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TITLE: Perspectives in Robotic Surgery

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Robotic surgery began in Australia in 2003(1). Since its introduction, there have been significant barriers to adoption. These barriers relate firstly to scepticism about the perceived benefits of robotic surgery compared to traditional open and laparoscopic surgery. Secondly Health Services must find the capital for installation of a $3-$4 million machine and then pay accompanying instrumentation and service costs per case, around $5000 per surgery. Finally, education for our training in robotic surgery has been hampered by the necessity to in-service on complex new surgical technology and simultaneously to learn new surgical robotic techniques.

Since laparoscopic surgery was introduced 25 years ago, we have clearly seen the benefits of minimally invasive surgery in improved patient outcomes. Minimally invasive surgery does provide small incisions, reduced, blood loss, reduced length of hospital stay and earlier return to normal activity. What robots do beyond laparoscopy is add a three-dimensional view for the surgeon in 10 times magnification. The machine provides digitised hand movements, which are intuitive rather than the counterintuitive moves, required in laparoscopy

The cost of the robot machines is likely to reduce by a third when competitive technology is introduced in Australia in 2021/22. Robotic instrument cost should commensurately reduce.

The final issue of robotic education and training will probably remain the most vexed. Many of our surgical trainers trained first in open and laparoscopic surgery and have then had to learn to use the robot without access to structured and linear training pathways. This type of learning was insightfully described by Beane as “Shadow Learning”(2). In sport, great athletes do not necessarily become great coaches. Similarly, in surgery expert surgeons are not necessarily great surgical teachers. Excellent surgical teachers are a precious resource and identification of those skilled educators will become more important with diffusion of robotic surgical machines into the Public Hospital sector.

The year 2021 will be a significant inflection point for the way surgery is delivered in Australia. For 20 years, Intuitive Surgical Sunnyvale California has been the monopoly vendor internationally in sales of robotic surgery machines. By early 2022, there will be a minimum of three new robotic surgical machine vendors in Australia. These machines will come from the United States, Medtronic Hugo Robot, the United Kingdom, Versius by Cambridge Medical Robotics, and Japan, the Hinotori Robot by Kawasaki Sysmex. These machines will likely be less expensive and instrumentation costs reduced such that they can be introduced into the Public Hospital system where surgical registrars are trained. It remains to be seen whether these competitors will provide technology of equivalent excellence to the da Vinci machines.

At present in Australia and New Zealand, very little robotic surgical training for SET trainees occurs in the public sector. In 2021, 52 of the 60 Da Vinci robots in Australia are sited in Private Hospitals. Surgeons wishing to embrace robotic surgery have to undertake expensive post fellowship training or learn on the job with minimal training in the operating room on patients. Robotic surgical training now is unstructured, haphazard and opportunistic. At present, there is no formal robotic training in the SET curriculum. The requirement for oversight of training is determined by the credentialing committee of the individual Hospital with the robot.

The following perspective articles look at the development, educational needs current status and future trends in application of robotic surgery in Australia. What will the surgeon of the next 10-15 years look like? According to the Future of Surgery report commissioned by the Royal College of Surgeons in England “the surgeon's role will become increasingly multifaceted. Surgeons will need to become multi-lingual. They need to understand the language of medicine, genetics, surgery, radiotherapy and bioengineering. Leadership, managerial and entrepreneurial skills will become increasingly important” (3). What skill sets will surgeons need to be able to embrace this digital technology? Many of us trained in the Halsted method established by residency at Johns Hopkins in 1904(4). On its inception, this rather brutal system involved 7-years, without vacation, men only, no spouses and 6-7 day working week. Clearly, on many levels this pedagogy is unsuitable in 2021. How can we affect change?

