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# Impact of Covid-19 on undergraduate and residency training

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## ARTICLE INFO

### Article history:

Received 31 August 2020

Accepted 21 September 2020

Available online 12 November 2020

### Keywords:

Covid-19

Learning

Resident

Trainee

Pandemic

Undergraduate students

## ABSTRACT

**Background:** The covid-19 pandemic has dramatically changed lives of residents and medical students. In particular, the learning process has undergone widely changes, especially due to the rules of social distancing which have forced universities and various institutes to modify lessons, work shifts and internships.

**Purpose:** The purpose of our review is to evaluate how the various institutes have faced the covid-19 emergency and guaranteed the perpetuation of the learning process of resident and students.

**Methods:** A comprehensive search of the medical literature in PubMed and Google Scholar was performed including all the works explaining how the institutes have reorganized teaching for resident and undergraduate students.

**Main findings:** The use of internet for the dissemination of teaching material and educational meetings has built bridges, albeit virtual, between resident and teachers. New techniques for teaching and conducting exams have been introduced. The rotating team system allowed the continuation of the teaching activity in safety.

**Conclusion:** Thanks to remodulation of the teach modalities, the massive use of internet platforms, a wise distribution of work shifts, and others, universities and hospitals have not only reduced the impact on the learning process of resident and students but also turn this pandemic into a moment of personal and professional growth for the new generation of healthcare professionals.

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## Introduction

The novel Covid-19 pandemic marked our lives in an indelible way, changing the reality we were used to. It affected negatively the educational training for all students worldwide; Given the social distancing recommendations, the Coronavirus emergency has led to significant modification within hospitals, such as limiting the presence of residents who are

on duty, cancelling elective procedures, decreasing the volume of acute care surgery following surgical professional societies guidelines, and cancelling lectures and educational conferences to adhere to social distancing recommendations.<sup>1–5</sup> Regarding teaching, in-person academic activities, including face-to-face teaching, and simulation laboratories have been interrupted, along with an interruption of the clinical rotation within the different areas of the same institution. The current pandemic emergency has imposed

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<https://doi.org/10.1016/j.surge.2020.09.014>

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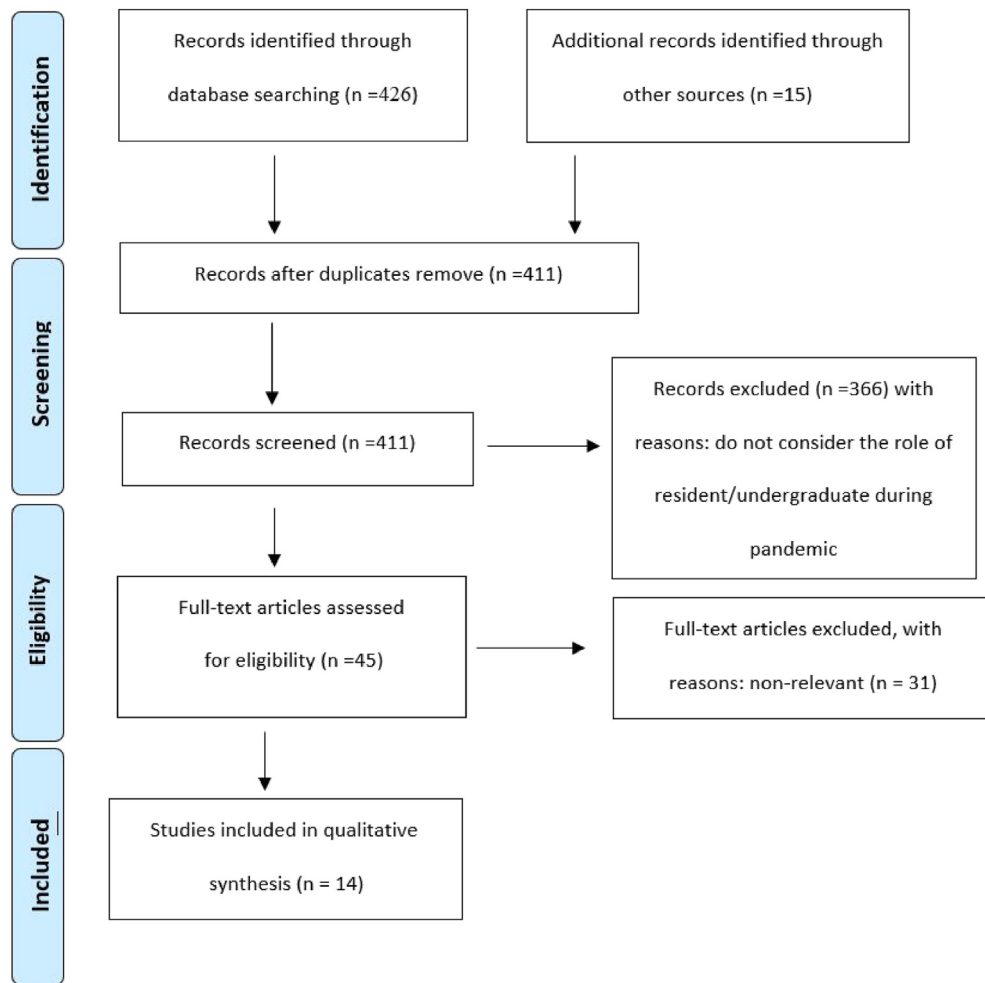


