

Impact of COVID-19 on Surgical Education (COVISurEd): A Global Overview Across Six Continents

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Abstract

Background: There has been a huge disruption of surgical education globally during the COVID-19 pandemic with the landscapes of surgical training programs changing drastically. This paper aims to give a collaborative overview of how COVID-19 affected surgical education globally.

Methods: This is a qualitative, international collaborative study conducted in eleven countries across Asia, Africa, Australasia, Europe, North America, and South America. The data on the impact of COVID-19 in each country were collected based on COVISurEd guidelines along with solutions to mitigate the impact.

Results: The common impact on surgical education during COVID-19 pandemic in all eleven countries was a decrease in opportunities for skills learning due to cancellation/postponement of elective surgery. In many countries, virtual training models were started via online platforms, exams were postponed, and training programs were modified.

Conclusions: COVID-19 pandemic has had a substantial impact on global surgical education. The extent to which the surgical training programs has been affected depended on the adaptability of the surgical training programs, availability of alternative skills teaching methods as simulation, and proactive response by surgical educators for remediation.

Introduction

The COVID-19 pandemic has disrupted surgical education and has affected clinical, research, and teaching components of surgical training globally [1, 2], with the decrease in elective surgery worldwide [3, 4]. A national survey of general surgery residents in the United States raised concerns about the adequacy of graduating surgery residents in preparation for fellowship and independent practice due to substantially decreased case volumes [5].

Although, this recognized global challenge in surgical education has been voiced differently in individual institution and countries [6, 7], there has been a common fundamental message: surgical education must change to adapt to the circumstances created by the pandemic [8-10]. Across surgical specialties, virtual education programs have been developed during the pandemic [11].

A systematic review of medical and surgical education during the COVID-19 pandemic noted the scarcity of high-quality studies [12] and a lack of objective data regarding operative case volumes, thus highlighting the need for more data on the effects of the pandemic on surgical training [13]. This study aims to give a global collaborative overview of how surgical education has been affected by the COVID-19 pandemic with a view to providing remediation for surgical training.

Methods

A collaborative study group named COVISurEd (Impact of COVID-19 on Surgical Education) was developed to conduct a qualitative international study of surgical education during the COVID-19 pandemic. The study team comprised surgeon educators and volunteers from 11 countries representing all six continents. Surgeon educators participating in the study were selected by convenience sampling. All educators were asked to provide written commentary on the state of surgical education during the COVID-19 pandemic specific to the institution and country he or she represented based on available literature or personal communications in case the published literature was not available. Guidelines for this written commentary and a protocol for how to obtain information of interest were provided to all contributing surgeon educators. Thus, qualitative data on the impact of COVID-19 in each country at the institutional or national level were collected based on the COVISurEd guidelines (Appendix). These data were then reviewed by the study team leads and compiled for discussion among team members.

Results

The impact of COVID-19 on surgical education in 11 countries across six continents; Asia (Nepal, Pakistan), Europe (Switzerland, United Kingdom), Australasia (Australia and New Zealand), Africa (Nigeria), North America (United States) and South America (Argentina, Colombia, Brazil)-is reported in this article.

Nepal

In Nepal, surgical education has been seriously disrupted due to COVID-19. In the academic general surgery unit of the National Academy of Medical Sciences, the annual number of elective surgery cases decreased substantially from 894 per year (elective surgery-411 and day care surgery- 483) [14] to 432 per year (elective surgery-283 and day care surgery-149) [15] with no substantive changes in emergency surgery cases during the first wave of the COVID-19 pandemic. This decrease in elective surgery has had a marked impact on the opportunities for operative skills acquisition and learning sessions in surgical wards. For remediation, the learning sessions transitioned to virtual platforms beginning in April 2020. The case-based teaching sessions on the surgical wards were replaced with the presentation of clinical case scenarios virtually and using images rather than hands-on patient examinations.

In a cross-sectional survey designed for assessing the resident's perception on newly introduced teaching methods conducted among 65 post graduate residents across surgical programs at the National Academy of Medical Sciences, 48 (74%) residents felt that the COVID-19 pandemic affected their surgical training, including elective surgical skills learning in 58 (89%) and emergency surgical skills learning in 41 (63%). Of interest, 56

(86%) residents felt that virtual classrooms were effective learning opportunities, but 45(69%) experienced technical constraints that inhibited learning with online classrooms. The intake of surgical trainees into the post graduate general surgery programs was delayed due to COVID-19. For the final examination of surgery trainees, many safety measures were adopted, and hybrid models were used. The need to establish well-equipped surgical simulation and virtual training centers, as identified in the earlier ASSURED study [16], was made evident by the trainees' responses during the COVID-19 pandemic.

