

How Patient Care During COVID-19 Pandemic Improved Subsequent Surgical Training: An Appraisal and Introspection

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1. Abstract

Surgical residency program across the world saw a dramatic change during the COVID-19 pandemic. Various new technologies like virtual methods of learning, simulation programmes were developed to continue training of the surgical residents. To find out how COVID-19 improved surgical training, we searched the literature and shortlisted 34 articles relevant to the topic and reviewed them. Most of the articles pointed out how physical form of training in surgical residency was converted to virtual platforms and simulation programmes. Literature also points how COVID-19 has led to the improved care of critically ill patients by the surgical residents in the post-COVID era. Team work and working together with all specialties were other areas that saw significant changes. We hope to put forward the positive changes in the surgical residency programmes encountered during COVID-19 and to carry forward these lessons for better training of residents in the future.

2. Introduction

COVID-19 originated in Wuhan, China in December 2019 [1] and soon became a global pandemic [2] at an unprecedented rate. On

12th March 2020, the World Health Organisation (WHO) declared COVID-19 as a pandemic [3]. The surgical residency programme all over the world saw a paradigm change during the pandemic.

In the surgical residency training, residents are expected to learn technical surgical skills, pre-operative, operative and post-operative disease courses and patient management. Surgical management skills include anticipation and understanding of the patient's problems, confident outlook, perseverance and competency of a surgeon to confront and manage any challenge that defines the profession. The global pandemic of 2019, resulted in the surge of non-surgical patients, leading to considerable changes being made to the surgical training and residency schedules. Healthcare service delivery required extensive re-configuration with considerable reduction in elective surgical procedures and cancellation of outpatient clinics. This further led to redeployment of surgical residents to Intensive Care Units (ICU) throughout the world. Many countries including India saw a huge surge of ICU admissions to manage critically ill-patients. This on one hand disrupted the sense of routine for the surgeons and residents, resulting in stress associated with higher risk of lives for healthcare workers caring

for COVID 19 patients and on the other hand enabled the surgical residents to take care of critically-ill patients. There was also disruption in academics, as examinations for United Kingdom's Royal College of Surgeons Membership (MRCS) and Fellowship (FRCS) were also revised to later dates [4]. All undergraduate, postgraduate and super-specialty training and examinations were postponed and disrupted in India. However, amongst all the challenges, valuable lessons have been learnt and continue to be learnt, which will benefit future healthcare services. Thus, the aim of this review is to evaluate the merits of the pandemic experience on the surgical residency curriculum in terms of transferrable skills, team work, management of critically-ill patients and career development.

3. Methods

Search terms such as 'COVID-19', 'coronavirus', 'SARS- CoV', 'MERS-CoV', 'Novel coronavirus', 'resident', 'surgical trainees', 'surgical training', 'surgical residents', 'surgical residency', 'virtual training', 'critical patients' were used for literature search in MEDLINE. The search was expanded by snowball method, boolean operator and we selected relevant articles for this review.

4. Virtual Reality Simulation for Surgical Training

COVID-19 pandemic had left surgical residents and trainees all over the world in a precarious position. Dramatic reduction in operative exposure, and in some cases, with a mandate to remain at home due to the lockdown imposed by most Governments, the surgical residents faced a great challenge in order to maintain their surgical skill and knowledge. Fortunately, in the light of technological advancements over the past several years, there were a number of options for the residents to maintain their knowledge and which were easily accessible from home. Technologies such as computer and phone-based applications provide access to operative video recordings, virtual reality operating room simulations and other interactive surgical platforms that benefitted the surgical residents during the COVID-19 pandemic. Apart from the wide availability of such applications, they have the potential to satisfy and supplement the learning needs of surgical trainees during such period of crisis, as defined by surgical education governing bodies [5]. Surgical simulation applications also has the potential to increase the proficiency of surgeons in the operating room, to decrease intraoperative errors, and reduce operative duration [6].