There are many barriers to modern registrar training. Not the least of which has been a near 90% reduction in elective surgical training for USA surgical residents due to COVID-19(5). COVID also reduced training opportunities for our registrars in 2020. Other barriers to training relate to safe working hours, not enough operations to train our surgeons adequately, and the reasonable desire for modern surgeons not to have to spend as much time as their predecessors in training. The present 6-year training path seems too long. It could be shortened by applying better education methods, such as metrics for evaluation of surgical performance to proficiency. Not all surgeons learn at the same pace and some will be much quicker than others to adapt and learn. A key benefit of robotic surgery relates to the easy video instruction. As described by Chen (6) and Mcquivey (7) "Video content is richer than text. One minute of video is worth 1.8 million words! The reasoning is: if a picture is worth 1000 words then a minute of video with 30 frames per second is worth of these 1.8 million words." We have a Global Evaluative Assessment of Robotic Skills (GEARS) score which is a subjective and time consuming way of evaluating robotic surgical competence(8). Another useful metric, Clinically Relevant Performance Metrics of Simulation (CRPMS) has recently been described by Ghazi(9). These CRPMSs have been validated in assessment of radical prostatectomy using high fidelity synthetic human organ models(9). The metrics of quality of performance of this surgery relate to preservation of the nerve bundle, integrity of the anastomosis between bladder and urethra, and negative cancer margins. These metrics have been objectively validated on a polyvinyl alcohol synthetic high fidelity human organ model of the prostate and bladder. New automated performance metrics (APMs) such as eye tracking and gaze behaviour comparing experts, and novices in robotic surgery is already reported(10). These automated performance metrics can also be applied to kinematic assessment that is instrument movement, and systems event data such as camera movement, clutching and use of heat energy in robotic surgery.

The key aim as we embrace digital technology in robotic surgery is to reduce complications by better training. Comparison to the aviation industry is instructive. The tolerance of the airline industry to pilot errors since simulation training was introduced is <0.0001%(11). At present the 30-day readmission rate after major surgery is 17%(12). Although of course not all readmissions are due to surgeon error if training improves with the addition of simulation then we might see reduction in surgical readmissions.

Robotic surgery was popularised by Urologist Dr Mani Menon in Detroit in 2002 when he was able to perform the technically difficult deep pelvic surgery of radical prostatectomy(13). Once this operation was made safe to be performed robotically, nephrectomy, partial nephrectomy, cystectomy and urinary diversion, retroperitoneal node dissection and pyeloplasty have become semi-standard of care in robotic urologic surgery. Following the introduction in urology, general surgery, colorectal surgery, ENT, cardiothoracic and gynaecology surgery was “roboticized”. In the following articles we look at the trends in these other disciplines. Reduction in cost of machines and instruments will mean that the simpler procedures previously prohibitively expensive to perform robotically such as appendicectomy, cholecystectomy and hernia repair will be able to be done with equivalence in cost and safety to open or laparoscopic methods. Our surgical education program is at the moment one-size fits all. It may be appropriate to consider a move into a competency-based education where some surgeons, who are rapid adapters can gain competency a lot quicker than their training colleagues can. We also have a problem that we do not have enough robotic surgical trainers. It has become clear that surgeons trained in open and laparoscopic surgery do not necessarily transition to become expert robotic surgeons(2). It is hard for surgeon who is a trainer to allow the trainee to take over the robotic console when that training surgeon is not comfortable or confident in his or her own ability in robotic surgery.

At the moment there is a competency based assessment in RACS SET training, where all trainees have to achieve competence to progress and complete their training. The curriculum does not have the ability to accelerate trainees through the programme. A revised curriculum which would include Robotics education would be competency based on structured and would be complimentary to the competency based programme and easier to incorporate as a result.

At present, there is no standardised International robotic surgical training curriculum. There is an opportunity to shift to a curriculum embedded in the SET training, which would be a linear, proficiency-based system with continuous evaluation by scoring to proficiency. Use of simulation training for registrars will allow skill acquisition by the trainee on their learning curve before patient exposure on the operating table. This education system would use a combination of online learning, simulation training similar to aviation education, virtual reality lessons, surgery on simple models and then surgery on high fidelity human organ models made from polyvinyl alcohol(14). Appropriately then the surgeon then progresses to mentored live human surgery recorded on video and scored by the surgeon trainer. In Australia at present education for robotic surgery, which is mandated by the vendor requires a visit to a wet lab for surgery on a porcine model and then mentorship by a colleague in early cases. This is considered adequate training. In some situations, cadavers are used as training models. Access to wet labs for surgical training will reduce dramatically in coming years due to cost constraints and ethical considerations regarding surgical training on live animals. We are witnessing the rise of the Surgical Robot.

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