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MINI-REVIEW

Simulators in the urological training armamentarium: A boon or a bane?

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Abstract Simulation devices have grasped the attention of almost all industries worldwide and the medical field has not been exempt. With technological advancement, it becomes important to assess whether medical simulators are the way forward as an adjunct or as a replacement to traditional training approaches by assessing their safety, efficacy and cost-effectiveness, and whether they should be made mandatory in the curriculum of urology training.

The present review aims to clarify some of these issues, as well as assess their role in urological training and present both the pros and cons of this simulation-based training.

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Introduction

Since their inception, simulators have grasped the attention of almost all industries worldwide, and the medical field has not been exempt. However, with technological advancement, are medical simulators the way forward as an adjunct or as a replacement to traditional training approaches? How safe, efficacious, cost-effective and user-friendly are they? Should they be made mandatory in the curriculum of any medical trainee?

These are just some of the questions that arise when one thinks about medical simulation in general and simulation in urology in particular.
To clarify, let us look at the inception, initiation, inculcation, innovation, as well as the inadvertent growing inclination of society, towards simulators.

What is simulation?

Simulation implies creation of an artificial environment, as near as possible to a real-life situation, so as to assess the response and reaction of an individual to that particular situation. In other words, it can be called a ‘dress rehearsal’ for the finale [1].

Initiation of simulation

Simulators have been used vociferously in the aviation industry for over a century, and today’s pilots have a mandatory requirement of a certain number of ‘simulator flying hours’ before they can be deemed safe to fly even as second-in-command [1].

In addition to the airline sector, military personnel have been using various simulation techniques in their training programmes. Simulator war preparedness is an excellent way to judge an individual’s response to life-threatening situations, during real-time war situations. The ‘Combat trauma patient simulation’ programme is one such simulator-based technology established in the USA to assess and analyse the feasibility of simulation in a battlefield situation [2].

Not to mention, the hedonistic entertainment industry, comprising movies, films, video games of all genres, so as to cater to all age groups of society. Various simulated-gaming consoles have been developed to give near-realistic environments to the gamers.

However, the medical field is a safety-critical domain where the lives of real people are at stake and thus the widespread use of simulators could form an important adjunct to the training of an individual.

Inculcation of simulation in surgery

The earliest medical simulators were mere simple human models made of clay and stone, followed by mannequins, mock-patients, and plastic simulators.

Developments in simulator technology have resulted in a plethora of new, improved versions, to the extent that a ‘Society For Simulation in Healthcare’ was formed in 2012 to enable and promote interprofessional advancements in the application of medical simulation [3].

Traditionally, surgical skills were gained by long-term apprenticeship alongside senior surgeons, with very long learning curves. However, in the current economic climate, institutions cannot invest so much time, effort and money, in to such a long apprenticeship.

Additionally, today, where accountability and results are so important, simulators could probably be the way forward. Patients are no longer considered as mere ‘training objects’ and the Halstedian apprenticeship model of ‘see one, do one, teach one’ is no longer apt [1,2]. Each and every case is different and occasionally, a surgeon may get only one chance at success.

In the infancy of one’s surgical career, simulators would help shorten the learning curve by enabling repetitions and revisions, thus making the young surgeon adept at dealing with real-life intraoperative situations in a better and less stressful manner. Such training is well-controlled, stepwise and when supervised, can be tailored to meet individual needs.

Additionally, simulation training significantly reduces operative times, as well as the possibility of complications.

Simulation in urology

Urology, of all the surgical disciplines, is best suited to make maximum use of simulation technology, as a vast majority of surgeries are laparoscopic and endourological.

The various applications in urology worldwide are as follows:

a) Learning about anatomy [4,5]: The ‘Visible Human Project’, an initiative of the National Library of Medicine in the USA, is a large dataset of digitalised CT, MRI and tissue images, generated at intervals of 1 mm, which can be rotated in three-dimensions to understand the intricate anatomy of the pelvis. Additionally, surgical trainees may even indulge in virtual dissections.

b) DRE simulation [6,7]: Carcinoma of the prostate is a leading cause of death amongst elderly men and a DRE forms an important and sensitive screening tool and can be enunciated as the ‘Pandora’s box’ of the urologist, akin to the abdomen for a gastrointestinal surgeon. Students are initially taught DRE on rubber prostatic models having beads inserted into them, to enable the trainee to get the feel of a malignant gland. Burdea et al. [7] using virtual simulation with a ‘PHANToM’ haptic interface (to provide sensitive feedback to an examiner’s finger), were able to show the feasibility of the DRE simulator.

c) Cystoscopy [8]: Cystoscopy forms the backbone of any endourological procedure and thus the need for it to be surgically precise. Additionally, residents must be well versed with the instrument and its assembly. Cystoscopy simulation has been found to significantly reduce the scope-assembly times and aid in smooth insertion and scope removal. This could probably have long-term benefits, such as reduced urethral stricture rates, but this needs evaluation.

d) TURP/transurethral resection of bladder tumour (TURBT) [9,10]: TURP surgery forms the ‘bread and butter’ for every urologist, and thus the need to be adept at this procedure. Ballaro et al. [9] and Schout et al. [10] have assessed the validity of simulation in TURP/
TURBT surgeries and found that simulation-trained surgeons spent less time orientating themselves, resected more tissue, and had fewer errors.

c) **Ureterorenoscopy (URS)** [11]: URS (flexible/rigid) is an extension of an adequate cystoscopy and probably the most significant role of simulators would be here, so as to enable trainees to easily identify the ureteric orifices and negotiate their scopes up the ureter.