5. Computer-Based Platforms

There are over twenty computer-based platforms, including nine of surgical specialties, and among them fifteen computer-based platforms are freely accessible [7]. One platform (Incision Academy) was offering a 4-week free trial during the COVID-19 pandemic. A European-based online platform, Incision Academy, presents live intraoperative videos and demonstrated the steps of a given operation in details, and also had sections on interactive anatomy

learning and self-assessment [7]. Around 95% of American General Surgery residents subscribed to such programmes [8]. These online platforms also offered free live webinars and conferences. Similar platforms such as 'Surgery Squad' which is an interactive virtual reality platform, have online contents related to General Surgery, Ophthalmology, and Obstetrical procedures [7]. Among these platforms, two of them have been validated in peer-reviewed publications and have shown to increase the knowledge of residents in surgical procedures (pre-test: 42.5% vs post-test: 78.6%, $p < 0.0001$) and increased their confidence when preparing for live surgeries [9].

6. Phone-Based Platforms

Apart from computer-based platforms, there are educational phone-based platforms which also helped surgical residents of all subspecialties during the COVID-19 pandemic. Touch Surgery is one such phone-based surgical simulation application that includes twelve different surgical specialties including Cardiothoracic Surgery, Neurosurgery, Obstetrics and Gynecology, Ophthalmology, Oro-maxillofacial Surgery, Orthopedics and Trauma, Otolaryngology, Head and Neck Surgery, Plastic, Reconstructive and Aesthetic Surgery, Urology and Vascular Surgery [7]. Literature have reported that such platforms helped the surgical residents during the COVID-19 pandemic and most of the users found them to be realistic [10, 11]. The above-mentioned remote learning platforms could help expand educational opportunities beyond the walls of the hospital and mitigate the diminished surgical skill among residents during the COVID-19 public health crisis. COVID-19 pandemic has led to the increase use of VR simulators for training in surgical residency [12-16]. Study by Sommer et al. [17] has shown a positive impact of VSA (Virtual Spatial Ability) on surgical performance and time of completion in both basic and complex tasks. During the pandemic, with the repeated use of such VSA, residents were significantly able to increase their surgical skills and spatial imagination. These emphasised the role of VSA in surgical training [18,19].

7. Other Alternative Approaches for Surgical Training

Due to lockdowns imposed in different parts of the world, alternative surgical curriculum were designed that replaced the traditional face-to-face teaching programmes for surgical residents [20]. Distance education programmes, webinars, online teaching platforms gained popularity and helped residents to learn the basics of surgery and to interact with other colleagues from other part of the world and also with seniors.

Different e-learning modules were also used. One example of an online surgical educational platform is the Surgical Council on Resident Education (SCORE) Portal®. It provides residents with all sorts of educational materials and focussed on all areas of general surgery and its subspecialties. In 2019, SCORE merged with

the American Board of Surgery (ABS) [21] which made it a more validated online surgical learning platform. Literature have shown that well-designed online medical education activities at times are much better or even superior to traditional face-to-face learning activities [22].

8. Haptic Technology, Virtual Reality and Artificial Intelligence for Medical Education

Use of these technologies helped reduce physical contact during the COVID-19 pandemic and hence gained worldwide popularity. Actual surgical scenarios were made using surgical simulator system including a VR/ AR based graphical interface and a haptic interface. These enabled the surgical residents to get an idea about different surgical circumstances without the need of attending the hospital. Augmenting different haptic consoles and with the use of dual user haptic system, residents were able to receive guidance from an expert surgeon without being physically present [25].

9. Telemedicine

Telemedicine consultation concept gained popularity during the pandemic and different countries encouraged their residents to be an active part of such consultations, which reinforced both their medical and surgical knowledge as they had to deal with various types of patients over the phone [23]. Literature have shown that many clinicians and residents have reported that such electronic consultations helped to enhance their knowledge and gain confidence to tackle with different spectrum of patients [24].

