RACS Medical Student Award

Annual Essay Competition 2021

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Word Count: 2899

What is the role of medical schools and universities in practical surgical education in a social media and online world?

In his 2002 collection of writings *Complications*, renowned American surgeon-scientist Atul Gawande describes his experience inserting his first ever central line.[1] Gawande first sets the scene: it's the 1980s, he's a junior surgical registrar, he's seen central lines inserted in the past, he's practiced inserting them on models. Today, it's his turn. As Gawande consents the patient, running through the risks of the procedure and the likelihoods of those risks happening, he reflects on the tension inherent to all practical surgical education: the patient would of course want this central line inserted by a seasoned expert, someone who has inserted thousands of lines in the past. For the surgical trainee though, hands-on learning is hard to come by, and the obligation is to seize any opportunity to upskill. So, it was a nervous Gawande, and not a seasoned expert, attempting to cannulate the patient's subclavian vein that day. Unsurprisingly, he missed.

Almost 40 years on from that story, and the model of learning in surgery is in some ways unchanged. Practical surgical education often still involves subjecting willing patients to procedures at the hands of less-than-experienced medical students and junior trainees. In the last two years, though, a new difficulty has emerged. In the midst of the Covid pandemic, as medical students are banished from hospitals, elective surgeries are cancelled and clinics are transferred online, what happens when that hands-on-the-patient experience is less available? Or not available at all?

Enter eLearning, the use of online technologies and social media platforms to deliver surgical education[2]. These modalities have been available in some shape or form for over a decade now, and have been widely taken up by medical schools and surgical training programs. However, it is perhaps only since the Covid pandemic that the value of eLearning has been truly appreciated. In a social media and online world, medical schools and universities must be proactive in integrating eLearning into their curricula, making the most of the accessibility, flexibility and scope these tools provide. At the same time, online and social media resources do have their limitations, and the role of medical schools is in guiding students to high-quality resources and in education on critical appraisal. Moreover, eLearning cannot completely replace in-person learning: the more conventional fora of practical surgical education do offer unique advantages. Therefore, medical schools must tread a fine line, keeping in touch with an online world while ensuring that the necessary experiences in the simulation lab and in the hospital are still on offer.

Before we go on, what is really meant by the phrase "practical surgical education"? Of course, part of the teaching of surgery consists of learning to perform physical procedures. These range from diagnostic procedures like collecting bloods, to therapeutic procedures like suturing wounds, to a basic understanding of more complex operations, such as by observing a laparoscopic cholecystectomy [3]. Interlinked is knowledge of surgically relevant anatomy, knowledge which is often best tested and reinforced in the operating theatre. As one paper reviewing undergraduate curricula in the UK stresses, however, practical surgical education also includes learning about practical aspects of care before and after procedures.[4] Medical schools aim for students to become familiar with surgical decision-making, understanding when to operate and when not to based on careful patient selection;

with pre-operative and post-operative care, including optimising the patient's fitness for surgery and managing complications; and with effective patient communication, including gaining consent for procedures and breaking bad news about unfavourable outcomes. Importantly, a large part of this teaching occurs outside the operating theatre. Ward rounds, outpatient clinics and department meetings all represent unique settings for students to further their knowledge of day-to-day surgical issues and put their practical skills to the test.

It can be difficult to imagine then how practical surgical education can be delivered online. As with all fields of medicine, however, there already exists an absolute universe of online resources aimed at teaching surgery to medical students and junior doctors. At a knowledge level, this includes livestreams of surgical conferences, or applications collating articles recently published in surgical journals (Read by QxMd is one example).[5] In terms of practical education specifically, a key innovation has been the availability of high-quality surgical videos online on expert video catalogues and peer-reviewed academic video journals like GIBLIB, WebSurg and the Journal of Medical Insight (JOMI).[6,7] GIBLIB, labelled by some as the "Netflix of medical education", provides an extensive library of surgical procedures in 4K high resolution or 360o virtual reality. From the comfort of your own home (well away from the icy breeze of a cooled operating theatre and the wrath of an exhausted scrub nurse), you can flick between a robotic adrenalectomy, a modified radical mastectomy and a rotator cuff repair, each with commentary by the surgeon talking you through the procedure.[8] Online resources for more basic procedures are also available: every medical student in 2021 will be familiar with Geeky Medics, a British website where you can access clear images and well-designed video guides on surgical skills like tying a horizontal mattress suture.[9] For anatomy education, no longer is eLearning limited to hours-long online lectures. Today, medical students can access step-by-step dissections of cadavers in high resolution online.[10] On specialty-specific anatomy resources, like the Neurosurgical Atlas, a comprehensive library of annotated neuroanatomical specimens is available, as well as animated 3D models that can be zoomed in and out and rotated in all directions.[11] Even the 'softer' aspects of surgical education have been made available online. In the CLASSIE online ethics modules developed at the University of New South Wales, virtual reality technology is used to familiarise students with complex ethical scenarios. For the surgery module, the scenario is of a 15-year old Jehovah's Witness boy with large-volume rectal bleeding who is refusing a blood transfusion. Situated as an observer in the room, the student can rotate the online view 360o as they watch the surgical registrar's difficult discussion with the patient and his family, then access interviews with each stakeholder individually discussing why they felt the way they did.[12]