Colombia

In Colombia, surgical training programs have been markedly disrupted due to the decrease in surgical case volume and the unfortunate loss of many great surgical mentors due to COVID-19 infections. Most university training programs have virtual programs for surgical trainees, and in many regions, academic activities requiring physical presence were restricted. The lack of hands-on learning opportunities led the universities to develop surgical simulation labs, which generated considerable financial and technical difficulties for surgical training programs, including higher costs of surgical training and limited ability to expose surgical trainees to a broad variety of surgical procedures in the simulation lab. The incorporation of social media was encouraged for surgical education with a greater reliance on surgical videos for learning basic surgical principles, such as surgical knot tying and other basic technical skills for surgery trainees in the early years of training. The surgery trainees have lost a great deal of surgical exposure. During the two waves of the COVID-19 pandemic in Colombia, more than 70% of elective operations were cancelled. Although emergency surgery continued during the pandemic, there still was a lesser volume of acute care surgery and trauma patients, as has been reported in other institution and countries. While there was no apparent effect on graduating the surgical residents who were in the final year of residency, the duration of surgery training of new trainees was delayed for up to eight months in 2020. Several training programs were forced to stop their formal teaching activities in the first several months of the COVID-19 pandemic to manage all the critically ill patients, but they have modified their educational activities in attempts to educate surgery residents for this novel situation of surgical practice. On talking to many surgery residents in multiple training programs throughout the country, many residents have felt that these methods of training are inadequate. These residents are looking forward for the return to the operating room for surgical training. However, the COVID-19 pandemic has had some positive effects in that this pandemic led to the development of innovative avenues of surgical education by surgical faculties using improved methodologies of simulation and other forms of virtual teaching and learning in Colombian hospitals.

Brazil

The population of Brazil has been severely devastated by the COVID-19 pandemic. Based on the university experience, both the surgical clinics and elective operations were

discontinued for three weeks, followed eventually by resumption of operative care for oncologic cases only. Emergency surgery services were continued during the pandemic. As might be expected, this attempt to mitigate the spread of the virus led to severe disruption of the formal surgical training program due to lack of operative cases and the need for mandatory coverage of COVID wards by the surgery residents. The same was noticed in other centers [17, 18]. Despite the preservation of emergency surgery services during the pandemic, there was discussion among the surgical faculties about the necessity for repeating the lost year of training. This additional year; however, was not instituted. Due to these changes in surgical training, there has been considerable uncertainty about the future adequacy of the national surgical workforce. There were no modifications made in surgical curriculum, teaching methods, assessment, nor the surgical training programs which led to a decrease in educational opportunities. Most medical centers in Brazil have little if any formal simulation centers for surgery training; indeed, most training programs in surgery in the past have relied on animal models in the laboratory to teach surgical techniques.

United Kingdom

In the United Kingdom, surgical training has been disrupted in many regions [1, 10]. At many hospitals, all non-urgent benign surgeries were suspended for at least three months [19], while emergency and urgent cancer operations were continued throughout. Due to the effects of this COVID-19 pandemic, the Royal College of Surgeons postponed the FRCS (Fellowship of the Royal College of Surgeons) graduation examinations. A survey of surgery trainees in West Scotland showed that more than 70% of the responders believed that they had decreased opportunities to operate as the primary surgeon and had not attended any teaching or out-patient clinics [20]; additionally, over a quarter (29%) had no access to a laparoscopic box trainer. The conclusions of this study were that there has been at the least a short-term impact on the education of surgery trainees with these trainees entering the next stage of training with decreased confidence levels and potentially decreased technical ability compared to their peers in previous years. Review of trainee logbooks comparing 2019 and 2020 showed a 50% decrease in trainees as the primary operating surgeon [21]. In Scotland, the number of admissions to emergency general surgery were reduced by almost 60% during COVID-19 [22]. There was no substantial modification nor revision in the surgical education curricula [23].

Pakistan

As per the COVID-19 prevention standard operating procedures by the government, all teaching and learning in surgical wards, specialized hands-on training programs and workshops were suspended by College of Physicians and Surgeons of Pakistan, which is the competent authority that supervises postgraduate training in all specialties [24]. Teaching activities requiring a physical presence were suspended; instead, a virtual approach with online lectures and mortality/morbidity meetings were held whenever possible. Elective surgical services were completely suspended for at least four months

from March to June 2020 in most surgical centers [25-27]. Emergency surgery and trauma surgery continued selectively as deemed necessary. Because there was no elective surgery performed in most centers for at least four to six months, surgical training was severely hampered. Surgical trainees faced major setbacks in their learning and especially in hands-on training [28, 29].

Teaching methods changed from “physical presence” to “online” learning along with delivery of surgical webinars. Despite this change, there were no changes in the planned overall curriculum [30]. The COVID-19 pandemic led to the start of online lectures, but this method was neither preferred nor readily accepted by surgical faculties along with trainees, and many surgical faculties opted instead to suspend all teaching activities until the resumption of a normal surgical schedule. These changes directly impacted the planned dates of graduation of surgery residents, because exit exams were postponed from March to September 2020 [31]. Additionally, the exit exams were conducted on-line, and the number of trainees allowed to sit the exams were limited for safety measures.

Most surgery trainees were redirected to work on the COVID wards where, unfortunately, many contracted COVID-19 and had to take breaks for isolation and quarantine. This was a stressful experience for all surgery trainees, because their career educational expectations were altered and directed away from their chosen surgical units for protracted periods of time. Most of the surgery trainees were fatigued by constant fear of spreading COVID-19 to their families [32, 33]; moreover, because of their extended necessary time on the COVID wards, these trainees were not very active in online learning due to time constraints.