10. Management of Critically-ill Patients

During the pandemic, surgical residents were posted in ICU for managing the critically ill patients. Improvement in skills were observed in procedures such as insertion of peripheral arterial catheters, central venous catheterisation, chest drain insertion and nasogastric tube insertion [26]. Residents also gained confidence in managing patients on ventilation. Communication is an important part for working in the ICU and enabled the surgical residents to improve their soft communication skills with patient, relatives and colleagues [26]. These additional skills of managing critically ill patients became an armamentarium for the professional growth of the residents.

11. Effects of COVID-19 on Urology Training

The abrupt reduction in elective surgeries and outpatient clinics led to limited learning opportunities [27]. In the study by Amparore et al. [28] the urology residents in Italy had similar on-call responsibilities as in the pre-COVID times, but there was a reduction in exposure to outpatient clinics, elective surgeries and also to diagnostic procedures. In order to minimise time in theatre, the emergency urological procedures during the COVID times were also performed by consultants rather than registrars. This led to impairment of training of the residents [27]. To overcome this, many centres took help of virtual learning. Vargo et al [29] through

the use of virtual platform created a structured framework for the training of urology residents despite lower surgical volume and absence of face-to-face teaching programmes. A critical component for developing expertise in surgeons and trainees is reflective practice (RP) which aims at promoting excellence in patient care using a structured framework. RP also had a major role in making complex decisions in the face of COVID-19 regarding service adaptations, scope of practice, end-of-life care and protecting the work-force. Darlington et al. [30] has pointed out the modifications in practice for the efficient management of urological malignancies in the COVID-19 pandemic with emphasis being laid upon obstructing and bleeding urological malignancies to prevent renal failure from obstruction and hemodynamic instability from bleeding. Emphasis was laid upon teamwork and co-operation between all specialties and subspecialties of the health care system. Like other specialties, COVID had changed the way of learning and practising Urology, and these lessons continues to guides even after the pandemic is over.

12. COVID-19 Pandemic and the Indian Surgical Residents

Like other parts of the world, the pandemic had also affected the surgical training of both general surgery and super-specialty residents in India. Mammen KJ et al. [31] in an appraisal has shown how the surgical residency programme deteriorated during the COVID-19 pandemic. To cope up with the changes, surgical associations like the Association of Surgeons of India (ASI), Urological Society of India (USI) came up with different online modes of surgical training and collaborated with other platforms worldwide. They conducted many webinars, online classes, operative video demonstrations and also encouraged the residents for virtual case presentations which enabled them to build up their knowledge despite the challenges faced. Surgical practise in India was also modified during the COVID times. One of the modifications was the postponement of laparoscopic surgeries due to the risk of virus transmission from aerosols. To prevent the spread of virus from aerosols, Das S et al. [32] used the concept of PIPAC therapy (Pressurized Intraperitoneal Aerosol Chemotherapy) in laparoscopic surgeries.

13. Working as a Team

Shortage of man-power and re-distribution of workforce to various departments lead to flattening of hierarchies within the workforce. Ability to work as a team in the best interest of the patient with appreciation of colleagues were other areas that saw a paradigm change during the pandemic [33].

14. Discussion

The whole world was affected by the COVID-19 pandemic in unprecedented ways in a short span of time. Surgical residents faced the greatest challenge during the pandemic as most of the elective surgeries were postponed and emergency surgeries were per-

