What Role Should Simulation Play In The Selection And Training of Urologists?

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ABSTRACT

Changing patterns of health care provision and rapid evolution of urological surgical techniques have resulted in trainees seldom receiving independent surgical experience. A drive toward senior-led care and restrictions on working hours have required a greater breadth of skills to be mastered in a shorter training period. Simulation affords the opportunity to compensate for this reduction in operative experience, developing surgical skills while minimising patient risk, financial expenditure and operating theatre use. A variety of simulation models may be used from cadaveric, synthetic and animal models to advanced virtual reality. While this form of training has limitations, it has potential to significantly aid procedural competence prior to real-life practice. Clear benefits, including improvements to equipment familiarity and trainee confidence, have been demonstrated, although direct transferability to operating-theatre performance is not conclusively evidenced. With advances in technology, simulation is likely to significantly aid the current and future selection and training of urologists.

I. INTRODUCTION

Urologist training has evolved considerably since the Halstedian apprenticeships of the early surgeons. At present expertise is developed through a complex programme of teaching and assessments. Yet as trainee numbers rise, opportunities to advance procedural and technical skills become increasingly scarce. Concurrently the widespread development of novel techniques and a trend toward minimally invasive urological procedures has required mastery of a progressively broader repertoire of specialist skills (Wignall et al. 2008). Gaining of proficiency in ureteroscopy, for example, is rendered more challenging due to the loss of depth perception and tactile feedback available in traditional 3-dimensional procedures (McDougall 2007).

Furthermore, implementation of the European Working Time Directive (EWTD) (The Association of Surgeons of Great Britain and Ireland 2008) across Europe and introduction of the 80 hour per week limit by the Accreditation Council For Graduate Medical Education (ACGME) (Philibert et al. 2002) in the USA have limited the number of training hours available during the designated training period. A move to reduce ‘out of hours’ operating, increasing patient reluctance to being ‘practiced on’ (Gallagher & Traynor 2008) and a paradigm shift from consultant-led to consultant-delivered care in the UK has resulted in trainees seldom gaining independent surgical experience. Taken together, the number of hours of training a surgical trainee may expect to have completed prior to consultancy has fallen from 30,000 to 8,000 (Chikwe et al. 2004). These constraints have forced adjustment to a more rigorous, competency-focused assessment of proficiency, rather than an assumption of aptitude through experience.

Innovation broadening the number of occasions where surgical intervention may be indicated, coupled with an ageing population more expectant of remedial treatment, has heightened demand leading to a conflict between service provision and training. Reform is therefore necessary to ensure that surgical trainees are sufficiently equipped to act autonomously upon completion of their training and subsequently deliver instruction. Several solutions, including e-learning and compulsory fellowship training programs, have been proposed to augment
<table>
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<th>Model</th>
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<tr>
<td>Cadaveric simulation</td>
<td>Fresh frozen human cadavers</td>
<td>High fidelity&lt;br&gt;Shown to develop transferable operative skills&lt;br&gt;Permits understanding of relevant clinical anatomy and surgical approaches&lt;br&gt;Entire operations can be practiced</td>
<td>Not easily accessible&lt;br&gt;Specialist storage demands&lt;br&gt;Time-consuming preparation&lt;br&gt;Relies on tissue donation&lt;br&gt;Risk of disease transmission&lt;br&gt;Lack of uniformity amongst specimens</td>
<td>Continuing medical education&lt;br&gt;Advanced procedural knowledge and dissection</td>
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<td>Synthetic simulation</td>
<td>Peg boards&lt;br&gt;Inanimate models&lt;br&gt;Synthetic suturing mats</td>
<td>Widely available&lt;br&gt;Reusable&lt;br&gt;Wide range of procedures may be possible&lt;br&gt;Modern simulators can provide haptic feedback&lt;br&gt;Relatively inexpensive&lt;br&gt;Develop understanding and familiarity with surgical instruments and equipment&lt;br&gt;Able to record progress and assess motion analysis&lt;br&gt;Allows for development of hand-eye co-ordination and triangulation</td>
<td>Often low fidelity&lt;br&gt;High initial setup cost&lt;br&gt;Lack of true haptic feedback</td>
<td>Basic skills for novice learners&lt;br&gt;Discrete skills</td>
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<td>Virtual reality</td>
<td>Computer-based simulation models</td>
<td>Reusable&lt;br&gt;Minimal setup time&lt;br&gt;Instant performance feedback&lt;br&gt;Able to record progress and assess motion analysis&lt;br&gt;Wide range of procedures may be possible&lt;br&gt;Allows for scenario simulation of a whole task</td>
<td>Maintenance&lt;br&gt;High initial setup cost&lt;br&gt;Unreliable haptics</td>
<td>Discrete skills&lt;br&gt;Procedural training</td>
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<td>Animal</td>
<td>Discrete skills&lt;br&gt;Procedural training</td>
<td>High fidelity&lt;br&gt;Complete procedure simulation</td>
<td>Animal anatomical differences&lt;br&gt;Cost&lt;br&gt;Special facilities required&lt;br&gt;Ethical concerns</td>
<td>Advanced procedural knowledge&lt;br&gt;Dissection skills</td>
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<td>Cognitive simulation</td>
<td>Mentally rehearsing</td>
<td>Potentially cost free&lt;br&gt;Point of care education&lt;br&gt;Accessible on mobile devices</td>
<td>Limited evidence to support improvement in technical procedural skills or use in clinical training</td>
<td>Basic procedural understanding</td>
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**TABLE I.** The advantages and disadvantages of the main simulation modalities available to urology trainees
learning opportunities within existing resource restraints. One such solution, simulation, affords the opportunity to repeatedly practice a novel procedure before operating on patients while improving confidence, maintaining patient-safety (Dawe et al. 2014) and bypassing the error-prone phase of the learning curve (Aggarwal & Darzi 2006). With high-fidelity simulators it may even be possible for non-technical skills including communication, leadership and multi-disciplinary teamwork to be practiced to complement procedural proficiency (Arora et al. 2011). As the benefits are well recognized in many specialties including anesthesitics (Gaba et al. 1996), emergency medicine (Small et al. 1999) and general surgery (Reznick & MacRae 2006), simulation is advocated by many royal colleges and governing medical bodies in the UK (Donaldson 2008).

