

Surgical resident training in Pakistan and benefits of simulation based training

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Abstract

Apprentice-mentor is the traditional method for training surgical residents, but with the advent of time, advanced techniques have been developed to train residents. Simulation training is a time-effective method for training residents and is being used globally, but the majority of training hospitals in Pakistan have been practising apprenticeship model since it came into being. This review was planned to demonstrate the results of studies comparing the efficacy of trainees trained via the traditional apprenticeship model versus simulator-based training. Pubmed and Google Scholar were searched. Keywords used were 'simulation-based training', 'laparoscopic simulators' and 'surgical teaching methods'. Articles published between 1995 and 2017 were selected for review. The search was limited to articles published in English language. The review advocates implementation of simulation for training as well as assessment. This can be a magnificent step towards upgrading our healthcare system.

Keywords: Simulation-based surgical training, Apprenticeship model, Surgical assessment tools.

<https://doi.org/10.5455/JPMA.282116>

Introduction

First simulator models introduced were animal models. Operating on animal models can provide an optimal environment for the development of surgical skills and competence. But ethical questions were raised for using animal models. Later on, black box and virtual reality (VR) simulators were introduced. The surgical black box is a closed box with the camera fitted inside which provides images of laparoscopic tasks performed inside. These are simple and inexpensive and have shown good results on teaching medical students and residents basic surgical skills. Black box training requires the presence of tutor for judging performance. In contrast, VR simulators are highly expensive appliances introduced currently for better surgical training. The cost of these

devices may reach up to six digits. It involves interaction with three-dimensional images and the trainee could repeat complex surgical procedures such as dissection of blood vessels, management of complications like major bleeding during surgery and haemorrhage. Prior simulation training benefits the surgeon in concentrating on decision-making rather than basic technical issues while operating.¹ Due to variable patient flow relying solely on traditional learning methods and mentorship has become increasingly difficult to train surgeons.²

Where Pakistan Stands in Simulation Based Training

In Pakistan, the traditional method for training surgeons is used, known as "apprentice-mentor" method. It involves mastering surgical skills by observation and then proceeding towards observed skills. This method commences with performing simple surgical procedures and then proceeding to complex operations. Key factors limiting learning by this method includes patient safety issues, short patient stay and limited working hours. Hence 21st century demands modern learning strategies without bringing into question patient safety.³

In 2007, the first virtual trainer lab was introduced in the surgical department of Holy Family Hospital, Rawalpindi. This occurred in collaboration with Pakistan-US science and technology cooperation and Virginia Commonwealth University, Richmond, USA. This lab training was composed of 3 modules which comprised lectures on basic surgical training and demonstrations on VR simulators. In 2008-9, 50 surgical residents were trained. Master trainers were selected to conduct training of post-graduate trainees and this training programme is still producing trainees who are working all over Pakistan.⁴

In Karachi, Agha Khan University Hospital (AKUH), Liaquat National Hospital (LNH) and Sindh Institute of Urology and Transplantation (SIUT) are offering regular workshops on simulation training but government setups, such as Jinnah Postgraduate Medical Centre (JPMC) and Civil Hospital Karachi (CHK) lack these facilities. However, weighing the benefits of simulation training, it is suggested that these institutions should incorporate simulation-based training at the earliest possible date.

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Services Hospital, Lahore, has also incorporated simulation-based training for training its surgical residents. These trainers are used to train surgical residents in five basic laparoscopic surgical skills. This is in accordance with the McGill inanimate system for training and evaluation of laparoscopic skills (MISTELS) programme (7 of box trainers). A study compared surgical proficiency of residents trained over simulation versus those trained using traditional apprenticeship model. Group A underwent simulation training for six months whereas group B did not received any simulation-based training. Scores before and after the training were recorded using global assessment of laparoscopic surgery (GOALS) score. Group A improved its scores from 7.16 ± 1.48 to 14.76 ± 1.67 ($p < 0.001$). Group B improved its scores from 7.46 ± 1.04 to 9.76 ± 0.79 ($p < 0.001$).⁵

Researchers over the globe comparing the benefits of simulation training with apprenticeship model