Fig. 1 – PRISMA 2009 flow diagram.

significant loads on universities and hospitals to promote continued safety, education, and quality patient care.<sup>4,5,6</sup> The present article evaluated the methods used by the various institutions to overcome the difficulties that have arisen to allow continuation of training courses medical students and post-graduate medical trainees and identify possible differences between the various institutes.

## Methods

A comprehensive search of the medical literature in PubMed and Google Scholar was performed. The following Keywords were used in combination: “Covid-19/coronavirus, SARS/CoV-2, pandemic, virtual, rotation, telemedicine, skills, learning, distance, training, students, resident/trainee, webinar, undergraduate students”. We considered for inclusion only studies that clearly stated the methods and techniques used by institutes to ensure the safety and continuous education of its own students. Reviews, letters, expert opinion and commentaries were not eligible for inclusion. The Prisma guidelines were followed (Fig. 1). The results of the literature search are shown in Table .1.

## Results

After removal of duplicate records, 411 articles were assessed. Then, following inspection of the title and the abstracts, 366 articles were excluded because although considering hospital reorganization during covid-19 they do not focus on resident or undergraduate. A further screening excluded another 31 articles because they do not specifically consider how the teaching of trainee or undergraduate students has changed. A total of 14 articles were included.

### Resident education

Given the quick spreading of the SARS-CoV-2 around the world, and the introduction of social distancing measures, many educational systems faced a mandatory closure of in-person activities. All universities suspended their frontal teaching, providing online lecture to guarantee students’ teaching and their right to study.<sup>7</sup> The internet has represented the keystone to produce the necessary connections between students and teachers. We assisted to a transitional paradigm from an in-person training to an online-training.

