'See one, practise on a simulator, do one' – the mantra of the modern surgeon

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Summary

Minimally invasive techniques are now well established in paediatric surgery. Training has traditionally been based on an apprenticeship model, as for open surgery. More recently the constraints of litigation, finance and restriction of doctors' working hours have led to a need to rethink this training. Simulation to learn and improve skills is by no means a new concept, but has been suggested as a way to address the above issues because it provides an ideal platform for acquiring the necessary skills for modern laparoscopic surgery. This paper explores some of the current issues of learning minimally invasive surgical skills in a simulated environment, and suggests that such simulation should not be seen in isolation but as a part of a wider and encompassing curriculum of learning for the 21st-century surgeon.

The skills needed to be a competent surgeon in the 21st century are complex and varied. A sound knowledge of the basic sciences and the anatomy of the human body were, and still are, the bedrock of practice. This knowledge is acquired by personal and group learning and attendance at specific courses and has been assessed by traditional methods of examination such as multiple-choice questions, written short questions and objective structured clinical examinations. A dilemma for the surgical tutor has always been that knowledge, and to a certain extent clinical decision making, have been and remain objectively assessable, but psychomotor skills (of surgery) have not. Some argue that ability in psychomotor and dexterity skills can and should be assessed before entry into surgical training,1 but this is not currently the norm in the UK. Subjective assessment of competence combined with achievement of index procedural numbers, in an apprentice-type model with individual trainers, has been the hallmark of training in open surgery. Clearly such subjectivity leads to an inevitable variation in the proficiency of surgeons at consultant level.² Current methods being considered to assess consultant surgeon competence for revalidation and relicensing in the UK are based on outcome and evidence of continuing professional development, as objective assessment of (open) operative skill is too problematic. Lord Darzi states: 'The surgical profession needs a reliable and valid method of assessing the operative skill of its members.' As laparoscopic surgery inherently provides a platform for simulated training, there now exists an opportunity to learn surgical skills safely

outside the operating theatre and then potentially assess standards between individual surgeons to a level of required competence.³ The Chief Medical Officer of the UK recognises the potential of simulation in modern surgical education.⁴

'See one, do one, teach one' is no longer valid for the 21st century surgeon.⁵ I will explore some of the issues currently facing surgical trainees and to what extent simulation can answer these needs.

The modern surgical trainee

Modern (paediatric) surgical trainees are faced with many constraints and pressures on their training.

- These involve the need:
- to acquire the skills and knowledge to become a competent surgeon in a greatly reduced time compared with their seniors
- to acquire these abilities, but not at the price of compromising patient care or safety
- to acquire skills that many of their trainers are themselves still trying to obtain
- to demonstrate that their skills have reached a point acceptable for independent practice
- to continue to demonstrate that this level of achievement has been updated and is in line with new concepts and treatment modalities
- to acquire these skills while not affecting the financial position of the medical environment in which they work.

For the junior surgeon, simulated training provides several potential advantages.

- Training can occur in a controlled and safe (for the patient) environment. 'Safe' mistakes can be made and rapid progression through a learning curve can be achieved.
- Some virtual reality trainers allow sequential collection of 'scores' to demonstrate improvement in the skill at hand.
- Training can occur at a time convenient for the trainee (outside of current working time constraints).
- Training can occur when senior surgical staff are not present, thus freeing up time for other activity.

There is now increased recognition of the need to learn laparoscopy by an expansion of the number of minimally invasive procedures in the current paediatric surgery curriculum,⁶ but personal communication with paediatric surgical trainees in the UK has shown that many have difficulties in obtaining simulated training because of their current work shifts and the local availability of simulated learning environments. Such problems are not unique to the UK.⁷

Simulation

Simulation has been described by Gaba as 'A technique (not a tool or technology) to replace, augment or amplify reality with guided experiences, often immersive in nature, that evoke or replicate substantial aspects of the real world in an interactive fashion.'⁸

Simulation has been apparent in medical training for centuries utilising prosection tissue and animal models. More recently prosthetic material has been used to facilitate training in areas such as basic surgical skills and vascular surgery. Simulation in minimally invasive surgery has progressed rapidly over the last two decades and is essentially of two different types, box trainers and virtual or augmented (computer-based) reality. Box (or video) trainers employ vision along a standard camera set up from an enclosed box system (Fig. 1). This has some advantages, including:

- · relatively cheap compared with virtual reality
- · providing haptic feedback for the learner
- providing a more 'life-like' experience, with use of similar instruments to the real-life operative environment.

Virtual reality simulators, while being expensive, offer certain benefits including:

- objective collection of procedure 'scores' for intra- and inter-user comparison (e.g. MISTELS programme – McGill Inanimate System for Training and Evaluation of Laparoscopic Skills)
- providing experience over a wide range of surgical procedures, the difficulty of which can be varied
- surgical complications are encountered safely, allowing the trainee to develop strategies of management.

