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Paradigm shift in the surgical training: The era of innovation, simulation and beyond

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NARRATIVE REVIEW

Paradigm shift in the surgical training: The era of innovation, simulation and beyond

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Abstract

This is an era of transformation of surgical education and training. Modern methods of training are being introduced at a rapid pace and are being adopted in surgical practice not only to improve the outcomes and patient satisfaction, but also to provide an opportunity to develop a new well-structured training curriculum by integrating both traditional and modern approaches to teach and learn surgical skills. Various surgical simulators are in use as training aids and are constantly undergoing further refinement and development. To achieve a smooth transition in surgical training to modern methods, a structured programme has to be developed and validated to bridge the gaps in terms of safety, efficiency and ethics during the training process.

Keywords: Surgical training, Curriculum, Simulations, Innovation, Evolution.

Introduction

Achievement of surgical competence is a complex process and involves accumulation of sound knowledge base, a requisite set of psychomotor and cognitive skills, including tactile function with hand-eye coordination. These, combined with professional attitude and bedside manners, result in specialist care of surgical patients with safety.[1,2] The traditional approach of training was by apprenticeship model where the trainee learnt "by doing", also referred to as the "see one, do one, teach one" model.[3] This centuries old approach to surgical training was subsequently evolved through competitive pyramidal and rectangular supervised surgical training models. Recently these old paradigms are challenged due to legal and ethical concerns for patient safety, the escalating cost of surgery, prolongation of hospital stay and procedure-related adverse outcomes, and thus, creating space for innovation in the form of increased interest in simulation.[2]

The innovations have kept human history away from monotony, and digital technology brought revolution that was never seen before, with communication and education being the prime examples. In the field of medicine, the introduction of simulation and wet-lab into training is a major innovation in surgical education. In modern surgical training the simulation is of paramount importance as it facilitates the learning and judgment based on cognitive task analysis of the operative steps and potential risk points for each surgical procedure.[4] An inanimate curriculum outside operation room (OR) based on hands-on surgical practice, enhances the necessary eye-hand coordination, shortens learning curve, improves patient safety and enhance efficiency.[5,6]

The goal of any surgical train programme is to help the junior surgeons automate these basic psychomotor and cognitive skills before they operate on a real patient. The technical skill scoring simulation drills can improve performance and boost self-accountability that allow the trainees to review their manoeuvres and receive graded feedback on their own performance. This paradigm shift is important not only for new surgical trainees, but also for established surgeons who need to learn new technical skills to keep pace with the evolving medical technology and procedures.[7] The current narrative review was planned to share information about the transition of surgical training hierarchy from apprenticeship to simulation-based learning and its impact and future perspective on surgical skills training.

Historical aspect of surgical training

Surgical training has undergone transformation from apprenticeship model that required indefinite time of association with surgical giants via a passive phenomenon. This approach was then replaced by a very competitive time-bound pyramidal system introduced by Halsted.[8] In this modified version, there was a gradual increase in the responsibility assigned for each year of training, allowing it only to those to master surgical skills and be an independent operator who were competitive, hard-workers and showed endurance to tolerate the hardships of intense surgical training. Nevertheless, the drawback of this model was attrition in the middle and eventually a decreased number of independent surgeons to cater to the growing needs of

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society. This system was followed by the rectangular programme that was more flexible and accommodative, leading to increased number of independent graduating surgeons.

Dry and wet-lab simulation

The surgical discipline depends upon the surgeon's ability to extend and apply motor skills and dexterity in a coordinated manner to carry out simple to complex surgical procedures with ease and safety to achieve desirable outcomes. The common methods of simulations are divided into wet and dry lab simulation where virtual reality (VR) simulation allows monitoring of important surgical features, like economy of movement and tissue handling.[9] Wet-lab represents animal-based module that can be modified based on trainees' level of competence and objectives that can be accomplished by repeated and regular practice. Dry labs provide opportunity to work in a simulated environment by using task trainers or VR simulators aimed to rehearse and achieve the desired level of competence.[10] Wet-lab trainings can be further subdivided into in-vivo modules, where living anaesthetised animals are used, and ex-vivo modules, where only animal tissues are used. The introduction of wet-labs in surgical training as a part of curriculum is considered highly exciting and admired by the most by the trainees. The animal models or cadavers provide them ideal environment to learn the anatomy and apply basic skills of surgical curriculum that is cut and sow. The skills acquired in this fashion can be transferable in OR and increase the confidence of attending surgeons to facilitate trainees' progression by allowing them to participate at a higher level.[11]