**Table 1 – Residency covid-19 training impact on surgical, medical and services specialities.**

Authors (and affiliations)	Specialty	Learning tools	Reorganization of work shifts	Assessment method
Okland et al. <sup>24</sup> Department of Otolaryngology, Head and Neck Surgery, Stanford University, Palo Alto, CA, USA;	Otolaryngology	Surgical simulation, 3D printing, Surgical kits, 3D Take-home simulation	–	Pre and post surveys are provided to the residents to evaluate the utility of the exercise
Leck et al. <sup>33</sup> Division of Neurosurgery, Dalhousie University, Halifax, Nova Scotia, Canada.	Neurosurgery	- Virtual online meeting guarantee half day teaching session: morbidity and mortality rounds, journal club, and multidisci- plinary team rounds - expanded telehealth management	Two separate teams of residents work 6 days on and 6 days off	–
Kogan et al. <sup>28</sup> Rush University Medical Center, Chicago	Orthopaedic & traumatology	Virtual learning – independent study – surgical simulation	Two groups of 15 resident: Home Team and Hospital Team. After a 2-week period, the Hospital team switches with the Home team, helping to ensure that at least half of the residents are healthy at any one time.	The Objective Structured Assessment of Technical Skills (OSATS), Global Rating Scales, and ABOS Surgical Skills Assessment Program Self-reported resident questionnaires
Schartw et al. <sup>22</sup> Department of Orthopaedics, Emory University School of Medicine, Atlanta, Georgia	Orthopaedics & Traumatology	- Daily one-and-a-half-hour collaborative, faculty-led interactive learning sessions on a topic - musculoskeletal subspecialty visits performed via video- enabled tele-medicine - academic endeavors: clinical research projects, grant writing, quality improvement ventures	Two teams structured as “active-duty inpatient” and “remotely- working.”	Mcq about daily topic
Sabharwal et al. <sup>23</sup> The Johns Hopkins University School of Medicine, Baltimore, Maryland	Orthopaedic & Traumatology	- Faculty-led teleconference: case presentation format - Prerecorded webinar viewing: teleconference topic (flipped classroom) - Assigned reading: covering next day's teleconference topic (flip- ped classroom)	–  2 teams: Team A (remote team) and Team B (on duty team) at each of 2 main hospitals that alternate clinical in- hospital duty every 14 days.	Chief resident-led teleconference: question review format, on earlier faculty-led topic completed independently In-training exam question completion and review (50 questions)
Malhotra et al. <sup>14</sup> All India Institute of Medical Sciences, New Delhi, India	Orthopaedic & Traumatology	Online lectures, Seminars and Journal Clubs with live streaming and interaction	Divided into multiple teams (Teams A & D rotate with teams B & C every 4 weeks) Each team comprise of senior and junior level residents One team is assigned for COVID care 25% residents are kept as reserve Others manage operative, inpatient and outpatient services on rotational basis	–

(continued on next page)

**Table 1 – (continued)**

Authors (and affiliations)	Specialty	Learning tools	Reorganization of work shifts	Assessment method
Nassar et al. <sup>25</sup> <i>Department of Surgery, University of Washington, Pacific St, Seattle, WA</i>	General surgery	Inpatient Care: This team performs all in patient clinical duties, including daily rounds, new consult staffing, admissions and discharges, and documentation. Operating Care: This team coordinates the operative care of patients and participates in the operations. Clinical Care: This team participates in outpatient clinics through telehealth The 3 teams would theoretically never physically interact	Three new larger teams called Alpha, Bravo, and Charlie. Each new team consisted of resident of all ranks, complemented by nurse practitioners. The clinical workload and mandatory staffing needs were similarly divided into 3 patient care domains: inpatient, operative, and clinic	–
Varga et al. <sup>26</sup> <i>Cleveland Clinic, Akron General Urology Program, Akron, OH</i>	Urology	3-h daily check.in conducted on virtual platform: - Indications for the major “high-priority elective” robotic cases for that week - AUA updates - Faculty/guest (previous graduate of the program) lecture or AUA Core curriculum topic of choice. Journal club	- One junior-level resident is designated as the “on call” resident for the 2 adult hospitals - Only emergent consults should be seen by the junior-level resident in order to limit patient interaction and the potential spread of COVID-19 - One senior resident is designated as the “backup” point of contact and is in the hospital during the day to help with major cases - One senior resident is to cover the children's hospital via home call	After each meeting, a summary email is sent by program director or chief residents to all members of the residency program, serving both as a debriefing as well as a tracking system of our academic progress during this challenging time.
Chick et al. <sup>12</sup> <i>Brooke Army Medical Center, San Antonio, Texas; and †University of California at San Francisco, San Francisco, California</i>	Surgical specialties	Flipped Virtual Classroom model  Online practice questions  Academic conferences via teleconference  Telehealth clinics with resident involvement  Facilitated use of surgical videos	Avoid gatherings >10 people Avoid rotations between different sites Cancel or postpone elective operations in a hospital setting Minimize nonessential personnel in the operating room Maintain disaster management and mass casualty triage principles	–
Almarzooq et al. <sup>11</sup> <i>Brigham and Women's Hospital, Heart and Vascular Center and Harvard Medical School, 75 Francis Street, Boston, Massachusetts</i>	Cardiology	Virtual educational Environment: Virtual Learning Platform	–	Mcq