A study defined that mastering surgical steps requires 3 steps: cognition, association and then automation.⁶ Another study randomly assigned half its students to VR training versus the other half trained as per standardised protocol of apprenticeship mentor method, and assessed the intra-operative performance of the groups during laparoscopic cholecystectomy (LC). Tissue dissection was 29% faster and mean errors were six times less likely with VR-trained students.⁷ A study showed that when surgeons were trained via simulators they performed better during their first-line cholecystectomies. However, this effect persisted up to only 10 cholecystectomies.⁸ It has been suggested that surgical training curriculum is composed of five components: Determining what skills are to be learned, teaching the skill, assessment of learned skill and assessment of curriculum built for learning the skill. Teaching and assessment of skill proceed simultaneously during resident training.² Virtual reality simulation training provides basic skills training along with performance assessment, but it lacks in acquisition of non-technical skills such as stress coping skills.⁸ Another study suggested that trainees who have been pre-trained have a greater cognitive function for handling intra-operative stress and making decisions.⁹ A study among surgical residents at the Yale University School of Medicine and the University of Toronto Had 67 residents participating via filling the online questionnaire. Overall, 95.5% residents believed that simulation-based surgical training had improved their

laparoscopic skills and 92.5% believed that skills learned during simulation training are directly transferable to operating room (OR). The most common factors influencing residents towards simulation training were the need for skill development and interest in minimally invasive surgical procedures. The most common reason for underutilisation of these skills was lack of free time during work hours as the simulation laboratory was only available during work hours. The most common simulation tools were live animal models, cadaveric tissue, and VR simulators. Overall, 56.7% participants agreed to the fact that simulation-based training should be mandatory before OR experience.¹⁰

In one study, surgeons from different specialties were invited to attend a one-day workshop on their cadavers. Their cadavers have been proved to be more effective than traditional formaldehyde-preserved cadavers. They contain relatively less amount of formaldehyde along with glycol, water and some salts. They have less odour, preserved tissue texture except for brain, eyes and blood vessels, and are cost-effective as the preserved tissue structure makes them acceptable for re-use. Surgeons were asked to fill similar questionnaires before and after the workshop. Surgeons concluded that their cadavers were realistic ($p < 0.001$), suitable for surgical simulation ($p = 0.015$) with reduced odour ($p = 0.002$) and were cost-effective ($p = 0.003$).¹¹

A study assessed the efficacy of two groups while performing porcine cadaveric LCs. One group ($n = 10$) was trained using the traditional apprenticeship model while the other group ($n = 10$) was trained using VR simulator. Each control group subject performed 5 cadaveric LCs. Each VR-trained subject performed 3 porcine LC. Ten experienced surgeons with previous > 100 LCs performed two porcine LCs each to set benchmark levels. Surgical skill assessment was performed using motion analysis and video-based global rating score. Results demonstrated that there were no differences in baseline skills of the two groups. First LC revealed differences between control and VR-trained for the time (4590 vs 2165 seconds), path length (169.2 vs 86.8 meters), number of movements (2446 vs 1029; $p = 0.009$) and video scores out of 35 (17 vs 25; $p = 0.001$). The scores of VR-trained surgeons matched expert scores. This study demonstrated the use of VR simulators as a cost-effective and time-effective approach towards surgical residents' training.¹²

One study reported expert opinions on simulation-based training. Participants included Heads of Surgery (HoS) and Training programme directors (TPDs). All of them agreed over the fact that simulation is a good training tool and can be used for training non-technical skills. They rejected the fact that simulation is only useful for novice surgeons for learning basic surgical skills. Overall, 14/15 HoS and 15/21 TPDs considered simulation useful for re-enacting stressful situations; 12/15 HoS and 16/21 TPDs felt that education centres must be accredited; 6/15 HoS and 14/21 TPDs considered it for trainee assessment; 8/15 HoS and 11/21 TPDs thought that simulation-based training should be made compulsory before live exposure to surgical techniques.¹³

A number of hours spent on simulator training have also a vast effect on learning. Result of a study conducted in Australia demonstrated improvement in time required for laproscopic tubal ligation where the trainees were given home box simulator training.¹⁴ In another study, participants received 3 hours of training and there was no positive influence of such training.¹⁵ There are evidences available from orthopaedic and other surgical specialities proving that trainees come up with more proficient results in a simulation based training program than those without the program.¹⁶