Transition towards minimal access

In the current era, minimally invasive surgery (MIS) has become a common practice in the field of surgery. Over the last few decades, a constant move from open to MIS and growth in this direction has been noticed.[12] MIS has brought revolution in surgical practice and procedures considered unethical by the surgical fraternity in the past are now considered as the norm. No one anymore denies innumerable advantages of MIS, including increased patient satisfaction in the context of cosmetics, pain and earlier hospital discharge.[13] The MIS has a spectrum of its own, varying between multiple small incisions to single port to no incision at all and using natural orifice to carry out invasive procedures. Urological procedures are prime examples of no incision surgical procedure. However, unlike open surgeries, it carries an extended challenge to teach these skills to trainee surgeons within a timeframe with due consideration to working-hour restrictions, patient safety and associated cost.[14] Similarly, video-assisted thoracic surgery (VATS) is the cornerstone of all MIS approaches to the thorax and is better tolerated by patients because of less pain, speedy recovery and minimised postoperative complications.[15]

Additionally, in cases of MIS, operating in a surgical field with two dimensions, using visual tactility, longer instrument with limited movement, teaching and training skills on live patients is extremely demanding and always creates apprehension in the mind of the trainer due to these reasons. Recognising all these limitations, MIS simulation is a valid solution to act as an ideal tool where errors are allowed to happen and repeated attempts can be made to master certain procedures in a simulated scenario. However, it is important for the trainees to keep in mind "fictional contract" i.e. they have to behave as if they are dealing with the real situation. This will not only help them achieve confidence and accuracy, but also facilitate them in reproducing these procedures in OR on real patients without compromising safety and integrity.

Robotic surgery simulator

There is considerable literature suggesting the enormous growth of robotic surgery over the last few decades.[16] Influencing several surgical disciplines, especially in the developed part of the world, and has surpassed some of the common general surgical procedures performed using laparoscope.[17] Although surgical training and education is all about strength, stamina and endurance, but human capacity, exhaustion, burnout factors are unavoidable. The executions of surgical technique are limited by the facts that there is a lack of dexterity of movement to work in certain plane and direction. Difficulty in accessing and approaching certain body parts where help from advanced technology in the form of video assistance, endoscopies, refined instruments and use of robotics to overcome dexterity is required. This has led to popularisation of robotic surgeries in almost every specialty where handling of delicate tissue, dissection, resection and sowing through them has been facilitated by robotics whenever the minimal invasive approach is applied. This has led to the inclusion of computer-based robotic simulators as part of surgical training modules. The robotic approach helps overcome the issues related to accuracy, dexterity precise moves, three-dimensional (3D) visualisation, and ergonomics, enhancing the surgeon's skills to facilitate the minimally invasive procedures.[18] Keeping in view all these advantages of

robotics, the simulator programmes are designed in such a way that they record timing, number of attempts as a result of error, handling of the instrument and facility.[16] Recently there has been an increased use of robotics in various surgical specialties and as a result, several surgical training programmes have been developed that adopted robotic-assisted simulations as part of curriculum after due validation.[16] Although robotic-assisted surgeries and simulations are gaining popularity, there is a lack of validation and procedure-specific simulation modules. Further, there is questionable widespread availability for both trainee and attending surgeons, especially in resource-limited setups[16] like ours. There is no doubt that technological advancements will lead to increased utilisation of robots in certain specialties and to continue capacity-building, practicing models with gradual upgrading in skills are required to be applied in OR without compromising the safety of real patients.[19]

Impact of Covid-19 pandemic and transition to virtual interaction

Owing to the coronavirus disease-2019 (COVID-19) pandemic, the teaching and training of surgical disciplines have faced enormous setback as a result of substantial decrease in the surgical volumes across the globe. Strict strategies with limited numbers of surgeries are advised in most surgical disciplines to minimise exposure and adverse outcomes of procedures.[20] As far as academics are concerned, the ever-growing advances in computer technology has made it possible to continue holding webinars and online educational activities. The ease of access through the internet from anywhere has in fact, helped ensure increased and active participation. At the same time, improved presentation skills of the trainees have been observed. The shortfall in acquisition of technical surgical skills has been compensated at some places using simulation to keep trainees engaged in technical exercises in a simulated model of high fidelity. Similarly, continuous assessment and evaluation can be done virtually. Every approach has its own pros and cons, and we have to accommodate all these as per the given circumstances without compromising w the quality, safety and efficiency.

