



Review

An over-view of robot assisted surgery curricula and the status of their validation



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HIGHLIGHTS

- Several projects are underway to create a curriculum for robotic surgery.
- We review the main projects currently under development and validation.
- The curricula propose a range of methods using several simulation models.

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ABSTRACT

Introduction: Robotic surgery is a rapidly expanding field. Thus far training for robotic techniques has been unstructured and the requirements are variable across various regions. Several projects are currently underway to develop a robotic surgery curriculum and are in various stages of validation. We aimed to outline the structures of available curricula, their process of development, validation status and current utilization. **Methods:** We undertook a literature review of papers including the MeSH terms “Robotics” and “Education”. When we had an overview of curricula in development, we searched recent conference abstracts to gain up to date information. **Results:** The main curricula are the FRS, the FSRS, the Canadian BSTC and the ERUS initiative. They are in various stages of validation and offer a mixture of theoretical and practical training, using both physical and simulated models. **Discussion:** Whilst the FSRS is based on tasks on the RoSS virtual reality simulator, FRS and BSTC are designed for use on simulators and the robot itself. The ERUS curricula benefits from a combination of dry lab, wet lab and virtual reality components, which may allow skills to be more transferable to the OR as tasks are completed in several formats. Finally, the ERUS curricula includes the OR modular training programme as table assistant and console surgeon. **Conclusion:** Curricula are a crucial step in global standardisation of training and certification of surgeons for robotic surgical procedures. Many curricula are in early stages of development and more work is needed in development and validation of these programmes before training can be standardised.

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1. Introduction

Robotic surgery is a rapidly expanding field. In the past decade, over 1.5 million operations have been performed with the da Vinci Surgical System [1] and an increasing number of centres worldwide

are now investing in robots in specialties including Gynaecology, Urology, Cardiac, Thoracic, General and Head & Neck surgery. In some areas such as urology, robotic surgery is now becoming the preferred surgical approach for some indications, with reports of an estimated 80% of radical prostatectomies in the US in 2010 being robot-assisted [2]. Although robotic surgical training was originally exploratory, now robotic surgery is so prevalent that there is a need for a structured training curriculum for trainees [3].

Thus far, training for robotic techniques has been unstructured and the requirements for trainee surgeons have differed from hospital to hospital. Gaining credentials is therefore also variable

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between institutions. There has been a call from major governing bodies such as the Society of Urologic Robotic Surgeons, European Association of Urology and the American Urological Association for development of training curricula increasing preclinical exposure to surgical techniques and validated assessment tools of proficiency. [4,5].

Several projects are currently underway to develop a robotic surgery curriculum and are in various stages of validation. However, the definition of the term ‘curriculum’ is broad: according to the Oxford English Dictionary it is the “subjects comprising a course of study.” In a medical context, the Postgraduate Medical Education Training Board (PMETB) (now part of the General Medical Council, UK) defines a curriculum as “a statement of the intended aims and objectives, content, experiences, outcomes and processes of an educational programme.” This includes a description of training structure and the “expected methods of learning, teaching feedback and supervision” [6,7].

Therefore it is unsurprising that within surgical education there are several meanings to the term curriculum: some curricula are a short full-time course or module whereas others are all-inclusive fellowship-style courses that take several weeks or months to complete. Additionally, a curriculum can also be considered to be the entirety of experiences a trainee surgeon encounters in their journey from novice to expert.

This review outlines the historical perspectives of curriculum development, available curricula, their process of development, validation status and current utilization. It also identifies deficiencies in the literature and recommends direction of future research.

2. Historical perspective of curriculum development

The challenges of developing curricula are not new to the surgical community, especially when considering the introduction of laparoscopic surgery in the 1990s. In 1997 the Society of Gastrointestinal and Endoscopic Surgeons (SAGES) introduced the Fundamentals of Laparoscopic Surgery (FLS) course [8]. This is an evidence-based skills programme that was thoroughly validated and is now a popular course that is widely used. In the US it is a prerequisite for the ABS certifying examination (Appendix 1).