As several simulator modalities are available, with disparate advantages and disadvantages, each must undergo thorough evaluation through validation studies (Wignall et al. 2008) prior to utilisation. A summary of currently available simulation models for urology surgery can been seen in Table I.

II. CURRENT SELECTION PROCESS

There are at present 31 core surgical posts themed toward urology in the UK. Entry to specialty training is highly competitive, with selection predicated on the candidate’s application form, references and interview/selection centre performance. The interviews include a portfolio assessment, a simulated clinical scenario, an appraisal of communication skills and an evaluation of practical proficiency. The domains assessed include (Anon. 2016):

- Clinical knowledge and expertise
- Contributions towards research, auditing and teaching
- Organisation, leadership and problem solving
- Professional probity
- Evidence of a personal and learning commitment to urology

Thus aptitude for practical skills, attendance at relevant courses, evidence of relevant research achievements, demonstration of judgment under pressure and a realistic insight into urology are all prerequisite. Although integration of simulation in surgical training is not a new concept (e.g. cadaveric dissection) the relative infancy (Sairam 2015) of modern simulation techniques renders the use of simulation in assessment of prospective trainees controversial. This uncertainty necessitates their strict validation as a predlicative tool, as minor simulation infidelity could result in improper candidate selection (Macmillan & Cuschieri 1999).

Nevertheless, Virtual Reality (VR) has been suggested to adequately predict operative skill of prospective specialist applicants (Jacomides et al. 2004). Video-assessment and motion capture may objectively and reliably correlate to surgical performance, although wide-scale evidence for this is limited (Khan et al. 2013). Using a variety of simulation modalities including VR, Robotic Simulators and Bench-top models, senior clinicians performed significantly better than their junior colleagues in all sessions ($P < 0.001$) (Khan et al. 2013). Indeed a number of assessment tools to objectively evaluate technical skills learnt via surgical simulation have been developed including the Global Rating Scale Of Performance (GRS) and the Objective Structured Assessment Of Technical Skills (OSATS). Each involves scoring against pre-set criteria by a trained assessor. Specifically, the GRS checklist is comprised of specific surgical behaviours while OSATS focuses on a set of manoeuvres considered essential elements of a procedure. Each tool has been demonstrated to reduce the bias associated with direct observation by experts alone (Reznick et al. 1997) (Doyle et al. 2007).