formed by the consultants to reduce time in the operating theatre. Surgical residents and residents of allied specialties were affected both professionally and personally by the pandemic [31]. Considerable changes were made to the surgical training and residency training schedules. The pandemic on one hand changed the sense of routine for the surgical residents, and on the other hand enabled them to take care of critically-ill patients as there was redeployment of surgical residents to ICU worldwide. Due to the lockdown imposed by most Governments during the COVID-19 pandemic, the face-to-face academic programmes were cancelled and most residents across the world relied on the virtual simulation applications to maintain their knowledge. Several computer and phone-based applications were developed which provide access to operative video recordings, virtual reality operating room simulations and other interactive surgical platforms. As defined by the surgical education governing bodies [5], these applications had the potential to supplement the learning needs of the surgical residents and most of them were easily available. Over twenty computer-based platforms, including nine of surgical specialties, were freely accessible [7]. One of the platforms was 'Surgery Squad' which is an interactive virtual reality platform that have online contents related to General Surgery, Ophthalmology, and Obstetrical procedures [7]. Studies by Sugand K et al. [10] and Kowalewski KF et al. [11] have reported that most of the surgical residents using such platforms found them to be realistic. Alternative methods of surgical training such as webinars, online teaching platforms were used to teach the basics of surgery. e-learning modules were also used and one example of such an online surgical educational platform is the Surgical Council on Resident Education (SCORE) Portal®. SCORE provides residents with all sorts of educational materials and focussed on all areas of general surgery and its subspecialties [21]. Fordis M et al. [22] have shown that well-designed online medical education activities at times are much better or even superior to the traditional face-to-face learning programmes. Haptic technology, virtual reality and artificial intelligence were used in large numbers during COVID-19 to teach and train the residents. With the use of such technology, residents were able to receive guidance from an expert surgeon without being physically present [25]. Telemedicine gained popularity during COVID-19 as most patients were unable to travel due to the restrictions and lockdowns imposed by most Governments. In most countries, the residents were made an active part of the telemedicine team which reinforced the surgical as well as medical knowledge in them as they had to deal with various types of patient over the phone [23]. Learning to manage the critically-ill patients in the ICU was an added armamentarium, as the residents were exposed to a wide spectrum of patients. Working in the ICU residents gained confidence in managing the extremely sick and learned various procedures such as intubation, tracheostomy, central venous catheterisation etc. [26] and also improved upon their soft communication

skills, as communication forms an important part of management of patients in the ICU. When compared with the pre-COVID times surgical residents were found to manage the patients in the ICU with confidence.

Like other surgical specialties, urology also faced great unprecedented challenges during the COVID times. Amparore et al. [28] has shown that urology residents in Italy faced a reduction in exposure to outpatient clinics, elective surgeries and also to diagnostic procedures. Urology residency programmes also relied on virtual learning platforms. Despite the lower surgical volume and absence of face-to-face academic programmes, a structured framework through the use of virtual platform was created by Vargo et al. [29] for the training of urology residents. Modifications were also done for the treatment of genito-urinary malignancies, with emphasis being laid on bleeding and obstructing urological malignancies as shown by Darlington et al. [30]. Urology residency programme saw a change during the COVID-19 pandemic and the lessons learnt still continues to guide even after the pandemic is over. The training of surgical residents in India also deteriorated during the pandemic as shown by Mammen KJ et al. [31]. Various associations of surgeons and allied specialties like Association of Surgeons of India (ASI), Urological Society of India (USI) conducted online teaching programmes, webinars, operative video demonstrations for the residents which helped them to stay updated and gain knowledge even in the absence of offline face-to-face classes and bedside patient demonstrations. Modifications were also brought in the surgical practise in India during the COVID times with postponement of elective surgeries. Das S et al. [32] has used the concept of PIPAC therapy (Pressurized Intraperitoneal Aerosol Chemotherapy) during laparoscopic surgeries to prevent the transmission of virus from aerosols. Team work with flattening of hierarchies, appreciation of colleagues and to work unitedly for the best interest of the patient were among the other lessons learned during the pandemic. Hashimoto DA et al [34] has shown that during the pandemic, AI (Artificial intelligence) played a major role in surgical training by aiding with clinical diagnosis and decision making and is believed to play a major role in future also.

15. Conclusion

Residents of surgery and allied specialties were affected both personally and professionally by the pandemic as shown in an appraisal by Mammen KJ et al [31]. Despite the challenges faced in the residency programmes of various surgical specialties, areas such as use of alternative methods of learning like webinars, virtual reality simulation, management of critically ill patients in the ICU and team work saw a vast change. With this article, we hope to bring forward the positive impact that COVID-19 pandemic had on the surgical residency programmes in various parts of the world and to carry forward the important lessons learnt.

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