Best Practices for Robotic Surgery Training and Credentialing

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Purpose: With the rapid and widespread adoption of robotics in surgery, the minimally invasive surgical landscape has changed markedly within the last half decade. This change has had a significant impact on patients, surgeons and surgical trainees. This is no more apparent than in the field of urology. As with the advent of any new surgical technology, it is imperative that we develop comprehensive and responsible training and credentialing initiatives to ensure surgical outcomes and patient safety are not compromised during the learning process.

Materials and Methods: A literature search was conducted on surgical training curricula as well as robotic surgery training and credentialing to provide best practice recommendations for the development of a robotic surgery training curriculum and credentialing process.

Results: For trainees to attain the requisite knowledge and skills to provide safe and effective patient care, surgical training in robotics should involve a structured, competency based curriculum that allows the trainee to progress in a graduated fashion. This structured curriculum should involve preclinical and clinical components to facilitate the proper adoption and application of this new technology. Robotic surgery credentialing should involve an expert determined, standardized educational process, including a minimum criterion of proficiency.

Conclusions: Rather than being based on a set number of completed cases, robotic surgery credentialing should involve the demonstration of proficiency and safety in executing basic robotic skills and procedural tasks. In addition, the accreditation process should be iterative to ensure accountability to the patient.

Key Words: robotics; education, medical; internship and residency; credentialing; curriculum

Two decades ago the successful completion of the first laparoscopic nephrectomy by Clayman et al galvanized surgical innovation and started the MIUS revolution.¹ MIUS has come a long way since that momentous day in June 1990, such that the laparoscopic approach is now considered the gold standard in the management of most localized renal tumors requiring extirpative therapy.

During the last several years robotic surgery has been rapidly and readily adopted throughout the surgical world, nowhere more so than in the field of urology, where it has become the new face of MIUS. As the clinical applicability and implementation of robotic surgery in urology move forward at a fervent pace, it is imperative that initiatives be developed to provide surgeons with the requisite training to develop proficiency with this new technology, and to simultaneously ensure competency among those practicing clinicians.
Curriculum design for technical skill education involves setting expert determined goals and objectives at the outset, developing interventions targeted to these goals, and establishing assessment tools to certify competency in the desired skills. Sweet et al proposed that validity and curriculum development are interdependent, representing an iterative process such that concurrent validation occurs throughout the design of the educational curriculum rather than once it is completed. The AUA Laparoscopy and Robotic Surgery Committee has embraced these concepts of curriculum development as the platform on which a skills training program as well as assessment devices will be created for basic robotic surgery training.

It remains incumbent on the profession to develop, endorse and support the implementation of well organized educational curricula and proficiency based credentialing processes to ensure the safe and efficacious clinical application of this new technology. We discuss best practice recommendations in developing and implementing such training curricula for robotic surgery, recommendations that attempt to optimize the effectiveness of the curriculum and the maintenance of acceptable patient outcomes.

**MATERIALS AND METHODS**

A literature search through Pubmed, Medline, CINAHL, EMBASE, Web of Science, the Cochrane database of Systemic Reviews and Google Scholar was performed for publications dating from January 1970 to January 2010 on surgical training curricula and robotic surgical training. The search was limited to urology primarily.

**RESULTS AND DISCUSSION**

**Robotic Surgery Training for Residents and Fellows**

With an emphasis on proficiency, transparency, patient safety and fiscal responsibility in today’s health care system, surgical residency and fellowship training programs face significant barriers in providing opportunities for the transfer of surgical expertise to their trainees. This is particularly evident in the transfer of skills associated with new surgical technologies such as robotic surgery.

As a result it is necessary for the current robotic surgery training paradigm to include a large portion of proficiency development outside of the OR in preclinical training, resulting in a tiered approach to the training of robotic surgeons. This 2-stage approach, which includes preclinical and clinical components, attempts to minimize the footprint of surgical education on patient outcomes and has been embraced by several different groups. It is essential that the training curriculum be structured and objective or competency based, regardless of the number or type of components included in the preclinical and clinical training stages. Unfortunately to date there is no validated RSTC, and the optimal format and requisite curriculum components are still in the development stages. The AUA is currently directing significant attention to creating basic robotic surgery training guidelines, enlisting input and feedback from various surgical organizations as well as from expert clinicians nationwide.