Switzerland

Due to the lack of a structured national training program [34], the stated approach to surgical training has not officially been disrupted by the COVID-19 pandemic. But, because the elective theatre lists were cancelled during the first and second wave of the pandemic for several weeks, the number of operative procedures in which the surgery trainees participated decreased substantially. The main challenge for surgery trainees was in obtaining the required number of specific surgical procedures for minimum logbook requirements. At the start of the first wave of the pandemic, most elective procedures were cancelled. During the second wave, the elective procedures were considerably decreased due to bed demands in the intensive care unit for COVID-19 patients. In Basel University teaching hospital, emergency surgery, however, continued to take place.

Most postgraduate courses and congresses were cancelled. The lack of these educational opportunities as well as the lack of repeated, high volume intra-operative exposure had an influence on surgical training. There are four mandatory courses that every surgery resident needs to participate in to fulfill the criteria to sit for the board exam. All these factors described above delayed the training of individual residents, and in response, the board

exam to be held in the Spring of 2020 was cancelled and postponed to November 2020. In the French speaking regions of Switzerland, the change of resident rotations was postponed from May to July of 2020 [35].

Concern about the spread of COVID-19 led to the decrease in bedside teaching to a minimum, which affected surgical trainee-patient interactions. While the introduction of virtual courses and webinars arguably enabled easier access for teaching and learning, the increased time at hand led many trainees to turn their attention to completing research projects required for their training.

The Swiss Medical Association and Swiss Society of Surgery granted residents who were due to graduate during the pandemic a provisional specialist title. This waiver of some of the expected requirements for completing surgical training, although not ideal, did enable them to pursue as planned the post graduate positions as fully trained surgeons, with the permanent title to be granted pending the successful completion of the exam and necessary educational courses [36].

United States of America

In March 2020, when the COVID-19 pandemic reached hospitals in the United States in enormous numbers, many surgical residency programs, particularly those in the hardest-hit areas like New York City and Los Angeles, redeployed their surgery residents to help cover COVID-19 medical intensive care units and other areas of increased need. Because the vast majority of elective surgery was cancelled in response to or anticipation of limited hospital capacity, other programs, such as in Pennsylvania State, deployed their surgery residents to cover the needs of the hospital in taking care of the COVID-19 patients. In one survey of over one thousand general surgery residents, residents reported a substantial decline in case volume to three or fewer cases per week as well as a marked decrease in outpatient clinic experience [5]. Changes in clinical schedules, as well as the need to limit person gatherings, necessitated marked changes in the resident educational curriculum. In a survey of general surgery program directors in the United States, over 90% of respondents reported transitioning their didactic program to an online format [37]. This transition to a virtual program was enacted differently at various institutions, with university programs shifting to virtual formats before such shifts could be implemented in independent or community-based programs. Other educational adaptations included virtual mock oral boards and a weekly 'town hall' between program leadership and the residents, designed to provide updates on rapidly changing policies and allow residents to voice concerns in a time of great uncertainty.

Virginia Commonwealth University organized a collaboration of surgery residency programs whose faculty volunteered to give lectures using online platforms on a variety of topics in general surgery. This effort, named the National Surgery Resident Lecture Series (NSRLS) allowed residents from all the participating residency programs to interact with

one another and learn from faculty other than those at their own program. The collaborative effort was found to be beneficial for the participating programs, and it offered a model that was adopted by the Surgical Council on Resident Education (SCORE). SCORE added weekly webinars led by expert faculty from across the United States to their standardized curriculum aimed at surgery trainees. A study of the NSRLS and the SCORE webinars found both efforts to be successful, particularly in the earlier phases of their initiation [38].

Over time, as surgical volumes again increased, participation in the live NSRLS decreased, though attendance remained higher than expected. The ability to watch SCORE modules asynchronously was popular among trainees. These modules have since been matched to corresponding themed weekly modules and can be used for future learners.

Overall, the adaptations brought about by the challenges of the COVID-19 pandemic increased collaboration both within residency programs in the institution and between surgical residency programs across the country. The clinical education of many surgery residents was negatively impacted by limits on elective surgical cases and restrictions on trainee interactions with potential high-risk patients for their own protection; however, the innovative efforts of surgical educators helped ensure ongoing, high quality, didactic educational content.

In response to the COVID 19 pandemic, the American Board of Surgery oral (certifying) exams in the Spring of 2020 and the written (qualifying) exam in July 2020 were cancelled [39]. Due to the cancellation of the written exam, 2020 graduates of General Surgery programs were allowed to take their oral exam prior to taking their written exam. Both exams were also converted from in-person exams to virtual exams. Case minimum requirements were not modified for graduates, but the American Board of Surgery decreased the number of required weeks of clinical time by approximately 10% and allowed non-voluntary offsite time used for educational purposes to count toward clinical time [40].

Nigeria

The COVID-19 pandemic has had a tremendous impact on surgical education. The effect on surgical education included a decrease in academic programs, clinical activities, operative sessions, and research activities. In a survey across 50 institutions conducted about 8 weeks after the diagnosis of the first case in Nigeria, about 58% of respondents reported a complete shut-down of all academic activities [41]. In another study conducted shortly afterwards, only about 56% of academic teaching programs had adopted an online platform for academic activities [42]. A marked improvement in academic activities was, however, observed from a survey conducted about 18 weeks after the index case with about 88% of institutions holding academic activities, albeit at a decreased frequency compared to the pre-COVID era [2].