In the last two years, since the start of the Covid pandemic, these online resources have been taken up with a renewed enthusiasm by medical schools worldwide.[13] The advantages are obvious: as a medical student on a surgical term during the early days of the Covid pandemic, with personal protective equipment in short supply and serious concerns about room overcrowding, it is likely that you would have been barred from the operating theatres altogether. A fleeting exposure to a positive Covid case in 2021 may see a student isolating at home for 14 days and missing out on half of their placement with that surgical team. In years gone by, these situations would have made the loss of learning inevitable. Today, with the sheer range of online resources at students' disposal, there is a very real prospect of making up for this loss.

Are these online resources effective? The literature on eLearning for surgery is relatively substantial.[14] As far back as 2015, a study out of Johns Hopkins demonstrated that the use of virtual learning in general surgical term resulted in non-inferior academic outcomes and improved student satisfaction.[15] In the Covid context, a recently published case control study compared surgical skills competency of students taught with face-to-face tutorials with those taught by a newly-developed web-based surgical skills learning session. No significant difference was demonstrated between the study and control groups on a standardised marking scheme.[16] In a systematic review of e-learning for orthopaedic surgery, directed at students and residents, the authors concluded that the use of virtual patient cases, digital modelling, online tutorials and video recordings was comparable to standing teaching models for improvement in knowledge and clinical skills pre- and post-intervention.[17]

Social media platforms have also been used for surgical education. These platforms are, by their nature, easily accessible, with near-universal engagement and the potential for collaboration and discussion.[18] On Facebook, countless groups exist that allow anonymised cases to be posted for discussion, connecting surgeons from around the world: the Robotic Surgery Collaboration is one example. Medical students and juniors doctors are usually welcome to join these Facebook groups, an opportunity to witness discussions on complex cases by experts in their fields, just like at in-person department meetings or grand rounds presentations.[19] On Twitter, practical surgical education has been delivered via so-called "tweetorials", where a series of tweets are used as clinical tutorials on surgical topics, with links to useful education material [10]. Most recently, TikTok has emerged as a powerhouse in the social media space, and it didn't take long for content on surgical education to find its way on there. In fact, many surgeons have become TikTok celebrities: sharing short videos on how to scrub or how to suture, and 'behind-the-scenes' footage from inside the operating theatre. Even anatomy teaching has reached TikTok: the @instituteofhumananatomy (affectionately known as "Cadaver TikTok") uploads short commentated videos of anatomical specimens, and the account currently boasts over 6 million followers.[20]

In evaluating the prevalence and efficacy of social media use for surgical education, a recent publication in the ANZ Journal of Surgery by Larkins, Murphy and Loveday reviewed 37 surgical training institutions in Australia and New Zealand for their presence on social media. The study found that only 19% of institutions had an active social media account, and that only 14.7% of content published was educational; no analysis of the efficacy of education provided in this way was performed. Clearly, the formal use of social media remains limited, and further research on how effective these platforms are is required. Interestingly, educational content in the Larkins, Murphy and Loveday study attracted significantly more engagement (in terms of retweets on Twitter) than non-educational content, suggesting that audience for such teaching material does exist.[21]

Importantly, these online and social media resources are by no means without their issues. The most obvious concern is a lack of quality control. Take Youtube, which has long acted as a forum for the streaming of surgical videos, in much the same way as video journals like GIBLIB. What Youtube lacks, however, is a formal peer review process. A video of a sleeve

gastrectomy with mistakes in the commentary, outdated techniques or poor quality information is still going to be uploaded, and students watching this video may not have any way of distinguishing wrong practice from right.[22] Even if not inaccurate, content online may not be structured or presented in a way that aligns with a medical school's curriculum. Especially if content is not locally produced, it may contain hospital-specific or country-specific variations in practice. Then there are the practical limitations of the format. Videos on TikTok are designed to be less than 60 seconds to 3 minutes in length. This may be long enough to show video snippets of laparoscopic ports being inserted for an appendicectomy, but not nearly enough time to explain laparoscopic port insertion in any detail. Finally, there are considerations around content production, delivery and maintenance. In the paper by Larkins, Murphy and Loveday mentioned above, surgical institutions with an active social media account were surveyed on barriers to the use of these accounts for surgical education. The barriers most commonly described were a lack of funding and lack of support staff, while lack of technical expertise for content delivery, time required for updating content and lack of clarity on copyright issues were all also identified.[21]