**Preclinical Training**

The initial stage of a structured RSTC should involve preclinical training (see Appendix). It is essential for the trainee to become familiar with their tool, the da Vinci® Surgical System (henceforth “the robot”), which is currently the only commercially available robotic surgery platform. At present the 3 robot models are the standard da Vinci robot, the da Vinci S and the newest da Vinci Si model. Slight variability among the models exists with respect to technical specifications and functionality and, as such, the required training should be completed for the model the trainee will be using clinically at their institution.

Didactic sessions can provide the trainee an opportunity to become well acclimated with the components and the proper use of the robot. Intuitive Surgical®, the vendor of the robot, has created an on-line tutorial on the fundamentals of the da Vinci robot, which includes a technical overview of the robot, functional aspects of the system, as well as some troubleshooting tips. This on-line tutorial is available for the various robot models, and includes a multiple choice question based examination that can be used by training programs to evaluate trainee knowledge of the basic functional aspects of the robot (http://www.intuitivesurgical.com/assets/training_materials/dVS/Fundamentals_S/Fundamentals_S.htm). A more comprehensive on-line AUA robotic surgery course is currently in development under the auspices of the AUA Education Council Laparoscopy and Robotic Surgery Committee, and is scheduled to be available to the public in 2010. This course provides the content for the outline provided in the section of the AUA Core Curriculum that deals with robotic surgery.

Informal hands-on tutorials should also be an integral part of the initial preclinical stage of the curriculum. This allows for a low stress, interactive experience with the robot outside of a live clinical setting. Trainees should practice the robotic docking process, instrument insertion and exchange, as well as become familiar with sitting at the surgeon’s console and controlling the various aspects of the robotic interface through this platform.
The second component of the preclinical stage of a RSTC involves inanimate dry lab practice. Repetition of basic skills tasks such as ring-peg transfer, precision cutting or simple suturing and knot tying allows the trainee to become facile in instrument movement and articulation, camera and clutch navigation, and to become familiar with the 3-dimensional environment, all of which are requisite skills necessary to perform more complex procedural tasks. Other models that simulate specific tasks such as the urethrovesical anastomosis may also be used. Unfortunately, unlike traditional laparoscopy where all that is needed is a pelvic box trainer, laparoscopic instruments and a camera with monitor, dry lab robotic training requires access to a fully functional robot. This type of educational experience may not be feasible at all training centers. Therefore, alternative teaching strategies for this portion of the curriculum have been developed and are becoming more prevalent in training programs.

The use of VR surgical simulators has been shown to improve subsequent clinical performance and can shorten the learning curve associated with the acquisition of a new technological skill. Unfortunately there are only a few VR robotic simulators currently in development, most of which have not been fully validated. In addition, the cost of such VR robotic simulators may be significantly prohibitive for most centers. Software from MIMIC Technologies (Seattle, Washington) has recently been incorporated in the da Vinci Si system so that the surgeon console can be used for VR training without the need for the patient side cart or instruments. This teaching device, while having gone through extensive development with expert input and having preliminary assessment of face and content validity, is yet to undergo extensive construct and predictive validity testing.

Another important component of the preclinical training stage involves animate or cadaveric robotic training. This component allows the trainee to amalgamate and put into practice previously acquired basic robotic skills to perform more complex procedural tasks of higher fidelity. As these educational modalities are quite expensive, they are best used in teaching the nuances of high level skills or procedure specific training. The trainee is afforded an opportunity for interactive simulation of situations and potential problems that may be encountered in live clinical experiences in a low stakes environment. The integration of such hands-on laboratory sessions during residency or fellowship training is much more common for traditional laparoscopy as the availability of equipment is not as significant an issue as with robotic surgery. Industry directed courses are available to trainees in the form of 1 or 2-day programs during which didactic sessions are often combined with a hands-on laboratory session.

While there is a paucity of literature related to the construct validity of a structured training program for the acquisition of basic robotic skills, there is evidence to suggest that formal training for more advanced robotic skills is indeed beneficial. In addition, particularly with the animate and cadaveric robotic experiences, it is important for residents and fellows to have structured, interactive instruction by expert robotic surgeons who can provide real-time feedback.