Expectedly, this period of the pandemic was associated with an overall decrease in the total number of operations across institutions. This decrease was reflected more with elective operations compared to emergency procedures [43]. Academic meetings were held on virtual platforms. According to a survey, within three months of the pandemic in Nigeria, more than two thirds of institutions had adopted the use of online platforms for academic programs [43]. While this catered to academic programs, it did little in terms of other important clinical activities, such as operative sessions; indeed, only a minority of surgery trainees had access to virtual surgical simulations and telesurgery facilities [43]. The first group of examinations for surgery trainees scheduled originally in April and May 2020 by the West African College of Surgeons and the National Post Graduate Medical College of Nigeria was cancelled due to the pandemic [44]. The recruitment of new trainees into surgical residency was also delayed across several institutions. The activities of the colleges such as the presentation of update courses and graduation ceremonies of newly qualified specialists were conducted using virtual platforms.

Argentina

Due to COVID-19, the number of operations decreased considerably, thus markedly affecting the training of surgery residents. In the first eight months from the start of the pandemic, as mandated by the National government, most elective operations were suspended, which directly affected the training of surgery residents. There was a shift within the learning program towards the use of simulation models. The shift of the training model in part toward one of simulation in recent years helped to maintain some form of on-going training to a large extent during the pandemic. Unfortunately, many of the face-to-face academic sessions were suspended, and most of the formal educational activities shifted to an online platform. However, the reliance on virtual classes and hands-on practice in the simulation laboratory was generally well-accepted by the students. The surgery trainees had a four-month extension of their training period to compensate for the loss of the expected educational training prior to the pandemic, but the overall academic study plan was not modified. For the instructors, the adaptation to the virtual system has not been easy, however, many students have felt that this new model may be more beneficial in many respects, because they were already familiar with technology. The evaluation methods have been carried out through the online platform, providing apparently good practical feedback on performance.

Australia and New Zealand

There have been striking differences in how COVID-19 has been handled across both countries and between Australian states. Specialties which deliver primarily acute services had the least clinical disruptions [45]; in contrast, many elective procedure-predominant specialties were put on hold. Despite these disruptions, most trainees were able to meet case number/logbook requirements by the end of 2020 as surgical services slowly restarted.

Only the Australian State of Victoria has seen further disruption due to a lengthy lockdown through much of 2020 which led to a substantial backlog in elective surgery.

An integral aspect of surgical training in Australia and New Zealand is 6-monthly rotations. Travel restrictions made this difficult, but early consultation and initiatives by the Royal Australasian College of Surgeons (RACS) to liaise with governments and hospitals to advocate for trainees resulted in favorable transitions [46]. The structure and content of the surgical training curriculum remained unchanged throughout the pandemic without incurring any apparent loss of quality or standards to assessments; however, the mode of delivery of the curriculum changed with the increasing use of telehealth, use of webinars, and changes in assessment formats.

Trainee progression is based on the attainment of 10 competencies [47]. While achieving some of the competencies was made more difficult, such as operative competency due to decreased elective capacity, other competencies could still be realistically attained within the pandemic setting. The competency-based approach helped to identify global deficiencies in contrast to individual deficiencies in competency. Many face-to-face surgical courses were cancelled, and compulsory courses were often postponed. Trainees were provided future dates to make up attendance at courses and examinations, and any necessary additional time required was allowed for under the “RACS COVID-19: Overarching principles to guide decisions in respect of RACS Education and Training Programs”.

The general surgical science exam (GSSE), a requirement for commencing training, remained largely unchanged. The most notable changes in assessments were made to the final exit Fellowship exam which typically involves seven sections, two of which usually involve real patients. Timing of these exams was delayed, and the format was adjusted [48]. The exam had been delivered in one city at four to five locations over one weekend prior to COVID. The Fellowship exam has been held twice since COVID across five or six cities and 30 locations adding to the complexity of such an important decision point in the surgical training pathway. To facilitate this substantial change, some surgical specialties removed live patients altogether and replaced this approach with complex clinical scenarios and image stations. The development of this exam also required a collaborative effort from surgeons from different regions. Graduation of trainees or convocation did not occur in 2020. Instead, a multicenter, multi-time zone convocation occurred in a decentralized manner in May of 2021.

Discussion

In all the countries included in this COVISurEd, the common impact of COVID-19 on surgical education was due to postponement and cancellation of elective surgery which markedly decreased the number of available opportunities for clinical and surgical skills learning. In addition, changes in delivery of clinical care, decreased involvement of surgery

residents in rounds, and decrease in the size of the in-hospital resident workforce reduced learning opportunities for surgery trainees during COVID-19 pandemic [49]. This decrease in clinical involvement can be mitigated in part by innovative interventions, such as a personalized approach for additional surgery training during fellowship or practice [50] and an extensive use of virtual platforms, including simulated oral board examinations, didactic sessions, journal clubs, technical and clinical skill sessions in simulation centers, and weekly quizzes [51, 52]. The use of question-based assignments, written assignments, and web-based learning modules such as institutional webinars and lectures should be utilized.

