The American Journal of Surgery xxx (2017) 1–5

Contents lists available at ScienceDirect

The American Journal of Surgery

journal homepage: www.americanjournalofsurgery.com

Current robotic curricula for surgery residents: A need for additional cognitive and psychomotor focus

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ARTICLE INFO

Article history:
Received 26 April 2017
Received in revised form
26 June 2017
Accepted 7 September 2017

Keywords:
Robotic surgery
Resident training
Resident curricula

ABSTRACT

Background: Current robot surgery curricula developed by industry were designed for expert surgeons. We sought to identify the robotic curricula that currently exist in general surgery residencies and describe their components.

Methods: We identified 12 residency programs with robotic curricula. Using a structured coding form to identify themes including sequence, duration, emphasis and assessment, we generated a descriptive summary.

Results: Curricula followed a similar sequence: learners started with online modules and simulation exercises, followed by bedside experience during R2-R3 training years, and then operative opportunities on the console in the final years of training. Consistent portions of the curricula reflect a device-dependent training paradigm; they defined the sequence of instruction. Most curricula lacked specifics on duration and content of training activities. None clearly described cognitive or psychomotor skills needed by residents and none required a proficiency assessment before graduation.

Conclusions: Resident-specific robotic curricula remain grounded in initial industrial efforts to train experienced surgeons, are non-specific regarding the type and nature of hands on experience, and do not include discussion of operative technique and surgical concepts.

1. Introduction

The Food and Drug Administration (FDA) approved the first surgical robot in 2000 and today, numerous nationally recognized surgeons in disciplines such as urologic, gynecologic, thoracic, hepatobiliary, foregut, and bariatric surgery routinely use this technology.[1–10] Top surgical oncology centers throughout the country recognize the technology's importance and have recently invested in specific updated (Xi) robots for operating rooms dedicated to general surgery procedures.[11] These developments led surgical educators to recognize a need for structured robotic training during residency to appropriately prepare future surgeons for careers in which robotics likely will be used.[12]

Initial robotic training modules were designed to teach expert surgeons how to use a new technology. Intuitive Surgical (Sunnyvale, CA), the company that sells the only currently FDA-approved robot for general surgery procedures, developed several training pathways for surgeons and operating room staff. Within these pathways are various online modules and virtual simulation exercises that rely on Intuitive Surgical's DaVinci robotic console. In an effort to create a robotic curriculum independent of industry standards, the Fundamentals of Robotic Surgery (FRS) consortium comprising experts from various surgical specialties, education organizations, and governing boards, developed a multi-specialty robotic surgery curriculum through four consensus conferences.[13] This FRS curriculum officially launched March 1, 2014. However, despite intentions of developing an objective competency-based curriculum, the final product continues to reflect substantial influence from Intuitive Surgical, which the FRS acknowledges. A handful of similar projects are underway but remain in their early stages with limited validation evidence.[14] Residency programs throughout the country have subsequently implemented various robotic surgical curricula that reflect components of FRS and Intuitive Surgical training modules.[15–20] With implementation of semi-structured curricula, trainees demonstrate improved robotic performance.[21] Without a standardized curriculum, robotic curricula are emerging at training institutions throughout the

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https://doi.org/10.1016/j.amjsurg.2017.09.040
0002-9610/

country, but formats and content may vary widely, making outcomes difficult to interpret.

Although recent studies have illustrated the feasibility[15–17] and safety[15–18] of implementing a robotic curriculum for surgical trainees, none have described the components of a curriculum in detail. Furthermore, the dramatic expansion of robotic use in general surgery procedures at academic institutions exposes trainees to this technology with increasing frequency. Therefore, we sought to identify the robotic curricula that currently exist in general surgery residencies in the United States and to describe their various components.

2. Methods

To identify residency programs with current robotic curricula, we performed a literature review, collaborated with Intuitive Surgical's online community to identify programs with high resident activity, and contacted individual programs highlighting robotic use at their institutions. The literature review included publications in Pubmed and Google Scholar identified using the following key words: "resident robotic curricula," "robotics in general surgery," "residents and robotics," "robotic training in residency," "resident robotic surgery." Programs with multiple residents accessing and reviewing the online robotic modules were collected and then contacted to determine if a formal curriculum existed. To ensure appropriate comparisons, programs included in the study were limited to those with documented robotic curriculum for general surgery residents located within the United States.

After identifying the programs, we reviewed their robotic curricula using a content analysis. We specifically focused on curricular organization, cognitive content and psychomotor skills highlighted in the various curricula. We developed a coding sheet listing characteristics of the curriculum and the program and summarized these results descriptively to characterize the curricula. Institution names were kept anonymous to avoid any unintended risk that may result from data collection and distribution. We refer to them as Programs A through L. The University of California San Francisco (UCSF) Institutional Review Board approved this study as exempt.

3. Results

We identified 12 general surgery residency programs that had a structured robotic curriculum in place for their trainees. These included both public and private academic programs that were diversely located throughout the United States in both rural and metropolitan settings. Additional program characteristics are illustrated in Table 1.

The robotic curricular components for the 12 programs are illustrated in Table 2. The most consistent components (utilized by all 12 programs) were the completion of online modules and simulation exercises (both designed and accessed via the Intuitive Surgical platform). There were over 40 different simulation exercises, so although all programs use the simulation training, curricula vary as to which exercises are recommended versus required, and what defines completion.

3.1. Sequence

In the 12 programs, the sequence of resident exposure to the robotic curricular contents was consistent (Fig. 1). Residents begin by completing video modules from Intuitive Surgical's online community. These modules were developed by Intuitive Surgical to highlight specific components of the robotic technology, such as the vision system, console functions and docking capabilities. Next, the residents complete simulation exercises on the daVinci console. These exercises highlight different aspects of the surgical technology, including energy switching, camera targeting, instrument clutching, and suturing. These steps are then followed by the intraoperative exposure, when residents are present in the operating room during a robotic procedure. This begins with the role of bedside assistant, where residents participate in docking/undocking the robotic arms, instrument exchange, and occasionally manage an additional assist port. At some point later, residents move to the operative console (Fig. 1).

3.2. Timing

Programs varied widely with respect to the timing of the modules, simulation, and operative components of the robotic curricula (Table 2). For example, four programs reported residents have robotic operative exposure starting in the first or second postgraduate year (PGY). However in Program A, resident exposure to robotic surgery is focused and occurs exclusively for two months in their fourth year of training, whereas in three programs, residents must wait until PGY 3 to interact intraoperatively with robotic technology.

3.3. Performance

As shown in Table 2, for the online modules, no curricula had requirements beyond taking the module and completing a final multiple-choice assessment. For the simulations, some curricula defined "passing" as achieving a score greater than 90% on the mandatory exercises, whereas others chose a level of 80%. Program A required residents to spend 10 h practicing on the simulator. No

Table 1
Characteristics of Twelve General Surgery Residency Programs in the U.S. with Documented Robotic Curriculum.

Program	First Year Positions	Number of clinical residents	Type of Program	# of Robots
A	17	40	University	8
B	14	50	University	NA
C	11	43	University	5
D	25	48	University	NA
E	7	24	University	NA
F	20	53	University	NA
G	7	42	University	3
H	NA	NA	University	NA
I	11	35	University	3
J	22	77	University	7
K	14	38	University	2
L	20	41	University	NA

NA = Information unavailable.

Please cite this article in press as: Green CA, et al., Current robotic curricula for surgery residents: A need for additional cognitive and psychomotor focus, The American Journal of Surgery (2017), https://doi.org/10.1016/j.amjsurg.2017.09.040