Table 1 – (continued)

Authors (and affiliations)	Specialty	Learning tools	Reorganization of work shifts	Assessment method
Conroy et al. <sup>9</sup> Yale University School of Medicine (MC, HA), New Haven, CT	Psychiatry	AAGP COVID Curriculum: 30 online video modules, each delivered by an expert in the field. Lecture topics include a comprehensive range of subjects related to the assessment, diagnosis, and treatment of the older adult patients, along with special topics, such as cultural psychiatry and a Psychiatry Resident-In-Training Examination (PRITE) review	–	Trainees will be able to view each lecture and receive a certificate of completion regardless of their decision to complete the survey questions
Recht et al. <sup>10</sup> Department of Radiology, New York University Grossman School of Medicine, New York, New York	Radiology	“Simulated” daily readout (SDR): SDR provided the opportunity to present uncommon pathology with high educational impact to the residents who normally would only read about such entities but would not encounter them in daily practice due to low disease prevalence.	The number of cases on each worklist varied according to the training level of the residents and the week of the rotation three	–
Barberio et al. <sup>8</sup> Division of Gastroenterology, Department of Surgery, Oncology and Gastroenterology, University of Padua, Padua, Italy	Gastroenterology	endoscopic training • Implement simulation- based training opportunities (for example, virtual reality simulator models)	–	–
Pollom et al. <sup>30</sup> Stanford School of Medicine, Palo Alto, Stanford, California	Oncology	Distance learning • Local web- based lectures (for example, grand rounds, online graduation sessions, journal clubs, fellow core lectures and clinical cases through problem-based learning techniques) • Video- based education with interaction • National and international webinars or lectures, primarily via gastrointestinal societies	first week: didactic sessions second week: virtual clinics and give talks to the department For the virtual clinic experience, students are assigned to different services in teams of 2. Students work with the resident and faculty of their assigned service to see and present virtual clinic patients during the second week of the clerkship.	Complete pre- and postcourse self-assessments Attend didactic sessions and complete postlecture assessments Participate in virtual clinic and submit completed consult notes Give a journal club talk to the department

The pivot of this system was on-line meetings, which became the only moment of discussion and debate. Numerous platforms have been used for this purpose, including ZOOM™, GOTOMEETING™, MICROSOFT TEAM™ and many others. During the lockdown period, there was constant improvement of these programmes, improving

their versatility and accessibility to students and teachers. These meetings gave the opportunity to learn and discuss topics between students, trainee, residents and clinical and academic staff, or webinars from third party organisations.<sup>8–11</sup> In this scenario, an innovative teaching method arose: the flipped classroom strategy. Using this innovative