Consequently, the assessment of the knowledge and skills of surgery trainees needs to be modified based on an adopted change in the overall model of surgical training. The grading rubric should be updated by altering the weight of individual components based on adoption of novel methods. In these changed circumstances, direct monitoring and timely assessment for feedback to the surgery trainee is essential. The training programs need to assess the quality of graduates before they enter the surgical workforce.

Simulation centers can help surgery trainees to gain surgical skills and experience outside operating theatres [53]. Globally, many surgical training institutions still lack a surgical simulation training center [2]. In centers, where simulation training is available, its use has not always been prioritized and only encouraged during non-work hours. With the decrease in elective surgery, this is the time to increase the surgery trainees 'training hours' in simulation in a conscious, systematic, and graded manner. In centers where there are no opportunities for simulation training, there should be focused effort to develop a surgical simulation training center. Using continuous virtual simulation will allow trainees to keep abreast with their surgical skills [54], and the training program should consider the possibility and effectiveness of allowing supervised simulator cases to be incorporated into the logbook with objective documentation of an appropriate level of skill acquirement after these simulation courses.

Surgery trainees should be provided with opportunities for research, enhancement of non-technical skills, and professional development as well during such a global catastrophe. Skills in surgical audit, teaching, leadership, and research methodology could also be maximized. The majority of current surgical educators in many parts of the world have been trained in traditional apprenticeship model. An international collaborative initiative should be started to develop surgical faculty capable of training of surgical educators/trainers for a 'competency- based model' and 'surgical simulation training'.

There was a striking difference in the impact of COVID-19 across these different countries. In countries with competency-based model of surgical training programs, the time during decrease in elective surgery was utilized to train in non-skills-based competencies. In countries like Nepal, Colombia, and Brazil, there was a lack of simulation training centers which made it even difficult for continuation of training during COVID-19 pandemic. The conversion of teaching platforms from in-person presence to virtual platforms should be

supported by institutions especially in low resource settings where surgery trainees might not have appropriate access to advanced simulation models, technology and the internet. Although the paper represents the impact of COVID-19 on global surgical education, there is a limitation due to incomplete global representation and the greater representation of university affiliated surgical training programs as opposed to community-based training programs. Moreover, due to scarcity of research-based literature in many countries, the results are also based on experience and personal communications.

Conclusion

COVID-19 has had a marked negative impact on surgical education at a global level. Because the COVID pandemic is and has been an unprecedented situation where the circumstances are dynamic, a periodic evaluation of surgical training programs, teaching methods, and review of learning goals should be carried out to learn how to confront any similar catastrophe and prepare for future disruptions. While there is no universally accepted, effective substitute for hands-on operative experience, attempts to leverage virtual learning as well as surgical simulation have been undertaken worldwide to help bridge the gap in surgical training created by the COVID-19 pandemic. Future multi-national studies and interactions are needed to further evaluate the immediate and potential long-term impact of COVID-19 on surgery trainees.

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References

1. James HK, Pattison GTR (2020) Disruption to Surgical Training during Covid-19 in the United States, United Kingdom, Canada, and Australasia: A Rapid Review of Impact and Mitigation Efforts. *J Surg Educ.* Jan-Feb;78(1):308-314. doi: [10.1016/j.jsurg.2020.06.020](https://doi.org/10.1016/j.jsurg.2020.06.020). Epub 2020 Jun 25. PMID: 32694085; PMCID: PMC7315967.
2. Adesunkanmi AO, Ubom AE, Olasehinde O, et al. (2021) Impact of the COVID-19 Pandemic on Surgical Residency Training: Perspective from a Low-Middle Income Country. *World J Surg.* Jan;45(1):10-17. doi: [10.1007/s00268-020-05826-2](https://doi.org/10.1007/s00268-020-05826-2). Epub 2020 Oct 28. PMID: 33118075; PMCID: PMC7594960.
3. Potts JR 3rd (2020) Residency and Fellowship Program Accreditation: Effects of the Novel Coronavirus (COVID-19) Pandemic. *J Am Coll Surg.* 2020 Jun;230(6):1094-1097. doi: [10.1016/j.jamcollsurg.2020.03.026](https://doi.org/10.1016/j.jamcollsurg.2020.03.026).
4. Nassar AH, Zern NK, McIntyre LK, et al. (2020) Emergency Restructuring of a General Surgery Residency Program During the Coronavirus Disease 2019 Pandemic: The University of Washington Experience. *JAMA Surg.* Jul 1;155(7):624-627. doi: [10.1001/jamasurg.2020.1219](https://doi.org/10.1001/jamasurg.2020.1219). PMID: 32250417.
5. Aziz H, James T, Remulla D, et al. (2021) Effect of COVID-19 on Surgical Training Across the United States: A National Survey of General Surgery Residents. *J Surg Educ.* Mar-Apr;78(2):431-439. doi: [10.1016/j.jsurg.2020.07.037](https://doi.org/10.1016/j.jsurg.2020.07.037).
6. Munro C, Burke J, Allum W, et al. (2021) Covid-19 leaves surgical training in crisis. *BMJ.* Mar 12;372:n659. doi: [10.1136/bmj.n659](https://doi.org/10.1136/bmj.n659).
7. Adesoye T, Davis CH, Del Calvo H, et al. (2021) "Optimization of Surgical Resident Safety and Education During the COVID-19 Pandemic - Lessons Learned". *J Surg Educ.* Jan-Feb;78(1):315-320. doi: [10.1016/j.jsurg.2020.06.040](https://doi.org/10.1016/j.jsurg.2020.06.040).
8. Davis CE, Hayes L, Dent N, et al. (2021) Impact of COVID-19 on surgical training. *Br J Surg.* May 27;108(5):e199-e200. doi: [10.1093/bjs/znab057](https://doi.org/10.1093/bjs/znab057).
9. Daodu O, Panda N, Lopushinsky S, et al. (2020) COVID-19 - Considerations and Implications for Surgical Learners. *Ann Surg.* Jul;272(1):e22-e23. doi: [10.1097/SLA.0000000000003927](https://doi.org/10.1097/SLA.0000000000003927).
10. Burke J (2020) The impact of COVID-19 on surgical training. *Bull Royal Coll Surg Engl*102:S1, 3-3. doi: [10.1308/rcsbull.TB2020.2](https://doi.org/10.1308/rcsbull.TB2020.2)
11. Tabakin AL, Patel HV, Singer EA (2021) Lessons Learned from the COVID-19 Pandemic: A Call for a National Video-Based Curriculum for Urology Residents. *J Surg Educ.* Jan-Feb;78(1):324-326. doi: [10.1016/j.jsurg.2020.07.013](https://doi.org/10.1016/j.jsurg.2020.07.013).
12. Dedeilia A, Sotiropoulos MG, Hanrahan JG, et al. (2020) Medical and Surgical Education Challenges and Innovations in the COVID-19 Era: A Systematic Review. *In Vivo.* Jun;34(3 Suppl):1603-1611. doi: [10.21873/invivo.11950](https://doi.org/10.21873/invivo.11950).
13. Hope C, Reilly JJ, Griffiths G, et al. (2021) The impact of COVID-19 on surgical training: a systematic review. *Tech Coloproctol.* May;25(5):505-520. doi: [10.1007/s10151-020-02404-5](https://doi.org/10.1007/s10151-020-02404-5).
14. Joshi A et al. (2020) Bir Hospital Souvenir July 2020: 47-50