A multidisciplinary operating room team based simulation was done in New Zealand in 2015 among 20 surgical teams (including surgeons, trainees and technicians) which concluded that simulation course was rated excellent in terms of learning. It showed evidence that this programme showed improved BMRI scores (behavioural marker of risk index) indicating improved communication skills, team co-ordination and new strategies.¹⁷

Well-built curriculum along with simulation

Despite the time-effective advantages of simulation-based training, simulation alone cannot benefit residents' surgical training. It encompasses well-built curriculum, regular reinforcement and feedback, expert assistance, interactive social context and, above all, motivation. Motivation is crucial for effective training. It comes not only from senior residents but also from peers. In the 20th century, a Russian psychiatrist named Lev Vygotsky put forward the concept of zone of proximal development (ZPD) according to which, the learner can progress in decision-making even in the absence of assistance if the peers are capable.^{18,19} Simulation can

help in providing the opportunity to repeat surgical tasks, enhancing surgical proficiency but repetition alone can never reach the level of expertise which could be achieved in the presence of repetition along with motivation, determination and assistance. Tasks should be practised regularly to help them not to decay, and clinical knowledge should be kept updated to the point of over-learning. It has been suggested that short practice sessions are superior than mass sessions.²⁰

Simulation as a tool for assessment

Assessment of surgical skills has always been difficult. Previous methods for assessing trainees' performance include vivas, log book procedures and objective structured clinical examination (OSCE). Vivas are not standardised and results can vary between examiners. Log procedures have also failed because of limitations, including the attitude of senior resident assessing and also on patient factors. OSCE could only assess knowledge and attitude towards patients. VR simulators measure and store assessment parameters which are beneficial for self-assessment as well as assessment of trainee's skills. More advanced methods are now used for assessing technical skills of trainees. Some useful parameters include time taken, path and economy of movements. Researchers have observed that motion smoothness while object grasping, transfer, suturing etc can be measured for assessing surgical incompetence. They compared crowd performance rating with lap monitor assessment which closely analysed surgical steps. It was concluded that lap monitor assessment is a better tool than crowd assessment.²¹ Selection for residency training programmes and fellowships which are conventionally based on academic achievement and cognitive variables, there is still a trouble predicting over selecting doctors who would be successful surgeons. Simulation based assessment offers the selection board to assess the applicants knowledge, technical skills and abilities.²²

Why is Pakistan in dire need of simulation-based surgical training?

Hundreds of surgical and laparoscopic procedures are performed in Pakistan, but the surgical training methods question patients' safety while operating. It is seen that the surgeons themselves are not confident about their surgical skills. A study comprised 3rd, 4th and 5th-year surgical training residents doing their residency in seven

institutions accredited by the College of Physicians and Surgeons Pakistan (CPSP). The residents responded by filling a well-structured questionnaire. Overall, 37.5% residents responded that dry lab was available at their institution, but none responded that wet lab or VR simulators were available. Only 18.75% residents had ever attended a basic laparoscopy workshop. The researchers asked about trainees' perception on their surgical skills and none of the residents believed that their skills were excellent. Majority of residents i.e. 47.92% said their surgical skills were poor; 14.58% said good; 16.67% said average; 18.75% said below average; and 2% had no response to this question.²³

Globally, 272 million surgical procedures occur annually.²⁴ This number is increasing with the development of surgically treatable life-threatening conditions. Annually, there are around 44,000 to 98,000 deaths due to medical errors.²⁵ This is the number of deaths which can be prevented. Better learning tools can limit these deaths. Limitations associated with simulator training include affordability. Its high costs limit its use in many hospital settings. Proficiency in surgical skills is lost after 3 months. Hence, it is necessary to keep one self-updated.

Conclusion

Simulator training is used globally for training residents, but unfortunately Pakistan lacks this facility. If simulation training is made available in Pakistan, it can improve surgical training and the ultimate beneficiary will be patients. Top medical students in Pakistani medical universities generally opt for United States Medical License Exam (USMLE) or Professional Linguistic Assessment Board (PLAB) for acquiring quality medical training. If the training conditions in Pakistan are improved, it can lower the number of high-scoring medical students moving abroad. These students can improve current healthcare system in Pakistan.

Disclaimer: None.

Conflict of Interest: None.

Source of Funding: None.

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