Access to the resources necessary to implement many of the preclinical components of a RSTC may be difficult for some training programs, logistically and financially. As such, many programs will incorporate a minimal amount of preclinical training into the curriculum before proceeding directly to the clinical stages of the RSTC. This educational approach necessitates that a large portion of the learning curve associated with robotic surgery be addressed in the clinical setting, a situation that may not be in the best interests of the patients. Studies have shown that even 3 preclinical sessions practicing basic robotic skills can improve preclinical operative times by up to 40%.

Before progressing to the clinical stage of a RSTC, trainees should demonstrate that they have acquired the basic aptitude necessary to begin clinical training on the robot. This can be accomplished through informal assessment by an expert robotic surgeon or, ideally, through a formal evaluative process. Regardless, this should be a decision based on demonstrated proficiency as opposed to a specific volume of cases completed or static length of time spent on the robot. It is imperative that trainees attain the requisite basic skills necessary to proceed to more complex robotic tasks and procedures before moving to the next level of robotic training.

Clinical Training
The clinical training stage of a RSTC is comprised of procedure specific familiarization with the robot and direct robot console time (see Appendix). By focusing on a specific procedure, whether RARP, robotic partial nephrectomy or any other robotic procedure, the trainee will acquire skills in a much more efficient manner. Ideally the type of procedure with the highest volume of cases at one’s institution should dictate which is chosen for procedure specific familiarization training. This provides the trainee with an opportunity to effectively work through the clinical components of a RSTC in a timely fashion. The specific procedure should be clearly defined by the steps required to complete the operation from the initial positioning of the patient through to the final removal of ports and recovery of the patient.
These steps should delineate the degree of complexity of the surgical tasks involved to complete each of the steps and then be ordered from least difficult to most difficult, providing the trainee with a graduated progression in their curriculum.

Operative case observation and familiarization serve as the initial components of the clinical stage of a RSTC. Prerecorded operative footage or live operative cases in the OR can provide the trainee with an opportunity to directly observe the execution of the various steps involved in completing a specific robotic procedure from start to finish. A library of prerecorded operative video footage should be provided to trainees for reference so that they can review the specific steps as they proceed through the graduated RSTC. The ability to interact with the expert surgeon in real time is an added advantage of live case observation, while the ability to repeatedly review certain steps of the surgical case makes prerecorded videos particularly beneficial.

To consolidate the knowledge acquired during the procedure specific familiarization component of the RSTC, and to transition into the hands-on clinical training portion of the curriculum, trainees should first begin their operative experience as the bedside assistant to the main console surgeon. The ability to assist effectively for these robotic procedures demonstrates that the trainee has gained the knowledge of the steps of the procedure, a general proficiency in working in the robotic environment, a knowledge of the functionality and limitations of the robot itself, as well as the strategies and techniques used by the console surgeon(s) to complete the specific procedure. The importance of beginning the operative experience as a surgical assistant has been reinforced by several authors, and serves to consolidate trainee basic robotic knowledge and skills before commencing clinical training on the console. The number of cases recommended as the bedside assistant remains without a consensus, although most reports suggest a minimum of 10 cases during robotic surgery training. While this is essential in a training program, the ability to assist another surgeon for several cases may be difficult for an experienced surgeon who is beginning his/her robotic experience in a hospital that is establishing a new robotic surgical program.

Time on the surgeon console represents the final component of any RSTC. Regardless of the amount of training in the preclinical stage of a RSTC, a steep learning curve will be encountered once the trainee sits at the console in the live clinical setting. As such, it is crucial that this component of a RSTC be structured and involve an iterative process of trainee evaluation. In an ideal situation this would involve a graduated, step-wise progression of defined tasks and steps of the procedure, based on degree of difficulty, under the direct supervision of an expert robotic surgeon who is at the bedside or at the console with the trainee. This approach to robotic training has been emphasized by several studies and allows the trainee to acquire skills through repetition of specific skill tasks. When the trainee has demonstrated proficiency in a predefined step, through formal evaluation or based on an expert surgeon’s judgment, they would be moved on to the next sequentially difficult step of the procedure. Eventually the trainee will be able to integrate skills learned and practiced during each defined step into a comprehensive ability to complete the entire procedure. The learning process can be further enhanced through video recording and review of operative performance with a mentor or expert surgeon as it provides valuable formative feedback for the trainee.