This is where medical schools come into the picture. A major role of medical schools in today's online and social media world is in quality control: selecting out resources that are accurate, up-to-date, and consistent with the goals of their particular curriculum. Perhaps just as important is education on critical appraisal of online resources. Just as students are instructed on how to interpret journal articles and perform database searches, curricula may also incorporate teaching on how to identify and access high-quality educational resources, online and on social media [2] A secondary goal for medical schools may be content creation, developing online or social media resources that are local and tailored to their own curricula. However, not all medical schools will be equipped to create content, and given the overabundance of high-quality resources already available, it is perhaps wiser to direct students to already-established resources rather than expend additional time and resources for little benefit.

A compromise between online and in-person learning is simulation, an arena of surgical education which continues to advance by leaps and bounds. Just as pilots are trained to fly planes on sophisticated flight simulators, the simulation lab has for decades represented a useful setting for practical surgical education. Here, medical students and surgical trainees may practice laparoscopic techniques on specialised machines with haptic feedback, or in wet-lab courses on cadavers or animals. Increasingly, robotic surgical devices are available for simulation, where an eager surgical registrar can spend hours on end trying to suture a grape.[23] However, simulation labs can be incredibly expensive to establish and maintain, and access for students if often limited. One alternative is to scale down the simulation: whether it be suturing packs that students can buy online, or laparoscopic training boxes you can take home. However, the frontier in simulation seems to be virtual reality (VR) and augmented reality (AR) technologies. In 2016, a team at UCLA Medical Centre founded Osso VR, a VR-based surgical training program that uses a specialised headset to allow users to interact with a cadaver and surgical devices in 3D space. The technology was voted one of Time magazine's best inventions of 2019, and in one study, was demonstrated to improve surgical performance by 230% compared to traditional training methods.[24,25] Osso VR and other virtual reality programs like it may come to represent the gold standard for surgical stimulation for medical students and junior doctors in the future.

Of course, the tried-and-true method of practical surgical education is getting students into the hospital to learn. This offers learning that eLearning and simulation simply cannot provide. When watching a procedure performed in person, students can ask specific questions and receive real-time feedback in a way not possible when watching surgical videos online.[26] Then there's the manual, technical skills of being a surgeon: "you cannot learn to play the piano by going to concerts", and no form of simulation can fully replicate the experience of operating on a patient.[27] Finally, there are the subtle aspects of patient interactions that can be learnt only in person. Meeting face-to-face with the patient and their family before and after a procedure; seeing why a particular operation is decided on, based on the specifics of a patient's case; palpating the patient's abdomen yourself on the morning ward round: these benefits all link back to the broader understanding of what practical surgical education entails and cannot be entirely replaced by virtual learning.

Education of students in-person in the hospital does come with practical and ethical challenges of its own. As Atul Gawande reflected in *Complications*, it's unfortunate that learning for medical students and junior doctors often comes at the expense of the individual patient: as you fumble to suture up a wound, another human being is at stake who just wants the procedure completed uneventfully.[1] Weighed against this concern, however, is the very real societal obligation for younger doctors to be trained up for the future. In fact, most patients are very willing to contribute to the teaching of future generations of doctors, when performed under the appropriate supervision.[27] Therefore, it is important that medical schools recognise the limitations of eLearning and tread a fine line, ensuring that the necessary experiences in the hospital are still available. In the Covid context, this involves universities advocating for medical students to be permitted to remain in theatres and on the wards as much as possible, in order to maximise their surgical exposure and learn much-needed procedural skills.

Practical surgical education for medical students is challenging to deliver at the best of times, and in the context of the Covid pandemic, these challenges are only heightened. eLearning fora, both online and on social media, do offer incredible opportunities to deliver surgical education, and it is vital that medical schools and universities in today's world embrace these opportunities. Nevertheless, medical schools have an important role to play in guiding students to high-quality resources and ensuring students are well-trained to discern which resources to access themselves. And eLearning has its limits: there is no fully replacing in person, hands-on-the-patient experience in developing as a surgeon.

Several weeks after Atul Gawande's first attempt at inserting a central line, another patient needed a line in. This time, he didn't miss. The question is, how might things have changed if we placed Gawande not in the 1980s, but in the online world of the 2020s? This time, as a medical student he might have spent hours on the couch watching 4K, 3D, commentated "how to insert central line" videos on GIBLIB. He might have opened up TikTok on bus rides home from hospital and scrolled through quick clips of emergency doctors canulating subclavian veins. He might have practiced inserting lines with the Osso VR headset in the simulation lab, learning the preparation, the approach, the complications. When it then comes time for junior surgical registrar-Gawande to attempt to insert a central line on a nervous patient, there's a good chance that in this world, he would get it in the first time.

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