15. Joshi A et al. (2021) Bir Hospital Souvenir July 2021: 72-74
16. Joshi A, Borraez-Segura B, Anwer M et al. (2020) An International Collaborative. Study on Surgical Education for Quality Improvement (ASSURED): A Project by the 2017 International Society of Surgery (ISS/SIC) Travel Scholars International Working Group. *World J Surg*44:1400–1411. doi: [10.1007/s00268-019-05342-y](https://doi.org/10.1007/s00268-019-05342-y).
17. Prezotti JA, Henriques JVT, Favorito LA, et al. (2021) Impact of COVID-19 on education, health and lifestyle behaviour of Brazilian urology residents. *Int Braz J Urol.* Jul-Aug;47(4):753-776. doi: [10.1590/S1677-5538.IBJU.2021.99.09](https://doi.org/10.1590/S1677-5538.IBJU.2021.99.09).
18. Leite AK, Matos LL, Cernea CR, Kowalski LP (2021) The Impact of the COVID-19 Pandemic on Head and Neck Surgery Training: A Brazilian National Survey. *Int Arch Otorhinolaryngol.* Jul;25(3):e339-e342. doi: [10.1055/s-0041-1730019](https://doi.org/10.1055/s-0041-1730019). Epub 2021 Jun 25.
19. Iacobucci G (2020) Covid-19: all non-urgent elective surgery is suspended for at least three months in England. *BMJ.* Mar 18;368:m1106. doi: [10.1136/bmj.m1106](https://doi.org/10.1136/bmj.m1106).
20. Khan KS, Keay R, McLellan M, et al. (2020) Impact of the COVID-19 pandemic on core surgical training. *Scott Med J.* Nov;65(4):133-137. doi: [10.1177/0036933020949217](https://doi.org/10.1177/0036933020949217).
21. Joint Committee of Surgical Training, Association of Surgeons in Training, British Orthopaedics Trainees' Association, Confederation of Postgraduate Schools of Surgery (2021) Maximising training: making the most of every training opportunity. Available at <https://www.jcst.org/key-documents/>.
22. Dick L, Green J, Brown J, Kennedy E, Cassidy R, Othman S, Berlansky M. Changes in Emergency General Surgery During Covid-19 in Scotland: A Prospective Cohort Study. *World J Surg.* 2020 Nov;44(11):3590-3594. doi: [10.1007/s00268-020-05760-3](https://doi.org/10.1007/s00268-020-05760-3).
23. Joint Committee on Surgical Training (JCST). Covid-19 and Trainee Progression in 2020 (update VI). <https://www.jcst.org/key-documents/> [accessed 4 August 2021].
24. https://www.cpsp.edu.pk/files/news_notifications/cpsp-sec-2020-114.pdf
25. <https://mmnews.tv/opds-shut-down-across-govt-hospitals-in-sindh-to-limit-coronavirus-spread/?amp=1>
26. Alarming surge in Covid cases forces Civil Hospital Karachi to shut OPDs, cancel surgeries (<https://www.dawn.com/news/1637187>)
27. <https://www.thenews.com.pk/latest/629139-sindh-govt-imposes-province-wide-emergency-to-tackle-coronavirus>
28. Ammara S, Maria A, Amara Z, Sana S, Maheen R, et al. (2021) Impact of COVID-19 on the Number of Surgical Cases at a Tertiary Care Hospital in Karachi, Pakistan. *Biomed J Sci& Tech Res* 35(4):27826-27831.
29. Ahmed O, Asghar M, Khurshaidi M, et al. (2021) Provision of Surgical Services to COVID-19-Infected Patients at a Tertiary Care Center in Pakistan: A One-Year Clinical Review of the Year 2020 in General Surgery Department. *Cureus* 13(1): e12705. doi: [10.7759/cureus.12705](https://doi.org/10.7759/cureus.12705).
30. Farooq F, Rathore FA, Mansoor SN (2020) Challenges of Online Medical

