

Surgical training

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When this journal first went to press, surgical trainees followed an apprenticeship model propagated by William Halsted at the John Hopkins University School of Medicine. His 'see one, do one, teach one' method of teaching has been a surgical training mantra for generations. However, over the past decade the subject of surgical training has enjoyed greater exposure and there has been a change in attitude towards it. There is evidence that the quality of surgical training can affect patient outcomes¹. Surgical training has evolved into an academic discipline, with a growing body of evidence for potential improvements. Drivers for this change include pressures of time, innovation and introduction of new technology, and increasing awareness of patient safety requirements. Moreover, surgical trainees themselves have changed. This article discusses how surgical training has evolved, and explores potential advances and challenges to surgical training in the future.

Training a surgeon while simultaneously providing a high-volume and high-standard patient service is a challenging task. The current political focus of financial incentives for service delivery can act inadvertently as a barrier to training. The introduction of the European Working Time Directive has contributed to a reduction in volume of operative procedures for trainees. In addition, Birkmeyer and colleagues' seminal work² examining the volume–outcome relationship of surgeons and hospitals has transformed the geographical distribution of surgical procedures. As a result, the past decade has seen a

dramatic increase in subspecialization both of surgeons and, more importantly for training, of hospitals. For example, centralization of vascular procedures and upper gastrointestinal cancer resections largely restricts trainee exposure in these specialties to teaching hospitals. Consequently structured and targeted training is now crucial, as time alone will no longer ensure sufficient exposure to the breadth of training required to produce a competent surgeon.

The cumulative effects of reduced hours, reduced operative volume and surgical subspecialization have forced a shift from time and volume towards competency-based training. This shift has been assisted by the introduction of the structured Intercollegiate Surgical Curriculum Programme in the UK. Traditionally a well filled operative logbook acted as a surrogate marker of competence. Training improvements focused on increasing quantity through time in training or caseload. However, there is evidence that redesigning an internal medicine residency programme had demonstrable training benefits, despite a reduction in absolute numbers of patients seen³. Few would contest that volume has an important effect on surgical training; however, modern surgical practice has highlighted the need to be pragmatic and not rely on quantity alone. The move towards competency-based assessment has required a similar but challenging shift in focus from the number of hours of training to the quality of those training hours.

Constant surgical innovation means the modern trainee is potentially a

consultant surgeon, learning a novel method to perform a procedure they already have substantial experience with. This is exemplified by recent advances in minimally invasive surgery. In 2006, the National Institute for Health and Clinical Excellence recommended laparoscopic resection as an alternative to open resection for colorectal cancer. However, the guidance could not be followed owing to the lack of colorectal surgeons adequately trained to perform the laparoscopic resections. This led to the development of the LAPCO national training programme, which combined preclinical and clinical training with end-of-programme assessment to confirm competency. This innovative example of training both trainees and consultants facilitated the safe and successful introduction of a new surgical technique.

This is in sharp contrast with experiences during the introduction of laparoscopic cholecystectomy. Iatrogenic bile duct, bowel and aortic injuries encountered during early adoption of the laparoscopic approach to cholecystectomy underscored the need to train surgeons without compromising patient safety. Complications attributed to a surgeon's learning curve are no longer acceptable. This provided a catalyst to the concept of using a safe, standard and reproducible simulated environment to move learning curves away from the operating room and patients.

Basic simulation training has been used since the 1970s. Surgical educational researchers have now created an impressive body of evidence for the

effectiveness and efficiency of simulation. Fried and colleagues' research with video box trainers⁴ was instrumental in the development of the Fundamentals of Laparoscopic Surgery programme, which is now mandatory for American Board of Surgery certification. Competency-based virtual reality (VR) training programmes for basic laparoscopic skills⁵ and subsequently whole-procedure VR training curricula⁶ were developed. Similar principles have been applied to endovascular surgery and endoscopy.

Increasing evidence supports skills transfer from the simulation laboratory to the operating room, and ultimately to improved outcomes for patients⁷. Validation and acceptance of simulation has led to its development from a training instrument into an educational research platform. This has enabled research into novel educational concepts, such as deliberate practice⁸ and mental practice⁹. Such techniques have been described previously in domains outside medicine requiring technical expertise, such as music and sports. Innovative high-fidelity, whole operating room simulators now allow training and assessment of both technical and non-technical skills of entire surgical teams. Experienced surgeons will accept that, although technical skills can appear the most difficult to acquire, it can be surgical decision-making that truly separates the good from the great. Consequently, greater attention must be given to non-technical skills training, including teamwork and leadership skills, not only in the operating room but also on wards and in management boardrooms.

Despite substantial evidence of benefits from simulation training, a survey of 1130 UK surgical trainees revealed that under half had access to simulators and fewer than one-fifth of

those had access out of hours¹⁰. Incorporation of simulation curricula into surgical training programmes remains a challenge. This requires significant investment, a difficult undertaking in the current economic climate. However, evidence suggests that this could prove cost-effective in the mid-term¹¹. Surgical training is a process of equipping a trainee with generic skills to provide care for patients. VR simulation can go beyond generic training and provide patient-specific training. Advances in endovascular surgery have provided the opportunity to explore this exciting new technology¹², which could potentially herald the concept of patient-specific full procedure rehearsal. The introduction of robotic-assisted endovascular surgery may even provide the ability to practise a patient-specific procedure on a simulator and store the best attempt for a robot to undertake automatically. Immersive simulation training could also provide the opportunity to train surgeons for those extremely rare events that most will never encounter in their careers – the surgical equivalent of landing a plane on the Hudson River.