Moreover, it has also influenced the way the trainees are finally assessed for an exit exam. In most of the countries at the end of training, a governing body, which in our case is the College of Physicians and Surgeons, Pakistan (CPSP), with a board of examiners makes a thorough assessment of the graduating surgeons. These candidates are supposed to satisfy or convince the examiners by showing their confidence in reaching a diagnosis by interacting with live patients skilfully. In the era of the current pandemic, it was though a great challenge to conduct such exit exams. However, the examiners put their act together and were able to replicate real exams virtually. The candidates were supposed to reflect their training, experience and knowledge to interpret data and decide appropriate management that would become part of their practice in the future.

In view of decline in the cases of COVID-19, restoration of regular activities in stages have been observed. As a precaution, expecting a challenge of the second wave ahead, it is preferable to be compliant with standard operating procedures (SOPs) related to COVID-19 and continue to carry on practising virtual interactions more often considering it as the new norm until and unless international health agencies announce the end of the pandemic and/or effective vaccine is widely available.

Future prospects

A variety of simulations are available for both for trainees and the trainers to be utilised and considered an opportunity in the current situation of shorter-length training, ethical issues and financial consideration, more so in private healthcare organisations. Although there is a great potential of simulation-based learning in providing greater educational opportunities to surgeons in training and allowing the faculty to have improved performance. Nevertheless in low and middle-income countries (LMICs) the prerequisites of institutional support, readiness to extend human and infrastructural resources is usually lacking when it comes to the execution. The authorities concerned have to allocate a dedicated budget for its full integration in the system by long-term planning. This will in turn enhance uniform curriculum and training methodologies in the entire country and prepare graduates to meet the societal needs according to international standards.

One of the most important aspects of surgical education and training is the acknowledgment of the fact that there is no match for time spent in wards and clinics and OR with patients and consolidating the experience with reading textbooks and literature. However, in the current challenging situation, surgical education can be further reinforced by modern methods of problem-based learning (PBL) and simulation-based technology with subsequent trainee's systematic evaluation of acquired knowledge, skills and understanding.[21]

Surgical training simulators in all forms are considered effective tools and help to speed up learning curve in an

environment away from the patients where errors can be made without adverse consequences.[22] Establishing such a programme is bound to face the challenges of scepticism and adjustment to the system, and thereby demands careful and deliberate validation in terms of cost-effectiveness. Because attributes, like established validity, reliability, educational impact and cost-effectiveness, are some of the important qualities of an ideal simulator.[23,24]

Although the paradigm shift is crucial, the traditional formative structured assessment should also and always be emphasised along with simulator outputs. The desired curriculum is designed in a way that it should include methods of enhancing knowledge, skills acquisition through dry and wet-laboratories, real-life case observation in a training centre, bedside assistance, and a mentoring console.[25] Cost implications could be addressed by joint investments and inter-institutional collaboration by rotation strategies of the trainees. The increasing knowledge and understanding of human structure and function in health and disease, advancement in diagnostic modalities and digital technology has helped to keep refining simulators for surgical training in entirely different ways along with assessment models that can be incorporated in the surgical curriculum.

As far as our perspective is concerned, education and training through simulators and hands-on workshops on animal models are the need of the hour with great potential for research and growth.[26,27] The widespread use of such modern methods is still lacking and only a few centres have such programmes in their curriculum and are regularly offering workshops on simulation for participation from across the country.[28] Once these simulator-based curriculums are established and are functional, they will not only address the multiple issues in surgical training discussed earlier, but also help in capacity-building[27] without wasting huge resources in obtaining such specialised skills abroad.

The way forward: The following recommendations based on literature[29] are made to facilitate comprehensive flexible curriculum development:

To establish and implement structured simulation-based surgical training according to international standards; to have widespread availability of simulation technology with expertise across the country; to adopt simulated models for all surgical disciplines; to ensure improved accessibility, awareness and high standards of local facilities to permit utilisation of these valuable resources; to encourage additional role of simulation training in non-technical skills, like communication and teamwork; and to have nationwide institutional accreditation of approved courses and facilities to maintain uniform standards that correspond to international standards.

Conclusions

Various surgical simulators are currently in use and are at different stages of further refinement and development. To achieve smooth transition in surgical training, a structured programme has to be developed by combining both old and new models that can address the gaps in terms of safety, efficiency and ethics.

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