When attempting to integrate a RSTC into an existing urology training program, several challenges may be encountered. Urology does not have a short, simple and common procedure such as laparoscopic cholecystectomy or appendectomy from which to gain early, basic robotic surgery experiences. The hands-on clinical robotic experience is often an immediate “swim in the deep end” for the trainee. This even further supports the idea of advancing the trainee through the clinical stages of training using a proficiency based, graduated step-wise model.

In addition, unlike traditional open surgical training where the mentor can be in close proximity to the trainee and facilitate hands-on teaching, in robotic surgery the mentor and trainee are separated in space, and the attending surgeon may not have full control of the operation as in open surgery. The fact that only 1 surgeon can be at the console at any 1 time is an educational issue that has been previously documented. In response to this concern Intuitive Surgical has developed the new da Vinci Si model that has an available dual console which will potentially allow for expert surgeon direction and supervision for procedural robotic training and collaboration. Although theoretically this new robotic system lends itself well to a safe educational stratagem, the increased cost incurred for the dual console will be a significantly prohibitive factor for most training programs (approximately an additional $500,000 at present).

Finally, as with traditional open surgical training, the ideal situation involves an expert surgeon mentoring or teaching a trainee. However, the current situation in some academic institutions is more often that of an experienced trainee mentoring a novice trainee. Until robotic surgery permeates more widely into the current cohort of postgraduate urologists, this will continue to be the case in many institutions.
Robotic Surgery Training for Postgraduate Urologists

As oncologic and functional outcomes data for robotic surgery mature, the adoption of this technology into the armamentarium of established postgraduate urologists is no longer driven solely by marketing and patient demand. While the need for a structured training curriculum still applies, unlike residents or fellows, most postgraduate urologists do not have protected educational time to participate in such curricula. The integration of a formal RSTC into an active clinical practice is fraught with logistic issues.

Having an established clinical robotic surgery program, complete with trained OR staff and expert colleagues, facilitates the adoption of robotics through a mentorship model. However, not all postgraduate urologists wanting to learn robotic surgery have this luxury. As such, they are forced to engage in continuing medical education courses provided by industry, private institutions or through organizations such as the AUA. Unfortunately not all of these courses follow a structured, competency based curriculum that includes multicomponent training. Evidence suggests that didactic based continuing medical education sessions are not effective in changing physician performance. Interactive sessions that provide the opportunity to practice skills are critical to effecting change in professional practice and patient outcomes.27

A comprehensive 5-day mini-fellowship training program developed at the University of California, Irvine not only includes didactic tutorials and live case observation in the OR, but also integrates dry lab inanimate training and procedure specific, hands-on labs with pigs and cadavers. Unfortunately this program is presently not duplicated anywhere else in the country, likely due to the expense of this laboratory based educational program (it is estimated to cost a minimum of $3,800). Despite the cost this postgraduate training curriculum has demonstrated a take rate of almost 80% at 3 years among attendees, further validating the necessity of a comprehensive, structured RSTC.14

Credentialing

Currently to our knowledge there are no governing body mandated credentialing guidelines for robotic surgery. The granting of robotic surgery privileges remains institution based and often includes industry driven certification, a method that is neither standardized nor competency based. However, without an established set of operating guidelines, this is the current landscape in which robotic surgery credentialing is delivered. This poses a particularly significant problem when dealing with postgraduate urologists who have not had any formal robotic surgery training during residency or fellowship. During residency or fellowship training the program director is responsible for confirming the competency of a graduating trainee with regard to specific surgical procedures, including robotic surgery. This has historically been done on review of case logs and based on the number of surgical cases performed by that trainee. However, increasing focus is being directed at formally determining surgeon proficiency with surgical techniques and procedures in surgical training programs. This is increasingly the case in minimally invasive surgery.

Ideally robotic surgery credentialing should not be an industry driven process, but one that is a result of a standardized, competency based, peer evaluation system. It is important that this process be self-regulated by robotic surgery experts in a clear, comprehensive and iterative manner. Expert groups such as the Society of Urologic Robotic Surgeons have already voiced their support for a policy of this nature,28 and the AUA is currently working toward developing a robotic surgery standard operating practices document to aid institutions and surgeons in this endeavor.