teaching method, learners were provided with didactic material, in the form of a pre-recorded video lecture, which they could watch prior to the online meeting. Students expressed high levels of satisfaction with pre-class video lectures because the videos can be accessed at any time and as often as they desire. Students also highly regarded the use of small group discussion-based activities in flipped classroom face-to-face sessions because these sessions increase their motivation to learn, and enhanced their level of engagement and interest in the subject matter.<sup>12,13</sup> Especially for surgical trainee interactive platforms provide surgical anatomy reviews, surgical procedure walkthroughs, practice test questions, and intricate patient cases.<sup>12–14</sup> However, their effectiveness in improving surgical performance remains limited.<sup>15–18</sup> The most popular video search engine for surgical trainees is YouTube™, whereas specialists tend to rely on videos from specialist surgical societies.<sup>16,19</sup> Caution should be exerted when choosing videos, because there is no current peer-review process for publishing medical videos online, with many top-ranked videos showing suboptimal technique.<sup>20</sup> Though virtual learning is able to support certain aspects of surgical education, it cannot obviously bridge certain gaps.<sup>12,21–23</sup> It is difficult for the current virtual platforms to address the lack of intra-operative experiences. Models and instruments, such as suturing kits with felt or silicone “tissue” or FLS (Fundamentals of Laparoscopic Surgery) box trainers, can be borrowed for technical practice. Written or verbal feedback can be provided remotely, either through faculty review of uploaded recordings or hosted virtual sessions in which residents focus their camera on their technical performance for faculty feedback in real-time.<sup>20,24–28</sup> Some obstacles related to the digital revolution in medical learning have been evidenced, including some teachers and educators struggling with new technologies, participants with poor bandwidth connections, and difficulties in viewing images. However, these limitations can be overcome with an investment of time and effort by staff suppliers who are familiar with these techniques.<sup>29</sup>

At the basis of surgical and medical education there is the theory of self-directed learning. In this transition period, trainees can use this time to reflect on their personal learning methodologies, establish a goal, such as improved in-service exam performance, or developing a deeper understanding of a certain topic using review materials textbooks, online review articles, and previously described virtual educational modules. In addition, students can use the time available for setting up or completing academic work and research projects.<sup>8,9,12–14,22–26,28</sup> With regard to the evaluation methods, the most used are the multiple-choice questions concerning the topics covered during the lecture of the day or of the previous days accompanied by the discussion among the residents. This represents a fundamental moment in the path the learning of these students during the lockdown period, as it keeps attention alive and allows the comparison between resident with different attitudes and interests and at the same time helps to develop the critical sense necessary to face the more and more challenges.<sup>11,22,23,30</sup>

### **Impact Covid-19 on surgical assistance**

In accordance with international guidelines, elective surgery was suspended, and only emergent and urgent cases could be operated. Consultations were accomplished mostly through a telemedicine platform. Exception was made for those patients with suspected of acute wound healing problems. Participation in these consultations provides continuity of clinical education without additional risk.<sup>31,32</sup> The other operative cases were staffed by no more than a single faculty and a single resident to limit exposure. Consequently, the number of residents physically present in hospitals decreased significantly, helping to prevent the spread of Covid-19. Residents were divided into two or more groups: the home group focused on virtual teaching, the in-service group and sometimes a reserve group (composed of two or three resident who stayed at home and were ready to replace a colleague on duty in the event of illness). Trainees rotated from one group to the other every two or more weeks. The duties of in-service resident varied from assisting in ward rounds, helping to implement ventilator protocols, providing general intensive care unit care, responding to ancillary staff queries, providing updates to the family of the Covid-19 patient, and monitoring overall patient status. To protect residents, full personal protective gear respirator masks, eyewear/face-shields, and full head/body gowns was provided to each resident and faculty, along with infrared laser thermometers to record temperatures at the beginning and end of shifts.<sup>16,24,25,27,28,30,35,36</sup>

### **Impact of Covid-19 impact on undergraduates**

During the Covid-19 lockdown, the life of an undergraduate medical student also underwent considerable upheaval. Those students away from their families and hometowns found themselves alone in full lockdown. Their education was interrupted, experiencing intense fear caused by uncertainty. More than half of medical students felt mentally unwell, as the corona virus outbreak determined high levels of anxiety.<sup>34</sup>

The Covid-19 pandemic introduced of new methods to provide education to medical students as well. Formal lectures were quickly converted into webinars available online, to be reached via the platforms mentioned in the previous section, in real time or recorded for later use by students wherever they were.<sup>35</sup> Current online webinars include key clinical conditions, case studies, didactic lectures and examination questions.

