdNet) access via ASPS Medical Student Forum Membership. Further information available at: https://www.plasticsurgery.org/for-medical-professionals/join-asps/medical-student-forum-membership
≤\$30	Suture materials. Link provided for purchase of suture material, silicone practice pad, forceps, and needle driver: https://www.amazon.com/Practice-Training-Include-Non-Absorbent-Surgical/dp/B07HQD6WRX/ref=sr_1_4?dchild=1&keywords=suture%2Bkit&qid=1588218853&s=industrial&sr=1-4&th=1
≤\$5	Cardboard box of minimum size 10 × 10 × 10, tape. If a box is used with varying dimensions, the longest dimension should be oriented vertically to maximize working space clearance. Any type of tape can be used to secure the bottom of the box to the chosen workspace.
N/A	Smartphone
\$0	Zoom application
\$0	<i>Color Atlas of Anatomy: A Photographic Study of the Human Body</i> , 7th ed., by Rohen et al. ¹⁵

ASPS, American Society of Plastic Surgeons.

software-compatible smartphone and laptop, as well as acquire basic surgical instruments and suture material through suggested retailers. The setup is otherwise constructed with simple, easily attainable materials in minimal time (Table 3) (Fig. 2). Before their rotation, students are provided links to high-quality open-source instructional videos for suture skills by Dr. Michael Zenn and expected to review this resource before starting the suture laboratory.¹⁸ The virtual suture laboratory, due to its one-on-one nature, is an opportunity for subinterns to ask questions about the program in a personal way. The virtual happy hour is an additional opportunity, albeit unstructured, to get to know residents' hobbies and experiences with program.

Educational Conferences

The Division of Plastic Surgery at University of California, San Diego began broadcasting our weekly plastic surgery conferences on Zoom beginning in July of 2019. Due to multiple clinical sites, the virtual medium has served as an excellent resource to ensure all members of the team could join conferences remotely when needed. Thus, virtual students were easily integrated into our educational and didactic conferences. Virtual subinterns are expected to attend these educational conferences, including didactic education based on the Plastic Surgery Education Network online curriculum. Students are invited to answer group questions, participate in case discussions, and ask questions of their own. Students are also invited to attend our journal club, plastic surgery grand rounds, and visiting professor lectures. Students received invites to these conferences even beyond the length of their participation in the subinternship.

Many of the division's weekly conferences involve case-based learning, including virtual

“weekly inpatient rounds” on Monday morning. Consults and cases performed during the prior weekend's call are discussed among resident and faculty members. Additional deidentified case discussions are held during morbidity and mortality and treatment and planning conferences.



Fig. 2. Virtual suture laboratory box trainer in use. The box trainer was used by both instructors and students during the virtual suture laboratory. Adapted from Dean RA, Reghunathan M, Hauch A, Reid CM, Gosman AA, Lance SH. Establishing a virtual curriculum for surgical subinternships. *Plast Reconstr Surg.* 2020;146:525e–527e.

Research and Mentorship

Research is a highly valued attribute in students applying to plastic surgery residency programs.¹⁹⁻²¹ Visiting students attend our weekly virtual Divisional Research Conference and are encouraged to join or initiate research projects. The weekly research meetings serve as an open forum to discuss ongoing research, present new research ideas, and allow students to join projects of interest. They are unable to work on chart review due to a lack of electronic medical record access but are involved in deidentified data analysis, survey projects, and systematic reviews. Rotators often continue to participate beyond the end of their 2-week rotation. To date, we have seen manuscript involvement of 11 of 25 subinterns.

Mentorship is an underserved need for many medical students pursuing plastic surgery, especially during their critical, final year of medical school in which students are making large career decisions. Establishing a connection with a more experienced surgeon is important throughout the entirety of one's career, especially for women and underrepresented groups in medicine.^{22,23} As Dr. Rod Rohrich explained, "As we grow to adulthood, mentorship by others becomes a key element for personal career success. Nowhere is that more important than the early years of medical training." Before the subinternship, students are solicited for their interests and potential desired faculty, from which we establish an assigned faculty mentor. They are then scheduled for discussion via Zoom video conferencing with the respective faculty twice during the rotation, with the option to request additional meetings after the completion of the subinternship. This also serves as a means to provide for meaningful letters of recommendation, which are important ranking tools.²¹