Although the FLS is a useful tool for minimally invasive surgical skills, it does not encompass training specific to robotic surgery, so a new curriculum must be developed and validated. It is being used as a benchmark for these new curricula, and various groups developing the robot assisted surgical curricula are aiming to develop their programmes to be analogous to the FLS [9].

Because there is no gold standard assessment tool in robotics, it has been difficult to determine concurrent validity, i.e. the performance correlation with the gold standard. One group has suggested Cross-Method validity: comparing performance in a variety of training methods. They used Global Evaluative Assessment of Robotic Skills (GEARS) to compare previously validated training tools [10]. Although global assessment methods such as GEARS(11) and instrument tracking methods such as trakSTAR™ Tool Tip Tracker are highly relevant to curricula, in this review we will focus on the content of the courses themselves rather than their assessments. An overview of available curricula has been provided in the following sections.

3. Methods

To gain a comprehensive overview of curriculum development internationally, we used several methods to gain information. Firstly, we did a PubMed search using the MeSH terms “surgery”, “robotic” and “education” and limited results to those with a full

text and published in the last 10 years. This search yielded 462 results. From this we examined the results and selected only papers with titles relevant to curricula, accreditation, programmes, teaching, or validation of teaching or assessment methods. From this we gathered 33 relevant papers related to our subject. We read these papers and identified those that were linked to a larger curriculum projects. Papers were only excluded if they clearly pertained to an isolated validation study that had no current application to a teaching curriculum. This included papers regarding validation or development of simulators themselves, as our group has recently reviewed this field [12]. Any references to other curricula within these papers were also flagged up for inclusion in our review.

Realising that much of the work of these groups is currently unpublished and has only been presented at conferences, we then used Google searches to find abstracts in conference archives for projects already on our list. When we had identified the main conferences accepting abstracts on this topic, we read through their archives for the last 5 years to check if we had missed any ongoing projects. Over several months we familiarized ourselves with the main projects and did thorough Google searches of each, ensuring that all data published online for each project was up to date.

When we had completed our list of projects and gained information on them, we discarded any projects that consisted of no more than a single poster presentation or abstract, as these were considered to be too small and undeveloped to be compared to the larger projects described below.

4. FRS: Fundamentals of Robotic Surgery

There are currently two groups developing curricula under the working title Fundamentals of Robotic Surgery (FRS). The larger group based at Florida Hospital Nicholson Center is a large, multi-center project that has been in development for several years. The second project, which we believe to be separate to the former group, was a poster presentation delivered at the SAGES 2012 annual meeting, although no other information is available to our knowledge. Both projects have been discussed in this review for completeness i.e. (a) Florida Hospital Group, and (b) Orlando Group.

4.1. Fundamentals of Robotic Surgery: Florida Hospital Nicholson Center group

4.1.1. Background

The Fundamentals of Robotic Surgery is a large multicenter project based at the Florida Hospital Nicholson Center, with team members from the Minimally Invasive Robotics Association and the US Department of Defense. It was officially launched online on March 1st 2014 and is currently undergoing validation.

The curriculum was developed by over 24 world experts in robotic surgery over two years. Content of the curriculum was decided through a series of consensus conferences attended by 14 leading surgical societies, where the FRS team gained expert input on the key skills and requirements of the robotic surgeon [13]. Initial ideas at these conferences were built upon a previously developed proficiency-based curriculum by Dulan et al. [14], which is described in full below.

After a first consensus conference to identify the 25 main outcome measures, the team split into three working groups for future conferences: a didactic and cognitive skills group, a psychomotor skills group and a team training and communications group. Each group identified a series of tasks, checklists or lectures most suitable to meet these learning outcomes.

When the FRS curriculum is fully developed there are plans to create a specialty-based accreditation scheme that will help

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