The ideal for surgeons would be the seamless transfer of virtual skills to the operating theatre environment. Evidence suggests that learning in either form of simulator does improve operative skills,^{9,10} although no clear advantage of one type over the other is evident.¹¹ It does also seem that extensive



Fig. 1. A box or video trainer.

prior experience in open surgery does not necessarily facilitate learning laparoscopic surgery.¹² The very important question is: does simulated surgical learning make for a better equipped surgeon? Decision making skills are known to have a significant influence on operative performance.¹³ Spencer argues that '... skilfully performed surgery is 75% decision making and only 25% dexterity'.¹⁴

Validity

The validity of laparoscopic surgical simulators has been extensively examined. Broadly speaking, such validity is of two types:

- Subjective, e.g. face, content, expert, referent examining the difference between experts and novices for a particular task or skill.
- Objective, e.g. construct, discriminative, concurrent, criterion, predictive examining the ability of a simulator to define its objective, for example in learning to perform an actual surgical procedure having trained on its simulated version.

While many studies comment on the validity of their simulator or task, few remember that such validity refers to the results from the simulator or experiment and not the simulator itself, and defined standards and methodologies are often not employed, thus detracting from the scientific merit of the study.¹⁵⁻¹⁷ Such lack of uniformity can make it difficult for units to decide which product to purchase for their local or regional educational needs.

Concern about simulated training

With regard to simulated laparoscopic training, questions remain about whether we are equipping surgeons with the necessary skills for open conversion. The open surgical skills of a generation are fading; it is ironical that few trainees will see the regular performance of 'maximal' access surgery. How will they deal with conversion, often in the context of complex and difficult surgery?

The so-called 'play-station' generation is one of humans experienced in the virtual world, where the consequences of failure are merely to reset the game or computer programme. Surgery is a high-risk profession, and each manoeuvre and procedure has to be conducted carefully with expert knowledge of the likely consequences.¹⁸ No reset function will deliver the trainee from surgical disaster, and risk taking cannot be tolerated.

There are aspects of surgical expertise and proficiency that simulators were clearly not designed for, such as the ability to work constructively in a team and situational decision making, particularly under stress. The extension of simulated surgical training is to expose the trainee to a controlled learning environment where every aspect of practice is assessed and analysed. Many large teaching hospitals in the UK now have entire wards or operating theatres designed solely for the purpose of simulation training. Such immersion in a simulated clinical environment can start to address not only the psychomotor skills and dexterity necessary for a successful operation, but also other crucial skills and abilities necessary for the ultimate goal for every surgeon – a successful outcome for the patient.

Simulation in modern surgical curricula

Modern curricula need to be varied and multimodal in order to encompass the needs of learning in the 21st century. Simulation has an important role in training as an adjunct and not necessarily a replacement for more traditional methods of learning.¹⁹ Emphasis should be placed on the goals to be achieved within the curriculum to enhance motivation on the part of surgical learners.²⁰ Setting objectives has a positive influence on achieving laparoscopic proficiency.²¹ Immediate and constructive feedback with rich and varied clinical exposure is also vital in developing skills and cognitive decision making processes.

Modern curriculum design requires a shift from a curriculum of content, where simple possession of knowledge and skills are the benchmark, to one of product and process where the learning surgeon is able not only to assimilate information but to use it to build on previous experience and formulate intelligent constructs. The surgeon should then be able to demonstrate excellence in every aspect of his or her professional practice and continue to do so throughout their career.

Aspects of the hidden curriculum that are often not (intentionally) taught are also very important in surgical learning and have a bearing on surgical learner's experience. How we become competent surgeons is often based on personal experience and our view of positive and negative role models. The simulated learning environment may help offset some of these negative experiences.

Adequate methods of assessment in surgical training will determine how well we can bridge the gap between what we plan and teach in a surgical curriculum, as opposed to what surgical trainees actually learn. As discussed earlier, simulation can help to provide some objectivity to the assessment of psychomotor and dexterity skills.

With regard to surgical simulation, Sweet *et al.* say that '... validity and curriculum development are interdependent, ongoing processes that are never truly complete'.²² No one simulator can be seen to have answered the question of how a trainee learns a procedure, or indeed how to become a surgeon. It merely serves to enhance one important aspect of the learning needs of a junior surgeon. Successful integration of simulators into surgical curricula remains the challenge for surgical educationalists and will undoubtedly develop as the practice of surgery develops. Satava states that 'simulators are only of value within the context of a total educational curriculum'.²³ The process of curricular design is a fluid one and requires regular review. Grant points out that 'at any one point curriculum design is a child of its time'.²⁴

Conclusion

Simulation as an aid to learning minimally invasive surgical procedures has surely become embedded in the culture and practice of surgical education. The surgical trainer must be aware, however, that it is not a means to an end. Many simulators have made their way into surgical departments with little thought as to how they would fulfil a necessary need within an existing surgical curriculum. Important questions, such as who funds and maintains the equipment, who provides the on-site training and how surgical learners are assessed, are often not considered or answered, especially outside large learning institutions. For simulation to fulfil its potential it must be submitted to the rigors of educational theory and adult learning, as are the other current components of surgical curricula. It must adapt to the ever-increasing complexity of the surgical challenge.

The day is very nearly upon us when we can say that the mantra of the modern surgeon is 'See one, practise on a simulator (with feedback), do one'.

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