Student Performance Assessment

Formal assessments of student knowledge were accomplished by reporting of scores on various Plastic Surgery Education Network modules and the completion of ClassMarker quizzes (ClassMarker Pty Ltd., Sydney, Australia) related to the self-study curriculum.²⁴ Each subintern also gives a final presentation on the topic of their choice in the second week of the subinternship. The virtual case reviews are critical in assessing knowledge base and subtleties of interpersonal interaction and personality. The mentorship meetings and research opportunities give insight into the student's personal motivations and interests. The virtual suture laboratory allows the instructor to assess the teachability and motor skills of each

student involved. The virtual happy hour at the end of the 2 weeks is a key time in which residents can assess the personality fit of each student with the program. At the end of each 2-week subinternship, residents and faculty fill out evaluations to remark on each of the student performance in the categories above. Each student also undergoes an exit interview with faculty feedback to better prepare the student for virtual residency interviews.

Course Assessment

Each student meets with the course director at the beginning of the subinternship to discuss their specific goals and questions and, at the end of the subinternship, to provide feedback. They also provide anonymous feedback through pre-subinternship and postsubinternship surveys. (See **Appendix, Supplemental Digital Content 2**, which shows a preinternship survey. These questions were used to anonymously assess student impressions of the program and goals for the subinternship prior to starting the course, <http://links.lww.com/PRS/F37>. See **Appendix, Supplemental Digital Content 3**, which shows a postinternship survey. These questions were used to anonymously assess student impressions of the subinternship and whether it accomplished the goals they set forth, <http://links.lww.com/PRS/F38>.) The surveys assess specifically which course objectives are met using a Likert scale to help identify which aspects of the course curriculum may need improvement going forward. Other programs are encouraged to contact us for access to a copy of the survey on Qualtrics (<https://www.qualtrics.com/>). In addition, resident feedback and attending feedback are solicited at the end of each rotation.

Preliminary analysis of survey results (of 25 respondents to the presubinternship survey and 22 respondents to the postsubinternship survey) demonstrates that most participants (60 percent) heard about the virtual subinternship through Instagram, with others gaining notice through the University of California, San Diego website (20 percent), word of mouth (16 percent), and mentors (16 percent). More than 80 percent of respondents chose the following as the top four goals of the subinternship: gain mentorship with faculty, evaluate personal fit with the residency program, improve didactic plastic surgery knowledge, and interact with program residents. The success in meeting these goals is described in **Table 4**. One hundred percent of students endorsed that they would participate in the virtual subinternship again, and nearly 20 percent said they would choose a virtual subinternship over

Table 4. Preliminary Survey Results: Course Objectives*

Course Objective	Subinterns Who Identified This As Their Course Objective?†	How Well Was This Objective Met?‡
Gain mentorship with faculty	23 (92)	4.5
Evaluate my personal fit with the residency program	23 (92)	4.5
Improve didactic plastic surgery knowledge	22 (88)	4.7
Interact with program residents	21 (84)	4.6
Experience day-to-day schedule of program	17 (68)	3.4
Gain opportunities to engage in research	15 (60)	3.8
Gain procedural/suturing skills	13 (52)	3.5

*This table summarizes preliminary survey results regarding course objectives from 25 respondents to the presubinternship survey and 22 respondents to the postsubinternship survey.

†Data are expressed as number of students (%).

‡Average Likert score, with 1 = not met, 5 = very well met.

an in-person subinternship. The most common identified strengths of our virtual subinternship compared to an in-person subinternship were (1) more face-to-face time with attendings, (2) a flexible schedule, and (3) reduced cost.

DISCUSSION

Benefits of the Virtual Subinternship

The era of COVID-19 has forced surgical programs nationwide to adapt to virtual learning platforms and other remote learning resources to provide quality surgical education to trainees. The primary goal of the virtual subinternship is to achieve high quality plastic surgery education in a structured timeframe while providing a conduit for communication between students, program faculty, and residents using a virtual platform. In the setting of a pandemic, the virtual subinternship curriculum presents obvious advantages for both programs and students.