- Education in Pakistan During COVID-19 Pandemic. *J Coll Physicians Surg Pak* 30(Supp2): S67-S69.
31. <https://www.cpsp.edu.pk/all-notifications.php> notifications dated 14th March 2020 and 21st March 2020
 32. Osama M, Zaheer F, Saeed H, et al. (2020) Impact of COVID-19 on surgical residency programs in Pakistan; A residents' perspective. Do programs need formal restructuring to adjust with the "new normal"? A cross-sectional survey study. *Int J Surg.* 79:252-256. doi: [10.1016/j.ijssu.2020.06.004](https://doi.org/10.1016/j.ijssu.2020.06.004).
 33. Pims doctors demand closure of OPDs (<https://www.dawn.com/news/1587653>)
 34. Moeckli B, Burgermeister LC, Siegrist M, et al. (2020) Evolution of the Surgical Residency System in Switzerland: An In-Depth Analysis Over 15 Years. *World J Surg.* Sep;44(9):2850-2856. doi: [10.1007/s00268-020-05552-9](https://doi.org/10.1007/s00268-020-05552-9).
 35. Hänggeli C (2020) Notrecht in der Weiterbildung? *Schweizerische Ärztezeitung.* 101, 924.
 36. Swiss Society of Surgery: Update COVID-19. Available at <https://sgc-ssc.ch/medien/covid-19.html>.
 37. Kilcoyne MF, Cohan GN, Aranda-Michel E, et al. (2021) The impact of coronavirus 2019 on general surgery residency: A national survey of program directors. *Ann Med Surg (Lond).* 2021 Apr 16;65:102285. doi: [10.1016/j.amsu.2021.102285](https://doi.org/10.1016/j.amsu.2021.102285). PMID: 33948166; PMCID: PMC8080449.
 38. Theodorou CM, Joshi ART, Chahine AA, et al. (2021) Multi-institutional Collaborative Surgery Education Didactics: Virtual Adaptations During a Global Pandemic. *J Surg Educ.* 2021 Jul-Aug;78(4):1340-1344. doi: [10.1016/j.jsurg.2020.12.013](https://doi.org/10.1016/j.jsurg.2020.12.013).
 39. https://www.absurgery.org/default.jsp?news_covid19_junegsce
 40. https://www.absurgery.org/default.jsp?faq_gshardship
 41. Ogundele IO, Alakaloko FM, Nwokoro CC, et al. (2020) Early impact of COVID-19 pandemic on paediatric surgical practice in Nigeria: a national survey of paediatric surgeons. *BMJ Paediatr Open.* Sep 1;4(1):e000732. doi: [10.1136/bmjpo-2020-000732](https://doi.org/10.1136/bmjpo-2020-000732).
 42. Shodipo OM Abiodun AA, Toluse AM, et al. (2020) Impact of Covid-19 Pandemic on Surgical Practice and Training in Nigeria. *IOSR Journal of Dental and Medical Sciences (IOSR-JDMS),* 19(6):32-36.
 43. Omolabake BI, Ugwu BT, Abiodun AA, et al. (2020) Overview of the Effect of COVID-19 Pandemic on Residency Training in Surgery and Related Specialties in North-Central Nigeria. *J Adv Med Medical Res.* Dec 10:126-31. DOI: [10.9734/jamr/2020/v32i2330724](https://doi.org/10.9734/jamr/2020/v32i2330724).
 44. Ossai EN (2020) Impact of COVID-19 on medical education and the challenges: how prepared is Nigeria? *Pan Afr Med J.* Dec 14;37(Suppl 1):45. doi: [10.11604/pamj.supp.2020.37.45.24915](https://doi.org/10.11604/pamj.supp.2020.37.45.24915).
 45. <https://www.bbc.com/news/world-australia-54686812>
 46. <https://www.surgeons.org/en/media-centre/covid-19-information-hub>
 47. COVID-19: Overarching principles to guide decisions in respect of RACS