A welcome addition to the surgical literature has been an appreciation of the demands surgical training can put on a surgeon and indeed the significant risk of burn-out¹³. Historically, surgery was a male-dominated environment. However, by 2010 almost one-quarter of surgical trainees in the UK were women. As women now outnumber men in medical schools, this proportion is likely to rise further. This has undoubtedly required the development of flexible training. Surgical training programmes must embrace flexibility and look to facilitate diverse training pathways; some trainees may follow an academic career, whereas others may follow a management or teaching route.

Obtaining a national training number in surgery has always been competitive and selection processes will always be scrutinized intensely. A reliable, validated, global assessment scale for technical skills was described in this journal as early as 1997¹⁴. In addition there are now robust, validated assessment scales for assessing non-technical skills¹⁵. Limited integration of technical skills assessment into selection processes has begun, for example in cardiothoracic surgery. However, there is potential for expansion of both technical and non-technical assessment processes in all surgical specialties. To complete the shift towards competency-based training, robust skills assessments, rather than predetermined intervals, should determine training progression. With revalidation approaching, these validated assessment tools could conceivably play a significant role in the future careers of consultants as well as trainees.

Surgical practice has been transformed and the apprenticeship model is in desperate need of augmentation. Rapidly evolving new techniques, such as the development of robotic or natural orifice surgery, will continue to present challenges to surgical training. Innovative simulation techniques may offer the perfect training adjunct and ultimately lead to improved patient outcomes. An ethos of lifelong training should be adopted and technology will undoubtedly play an important role. There are reports of telementoring and many operative techniques are already shared among an international surgical community using online educational resources such as WeBSurg. Consideration must also be given to training the trainers themselves, to enhance the quality of training. The changing nature of educational commissioning is placing increased emphasis on hospitals to demonstrate high-quality

training to justify receiving trainees and their associated training budgets. There is presently no robust method to assess the quality of surgical training in a hospital, in contrast with the way clinical and research outcomes of an institution are assessed. An institution's reputation for training is largely anecdotal. The future presents an opportunity to encourage competition among institutions to improve the quality of training through innovative and evidence-based recommendations, rather than focusing on increasing quantity.

Disclosure

The authors declare no conflict of interest.

References

- 1 Asch DA, Nicholson S, Srinivas S, Herrin J, Epstein AJ. Evaluating obstetrical residency programs using patient outcomes. *JAMA* 2009; **302**: 1277–1283.
- 2 Birkmeyer JD, Siewers AE, Finlayson EV, Stukel TA, Lucas FL, Batista I *et al.* Hospital volume and surgical mortality in the United States. *N Engl J Med* 2002; **346**: 1128–1137.
- 3 McMahon GT, Katz JT, Thorndike ME, Levy BD, Loscalzo J. Evaluation of a redesign initiative in an internal-medicine residency. *N Engl J Med* 2010; **362**: 1304–1311.
- 4 Fried GM, Feldman LS, Vassiliou MC, Fraser SA, Stanbridge D, Ghitulescu G *et al.* Proving the value of simulation in laparoscopic surgery. *Ann Surg* 2004; **240**: 518–525.
- 5 Aggarwal R, Grantcharov TP, Eriksen JR, Blirup D, Kristiansen VB, Funch-Jensen P *et al.* An evidence-based virtual reality training program for novice laparoscopic surgeons. *Ann Surg* 2006; **244**: 310–314.
- 6 Aggarwal R, Crochet P, Dias A, Misra A, Ziprin P, Darzi A. Development of a virtual reality training curriculum for laparoscopic cholecystectomy. *Br J Surg* 2009; **96**: 1086–1093.
- 7 Zendejas B, Cook DA, Bingener J, Huebner M, Dunn WF, Sarr MG *et al.* Simulation-based mastery learning improves patient outcomes in laparoscopic inguinal hernia repair: a randomized controlled trial. *Ann Surg* 2011; **254**: 502–509.
- 8 Crochet P, Aggarwal R, Dubb SS, Ziprin P, Rajaretnam N, Grantcharov T *et al.* Deliberate practice on a virtual reality laparoscopic simulator enhances the quality of surgical technical skills. *Ann Surg* 2011; **253**: 1216–1222.
- 9 Arora S, Aggarwal R, Sirimanna P, Moran A, Grantcharov T, Kneebone R *et al.* Mental practice enhances surgical technical skills: a randomized controlled study. *Ann Surg* 2011; **253**: 265–270.
- 10 Milburn JA, Khera G, Hornby ST, Malone PS, Fitzgerald JE. Introduction, availability and role of simulation in surgical education and training: review of current evidence and recommendations from the Association of Surgeons in Training. *Int J Surg* 2012; **10**: 393–398.
- 11 Orzech N, Palter VN, Reznick RK, Aggarwal R, Grantcharov TP. A comparison of 2 *ex vivo* training curricula for advanced laparoscopic skills: a randomized controlled trial. *Ann Surg* 2012; **255**: 833–839.
- 12 Willaert WI, Aggarwal R, Van Herzele I, Plessers M, Stroobant N, Nestel D *et al.* Role of patient-specific virtual reality rehearsal in carotid artery stenting. *Br J Surg* 2012; **99**: 1304–1313.
- 13 Upton D, Mason V, Doran B, Solowiej K, Shiralkar U, Shiralkar S. The experience of burnout across different surgical specialties in the United Kingdom: a cross-sectional survey. *Surgery* 2012; **151**: 493–501.
- 14 Martin JA, Regehr G, Reznick R, MacRae H, Murnaghan J, Hutchison C *et al.* Objective structured assessment of technical skill (OSATS) for surgical residents. *Br J Surg* 1997; **84**: 273–278.
- 15 Crossley J, Marriott J, Purdie H, Beard JD. Prospective observational study to evaluate NOTSS (Non-Technical Skills for Surgeons) for assessing trainees' non-technical performance in the operating theatre. *Br J Surg* 2011; **98**: 1010–1020.