This virtual subinternship provides students with didactic discussion, insight into the case types/volume, and an opportunity to interact with the various personalities that compose a division or department of plastic surgery. The curriculum emphasizes core surgical principles and surgical anatomy while offering many opportunities for students to interact with faculty one on one. Virtual subinternship opens opportunities for students without a home program at their medical school to experience a rotation in plastic surgery. The mentorship and research opportunities are of particular value to these students, who have to

work much harder to gain the same opportunities that students with a plastic surgery program have ease of access to. An additional benefit of the virtual nature of the subinternship is the cost savings; the total estimated cost of this subinternship is approximately \$60 as compared to the average \$3591 that students report spending on their in-person subinternships.¹³

Vice versa, the faculty and residents get the chance to gauge each subinterns' knowledge base, technical skill, and personality, all virtually while maintaining student safety during the COVID-19 era. The program can assess each student's personality, although the evaluation of important selection characteristics such as compassion, maturity, honesty, and work ethic²¹ is somewhat limited because of the lack of patient care.²¹ As the match into integrated plastic surgery continues to be highly competitive^{25,26} with students having increasing research experience and impressive average exam scores,²⁰ assessing subjective qualities is increasingly important to establish a good fit.¹⁵ With almost half of plastic surgery applicants matching where they completed a subinternship,¹⁰ many program directors consider performance on subinternships to be the most important resident selection criterion.¹⁰

Challenges of the Virtual Subinternship

One of the most glaring challenges with a virtual rotation is the lack of prolonged day-to-day in-person contact. There are many intangibles and subtleties that occur during a prolonged several-week rotation at an institution which can never be achieved through a computer screen. Most obvious is a lack of direct patient interaction for subinterns, but equally valuable are the varied interpersonal exchanges, unpredicted clinical or logistical challenges, and sheer volume of exposure that can be reviewed by programs when students are in person. These all allow programs to draw comprehensive holistic conclusions of the potential applicant. Given the predictable scheduling of weekly conferences and the otherwise flexible scheduling of other sessions (i.e., mentorship meetings, virtual case reviews), scheduling conflicts existed but were rare. Given how the case reviews and mentorship were spread across the various teams, each individual resident or attending (other than the program director or chief) had, at most, two additional hour-long sessions per week apart from routine conferences. The program director and division chief carried the largest burden of work, often dedicating 3 or more hours per week to check-in and mentorship

sessions alone. This enabled them to form personal relationships with the students which aided in writing letters of recommendation and providing career guidance, networking opportunity, research opportunities, and other aspects of mentorship based on each student's unique background and interests. There is undoubtedly an opportunity cost for the residents and faculty to participate in the virtual subinternship, although this is likely no different than what would be expected through the traditional experience. Attention must be paid to appropriately instruct faculty in the use of virtual modalities. One additional area of challenge is the lack of clinical course credit that can be offered for a virtual rotation at our institution. Liaison Committee on Medical Education standards require students to be physically present and interact with patients to receive clinical course credit. One mitigation strategy explored locally is to offer students elective credit—something many of them do during their fourth year—and direct them to explore this option with their home institution.

Subinternships in the Time of COVID: What Does the Future Hold?

The virtual subinternship will continue to evolve and improve as student, residency, and faculty feedback shapes the curriculum. Amid a pandemic, the virtual subinternship has allowed participating students to gain education and exposure, while satisfying safety precautions. The preliminary survey results are promising that the virtual subinternship can overall be considered a success, albeit a work in progress. As more institutions adopt the virtual education platform, we believe that the option of the virtual subinternship will persist beyond the time of the current pandemic; our institution intends to continue offerings of this program. This experience demonstrates the merit of the virtual platform to meet the goals of mentorship, didactic teaching, and evaluating personality fit. There is work to be done to improve the course components related to patient interaction and the acquisition of technical skills, which will be shaped as we understand HIPAA regulations related to virtual learning and innovate virtual suturing materials.

This virtual subinternship is only one of many ways in which plastic surgery programs are adjusting to the new circumstances imposed by COVID-19. Other institutions are innovating clerkships of their own, and many are hosting virtual meet-and-greet sessions, including those hosted by the American Council of Academic Plastic Surgeons.

It is of utmost importance during this time to continue creating opportunities for fourth year medical students to engage with plastic surgery programs. We encourage the adoption of the virtual subinternship curriculum presented in this article by any interested plastic surgery program.

CONCLUSIONS

To our knowledge, the virtual subinternship offered at our institution based on the curriculum presented in this article was the first virtual subinternship to be offered in the country. Thus far, postrotation feedback has been promising, but further evaluation of the virtual subinternship is ongoing. Given the inability to safely offer in-person away rotations during the ongoing COVID-19 pandemic, we strongly encourage other residency training programs to offer similar virtual learning opportunities for medical students, particularly for those without access to a home plastic surgery training program.

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