- Education and Training Programs (v5). CAN 004 167 766 / NZCN 6235298
48. <https://www.surgeons.org/media-centre/covid-19-information-hub/racs-examinations-coronavirus-covid-19-faqs>
 49. White EM, Shaughnessy MP, Esposito AC, et al. (2021) Surgical Education in the Time of COVID: Understanding the Early Response of Surgical Training Programs to the Novel Coronavirus Pandemic. *J Surg Educ.* 2021 Mar-Apr;78(2):412-421. doi: [10.1016/j.jsurg.2020.07.036](https://doi.org/10.1016/j.jsurg.2020.07.036).
 50. Zheng J, Hundeyin M, He K, et al. (2020) General surgery chief residents' perspective on surgical education during the coronavirus disease 2019 (COVID-19) pandemic. *Surgery* Aug;168(2):222-225. doi: [10.1016/j.surg.2020.06.003](https://doi.org/10.1016/j.surg.2020.06.003).
 51. Surgical Council on Resident Education (SCORE) portal. Available at: <https://www.surgicalcore.org>
 52. Society of American Gastrointestinal and Endoscopic Surgeons. Available at: <https://www.sages.org/virtual-hernia-clinic/>
 53. Chick RC, Clifton GT, Peace KM, et al. (2020) Using Technology to Maintain the Education of Residents During the COVID-19 Pandemic. *J Surg Educ.* Jul-Aug;77(4):729-732. doi: [10.1016/j.jsurg.2020.03.018](https://doi.org/10.1016/j.jsurg.2020.03.018).
 54. Ehrlich H, McKenney M, Elkbuli A (2020) We Asked the Experts: Virtual Learning in Surgical Education During the COVID-19 Pandemic-Shaping the Future of Surgical Education and Training. *World J Surg.* Jul;44(7):2053-2055. doi: [10.1007/s00268-020-05574-3](https://doi.org/10.1007/s00268-020-05574-3).

Tables

Table 1: Impact Of COVID-19 In Surgical Training at Different Institutions Across Six Continents and Identified Solutions.

Institution	Country	Educational Methods Adopted during COVID-19	Impact on Surgical Training Programs Due to COVID-19	Impact on Examination & Assessment	Solutions Identified
National Academy of Medical Sciences, Bir Hospital	Nepal	Online Didactic & interactive sessions	Decrease in elective surgical skills learning opportunities	Entry exam delayed	Establish simulation training centers
		Online case discussion		Hybrid model utilizing virtual platforms	Strengthen skills lab
		Online training courses (Research methodology, Medical education)	Decreased bedside teaching	needed for exit exam	Improve technical support for trainees and faculty to adopt new teaching methods
Universidad Tecnológica de Pereira & Universidad El Bosque	Colombia	Virtual academic programs	Decrease in elective surgical skills learning opportunities	None	Increase funding for surgical simulation
		Simulated cases			
		Simulated skills labs	Loss of surgical mentors		Increase variety of procedures

		Social media interaction	Delay in starting new session		in simulation lab
		Surgical procedural videos			
Federal University of Sao Paulo	Brazil	None	Closure of surgery clinics Cancellation of elective surgery Virtual rounds	None	Establish simulation training centers Strengthen skills lab
University Hospitals Plymouth NHS Trust	United Kingdom	None	Cancellation of elective surgery	Graduation exams postponed	Use of virtual platforms
Jinnah postgraduate Medical Center	Pakistan	Online lecture Webinars	Training sessions and workshops suspended Cancellation of elective surgery	Exit exams postponed Online exams	Prioritization of surgical services
University Hospital	Switzerland	Virtual course	Decrease in elective surgical skills	Board(exit)	Remote training/exams

Basel		Webinar	learning opportunities	exam postponed	Virtual conference
			Postgraduate courses cancelled		Supervised simulation training
			Decrease bedside teaching		
Penn State Milton S. Hershey Medical Center	United States of America	Online didactics Virtual training Video training	Cancellation of elective surgery	Board exams cancelled Virtual exams	Collaboration between residency programs
Obafemi Awolowo University-Teaching Hospitals Complex	Nigeria	Online academic activities Surgical simulation Virtual update courses	Decrease in elective surgical skills learning opportunities	Postponement of entry and exit exams	Increase use of surgical simulation telesurgery
Hospital De Trauma Y Emergencia Dr Federico Abete Malvinas Argentinas	Argentina	Online academic activities Simulation training	Elective surgery postponed Four months training extension	Online evaluation	Virtual training with international participation

Middlemore Hospital, University of Auckland	New Zealand	Online courses Webinars Telehealth	Decrease in elective surgery Surgical courses cancelled	Postponement of exams Online assessment Use of teleconference	Decision-making in collaboration with surgery trainee committees
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Appendix: COVISurEd paper guidelines

Areas to be covered	Questions to answer
Surgical Education model in the country	Which model of surgical education and surgical training?
How has COVID -19 affected surgical education?	Any disruption in surgical training programs? Any modification in surgical training programs? Any major changes for the surgical trainees? Status of elective surgery ? Status of emergency surgery? Effect on surgery residents graduation? Effect on national surgical workforce?
Changes in surgical education curriculum	Any need of revision in the surgical education curriculum? Any modifications in surgical curriculum
Changes in teaching methods	Any start of new teaching methods for remediation? Any introduction of innovative methods of teaching? Acceptance of new methods by trainers?
Changes in assessment	Any modifications in assessment of surgical trainees? Any innovation in assessment tools and techniques?
Trainees experience	How did the trainees respond to changes? Acceptance of new teaching methods by trainees?
Recommendations	What are the Innovations in surgical education that can be recommended? What are the specific modifications in surgical education that can be applied globally? Has this pandemic provided with opportunity to improve surgical education? Any further recommendations for future

	unprecedented situations?
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