The transition to online medical education also promoted changes in examination methods. Following the recent success of Imperial College London's first ever online exam for final year students, other medical schools adopted a similar approach to ensure students remain engaged with their studies, with many universities adopting an open-book examination (OBE) approach. This approach allows students to use all their material (books, notes etc.) during the test, and represent an alternative from previous exam-hall settings (closed book). OBEs have been reported to reduce student

anxiety,<sup>36</sup> although it is not possible to generalize as some students often overestimate the help they can receive from the open book with a detrimental effect on the retention of notions and performance on exams. In addition, anxiety levels do not always have a negative effect on the student's performance, sometimes helping them to try their best and develop a stronger and more confident personality. However, with a global level of heightened fear and apprehension during the current COVID-19 pandemic, an approach to examining students that can minimise the symptoms of stress is welcomed.<sup>38</sup>

During the lockdown period, some universities recruited students for hospital-based roles as either students or early graduated frontline workers, while others prohibited any patient interaction.<sup>37,38</sup> Although medical students are a commendable source of help, their involvement must be carefully evaluated and their introduction to actual hospital clinical must be strictly controlled. Through their clinical attachments, they operate passively, shading teams, taking stories and observing procedures. Therefore, a well-structured program producing a stable learning environment does not guarantee that students will acquire the confidence and skills necessary to function properly during a pandemic; the lack of required knowledge and capability placed students, and patients, at risk during disaster situations.<sup>39,40</sup> Similar concerns are raised with the use of spontaneous volunteers in post-disaster situations by non-governmental voluntary organisations.<sup>41</sup> With constrained services, and national pleas for volunteers, there is potential for students to be misguided in their choice. In such situations, students can act as vectors for viral transmission, consume personal protective equipment and place an additional burden on teaching physicians.<sup>42</sup> Medical education alone does not justify these risks. However, the training of young medical students can benefit from the considerable resources offered by virtual learning and independent study.<sup>43,44–46</sup>

### Limitations

This work has several limitations. Firstly, the articles considered do not systematically analyse the characteristics and results of the measures introduced in this pandemic period, but merely report their experiences in a narrative manner. Second, most of the articles describe the organization of institutes of excellence in USA whose organization and economic availability is well above average, with few detailed testimonials from other countries. In some environments, internet connection does not reach the speed and stability required to guarantee the student an acceptable quality standard. For this reason, it will be the task of national governments to strengthen and extend broadband connections as much as possible in territories where distribution is poor. The extension of the network combined with the enhancement of educational systems, the use of virtual simulators, the establishment of databases of online lectures, the enhancement of access to on line libraries, will certainly require economic efforts that are not always sustainable in all parts of the world.<sup>14,22,27,36</sup>

### Conclusion

The work highlights first the promptness and efficiency with which medical education institutes managed to organize the teaching and the shift of postgraduate trainees allowing the necessary decrease in the presence of staff within hospitals, without cutting the necessary resources in this pandemic period. The use of internet for the dissemination of teaching material and educational meetings has built bridges, albeit virtual, between resident and teachers. The rotating team system has made it possible to achieve a balance between the safe and isolation of the resident and a certain amount of in-service hours. This unprecedented circumstance will change the way in which we deliver medical teaching and represents an opportunity for residents not only to focus on the theoretical aspects of their discipline but also a invaluable education in crisis management on a large scale and an opportunity to grow a common sense of belonging to face such adversities. However, maintaining the effective organization described will require continuous innovation and cooperation on the part of educational program directors, and leadership on the part of our professional societies to maintain rigorous standards of education and training for resident and medical student.

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