III. UTILISING SIMULATION

For many procedures the benefits of simulation are already well recognised. Numerous high-fidelity simulators, including the Uro-Scopic Trainer (Limbs and Things, UK), have been validated for use in endourological procedural practice (White et al. 2010). Indeed, repeated training for semi-rigid ureteroscopy with bench-top simulators significantly improves trainee confidence and performance (Brehmer & Swartz 2005). Similarly, novice exposure to the VR URO-Mentor (Simbionix, USA) for flexible cystoscopy improves time to procedure
consider simulations including the whole surgical
Encouragingly, between 94-100% of trainees consider simulations including the whole surgical team in mock operating theaters useful for development of non-technical skills (Gettman et al. 2009). Significant improvements in equipment setup and teamwork ratings have been described. As non-technical skills do not necessarily correlate with seniority (Lee et al. 2012), more experienced trainees may also benefit from this modality of simulation.

IV. CHALLENGES

As the selection and training applications of modern simulation are in their relative infancy, little consensus on how they might be validated has been reached. While many approaches have been adopted, the difficulty, expense and ethical uncertainty associated with conducting randomized trials to establish the impact of specific simulators has obligated educators to select methods on personal preference (Brewin et al. 2014). Furthermore, use of simulation demands additional equipment, a suitable environment and faculty resources (Ahmed et al. 2011).

It should be noted that the requirements for certification upon completion of training will not be met by simulation alone. The learning curve associated with more complex urological procedures, such as the avoidance of prostate cancer recurrence following radical prostatectomy, has been shown to plateau only after performing around 250 procedures (Vickers et al. 2007), and may not therefore be possible to bypass.

V. INCORPORATING SIMULATION

While there is little doubt that simulation has a significant role to play in both the recruitment and training of urologists, it will likely act as an adjunct to, rather than replacement of, traditional techniques. Continued advances in technology will further enhance realism and availability and thus help to compensate for reduced real-time theatre experience (Kneebone et al. 2004). Simulation should be included in modern proficiency-based curricula, with trainees ideally receiving repeated exposure over an extended period (McGaghie et al. 2010).

Feedback on performance would thereby enable appropriate targeted learning, with basic surgical skills taught via low-fidelity models prior to

As the mean number of Transurethral Resection of the Prostate (TURP) operations performed by a trainee prior to consultancy halved from 1990-2000 (Sweet et al. 2002), a simulation model, TURPsim™ VR simulator (Simbionix, USA) has been introduced to compensate for lost operative experience. Experts using this model perform significantly better than novices, while the latter improve gradually with repeated attempts (Bright et al. 2012). Similarly in one study, following practice using the PelvicVision TURP VR simulator (Meleritmedical AB), 65% more trainees were able to perform TURP (Källström et al. 2010).

A further role for simulation has been established in percutaneous nephrolithotomy, a procedure in which only 11% of urologists routinely gain percutaneous renal access without radiologist assistance (Bird et al. 2003). Using the PERC Mentor™ VR renal access simulator (Mentor Graphics, USA), novice performance improved for several metrics including fluoroscopy time (Mishra et al. 2010). Subsequent to this practice, all trainees were able to safely obtain access in a pig model (Mishra et al. 2010).

The increasing adoption of robotic-assisted urological techniques lends itself to practice via simulation (Hung et al. 2011). For example, VR modeling using the DV-Trainer (Mimic Technologies, Inc., Seattle, WA) improves surgeon proficiency using the da Vinci Surgical System (Intuitive Surgical, Inc., Sunnyvale, CA)(Cho et al. 2013). There are however limits to the utility of some simulation models. While laparoscopy training using low-fidelity box-simulators improves specific skills (e.g. suturing) (Laguna et al. 2006) overall operative proficiency remains unchanged (Traxer et al. 2001).

Conversely, VR-simulation of laparoscopy has been rated both useful and of above average realism (Brewin et al. 2010).

Encouragingly, between 94-100% of trainees consider simulations including the whole surgical
progressing onto full-procedural simulations (McGaghie et al. 2010). At present, trainees in the UK may record simulation experience into the Intercollegiate Surgical Curriculum Program Logbook (Anon n.d.). A centrally-coordinated urology simulation programme, SIMULATE, that describes a potential structured delivery method of non-technical and technical skills is now considered feasible, acceptable and able to display construct validity (Khan et al. 2013).

VI. CONCLUDING REMARKS

Nevertheless, evidence for the value of simulation as a transferable measure of proficiency in the operating theatre remains limited. Simulation often focuses on the technical aspect of surgery in isolation, failing to adequately replicate the many other components that must be managed for operative success. This restriction may be ameliorated through greater emphasis on integration of other elements including consent and pre-operative planning, consideration of alternative management options and intra-operative communication. Further research should assess the transfer of skills from simulation into practical settings, the impact on patient safety and validation of simulation fidelity.

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