The FLS curriculum was created by the Society of American Gastrointestinal and Endoscopic Surgeons to serve as a set of guidelines for laparoscopic surgery training and credentialing. After having been validated as a means of training and credentialing trainees,29 the FLS curriculum is now endorsed by the American College of Surgeons. All general surgery certification candidates, effective July 2010, will be required to have successfully completed the FLS training curriculum before being eligible for American Board of Surgery certification.

In a similar vein it is critical that urologists develop a validated RSTC and credentialing process, initiated and regulated by expert urological robotic surgery peers. Until such a curriculum and process are developed, the several requirements should be the bare minimum necessary to obtain robotic surgery credentialing, including 1) proficiency in basic laparoscopy, 2) technical certification for use of the da Vinci robot (model specific), 3) proof of basic preclinical training in robotic surgery and 4) clinical proficiency status obtained from an approved robotic surgery proctor.

There has been much debate as to the requisite number of proctored robotic cases for a trainee to be considered safe and, indeed, there is currently no consensus on this matter. Taking RARP as an example, the current literature reveals a wide range in the recommended number of cases required to move beyond the initial learning curve. Ahlering et al believe that a laparoscopically naïve surgeon can successfully adopt RARP in 8 to 12 cases,30 while Herrell and Smith determined that a minimum of 250 RARP cases were required to achieve comfort
and confidence comparable to open radical prostatectomy. The fact that such a large variation exists in regard to the initial robotics learning curve speaks to the dichotomous nature of this learning curve. There is a significant difference between a surgeon overcoming the technical learning curve as opposed to the outcomes learning curve for any given procedure, regardless of the surgical approach. Although the technical learning curve can be overcome during a defined training interval, an outcomes learning curve of a surgeon likely remains part of an ongoing, iterative process that can extend well into the senior years of practice.

As with any credentialing process, the goal should not be to single out the experts in the group but to ensure that those who receive credentialing have overcome the technical learning curve so that they can deliver safe and effective care to their patients. As such, although it need not be able to ascertain expertise, robotic surgery credentialing needs to be a competency based process whereby proficiency determines credentialing, not simply the completion of a set number of cases. And although there is likely a universal minimum number of cases that the majority of surgeons need to demonstrate proficiency, the eventual total number of cases an individual surgeon requires to achieve proficiency will likely be influenced by a number of factors such as that surgeon’s innate skill level, prior laparoscopic experience, case density during the initial learning curve and the presence or absence of peer collaborative learning.

Until a consensus is reached on a validated credentialing process such as this, an iterative system of granting temporary privileges could be instituted whereby the outcomes of a surgeon’s initial set number of unsupervised robotic surgery cases could be reviewed before granting unrestricted privileges. During this time assistance by another experienced surgeon would be preferred.

CONCLUSIONS
To remain accountable to our patients and minimize the footprint of surgical education, it is incumbent on surgeons to ensure that the integration of robotic surgery, as with any new surgical technology, be a safe and effective process. Although undeniably necessary, there currently does not exist a validated RSTC, nor is there consensus on a robotic surgery credentialing process. Organizations such as the AUA are directing significant attention and effort to address these 2 inadequacies of robotic urological surgical training and credentialing, which will ultimately benefit not only their surgeon members but the patients they treat. Structured, proficiency based advancement in robotic surgery training and credentialing is critical in providing surgeons with the necessary skills to provide optimized care and safely integrating this exciting new technology into the armamentarium of today’s urological surgeon.

APPENDIX
Structured Robotic Surgery Training Curriculum

Preclinical
1) Understanding of disease pathophysiology
2) Understanding of basic laparoscopy (physiology, technique, complications), eg AUA Handbook of Basic Laparoscopy and Robotic Surgery
3) Introduction to components and functionality of da Vinci robot
4) Dry lab practice to acquire basic skills, eg models, VR simulators, etc
5) Animate practice, eg pig or cadaveric lab sessions

Clinical
1) Procedure specific familiarization
   a) observation (videos, live OR cases)
   b) bedside assistance
2) Console time (graduated, step-wise process)

REFERENCES