d) **Percutaneous renal access** [12]: Percutaneous renal access is probably the epitome of a urology trainee’s skill and simulation/virtual reality (VR) can greatly reduce the learning curve. The PERC Mentor™ VR simulator to acquire percutaneous renal access has been well established and validated by Mishra et al. [12]. They found that there was significantly faster access with a minimum number of attempts and complications in simulator-trained surgeons.

e) **Laparoscopic procedures** [13]: VR has been widely used, in particular, during laparoscopy training. Operative times, blood loss, scope-path lengths, orientation and memory have been found to be much improved after simulation training. All this translates in better perioperative outcomes and patient comfort.

f) **Andrology** [14]: Grober et al. [14] have reported the use of a low-fidelity bench model for vaso-vasostomy simulation. Novice surgeons were found to be more adept when faced with real-life surgery after simulation training.

g) **URS** [11]: URS (flexible/rigid) is an extension of adequat cystoscopy and probably the most significant role of simulators would be here, so as to enable trainees to easily identify the ureteric orifices and negotiate their scopes up the ureter.

### Types of simulators validated

There are a wide variety of simulators that have been established for incorporation into surgical curricula, such as latex models of skin, artificial organs and tissues, fresh frozen cadavers, and the UroMentor and UroTrainer VR simulators. All of these have been validated for cystoscopy training purposes [4–8]. The UroMentor has been validated for use in URS training and the PelvicVision for TURP simulation [9–11]. The Procedicus MIST nephrectomy VR simulator for nephrectomy and the PERC Mentor for percutaneous nephrolithotomy have also been incorporated into the urology training curricula worldwide [12].

### Advantages of medical simulation

Simulation technology helps an individual to pre-empt real-life stressful situations in a controlled environment and enhances preparedness for the actual scenario.

Surrogacy is a fundamental basic of medical simulation. David Gaba, the pioneer of medical simulation, enunciated a five category division of simulation [1]:

- **Verbal simulation** implies simple ‘role playing’ to be aware of one’s role in different real-life, intraoperative situations.
- **Standardised patients** are actually pre-trained actors, to aid in history taking, communication skill development, as well as accurate physical examination.
- **Part-task trainers** are anatomical models of normal, as well as pathological disease processes.
- **Computer patients** are virtually created patients to aid in doctor–patient interaction.
- **Electronic patients** are those simulations that help in teamwork development.

Effectiveness of training was judged by how well and soon the trainees acquired the desired skills. These five tiers form the basis of the more sophisticated VR simulators in use today.

Medical simulation has been found to be safe and time efficient, with the ability to store performance history, which can be used to learn and re-learn, so as to minimise mistakes, shorten learning curves and expedite the entire training process.

Thomas Morstede, in 1446, wrote that surgeons should ‘be dextrous and have steady untrembling hands, and clear sight’ [15]: simulators can help surgeons to achieve this much earlier and with minimal patient risk, which in turn enhances real-situation surgical prognosis.

### Limitations

Medical simulation although vastly improved, can never be a substitute or replacement to real patient interaction-based conventional training. Purists have even gone on to claim that simulation is akin to a ‘tempest in a teapot’, ‘Man maketh a machine’ and not ‘Machine maketh man’ are what they would quote, so as to imply that at the best, simulators can be a supplement to medical training.

The disadvantages of the currently available simulator machines, are the lack of tactile sensation (haptic feedback), as well as the lack of tissue resistance to instrumentation. In addition, simulators cannot totally emulate real-life situations, which can also be considered another downfall. At present, there is no simulator available that provides the user with a sensory input of pressure or texture. Once these can be incorporated, it would probably constitute the ideal simulator for any training purpose.

However, for any surgical simulation-based training it is essential to demonstrate that the acquired simulation-based skills are actually transferrable to real patients. Additionally, cost constraints are another issue to be considered, especially in developing countries.

### Future scope

Robot-assisted surgery is currently the epitome of minimally invasive surgery, and each and every hospital is leaving ‘no stone unturned’, to leap ahead in the ‘rat-race’ of acquiring a robot. Thus, robot-assisted surgery simulators would logically be the next step in simulation technology.
Inculcation into every surgical curriculum, at the appropriate time, also remains food for thought. Whether these simulation skills can be extrapolated into surgical selection programmes to enable the most skilled individuals to enter into surgical domains, could also be a step in the future.

Every scientific advance goes through phases of suspicion, ridicule, blind acceptance, iatrogenic complications, and then a plateau and retrospection to allow prudent inclusion at the level it deserves. Medical simulation technology is developing with astounding rapidity and deserves to have a strong future in healthcare. The needs of medical training will inevitably create new demands, which will drive the market to develop the supply of simulation technology in medical schools and hospitals.

The challenges to surgical training are substantial and simulation has the potential to make a significant contribution to the development of surgical skills and curricula. It is thus mandatory that further studies be undertaken to provide the best evidence to determine how this simulation-based training can be used in the most safe, economic and beneficial way.

Conclusion

It would be safe to say that simulators in urology will help enhance clinical competence by enabling an easier and earlier amalgamation of technical and decision-making skills, and a calm response to stressful surgical situations.

The following paragraph may summarise what simulators mean to an individual trainee:

‘As we sow, so shall we reap...
The harder we work, our learning becomes less steep...
Repetition and revision...
Our mind undergoes a precondition...
So, when faced with any situation...
Our simulation helps in emulation’

Source of funding

None.

Conflict of interest

None.

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