



## A survey of robotic surgery training curricula in general surgery residency programs: How close are we to a standardized curriculum?



Cynthia M. Tom<sup>a, b</sup>, James D. Maciel<sup>a, b</sup>, Abraham Korn<sup>a, b</sup>, Junko J. Ozao-Choy<sup>a, b</sup>, Danielle M. Hari<sup>a, b</sup>, Angela L. Neville<sup>a, b</sup>, Christian de Virgilio<sup>a, b</sup>, Christine Dauphine<sup>a, b, \*</sup>

<sup>a</sup> Department of Surgery, Harbor-UCLA Medical Center, David Geffen School of Medicine at UCLA, 1000 West Carson Street, Torrance, CA, 90502, United States

<sup>b</sup> Los Angeles Biomedical Research Institute, 1124 West Carson Street, Torrance, CA, 90502, United States

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### ABSTRACT

**Background:** Robotic surgery is increasingly adopted into surgical practice, but it remains unclear what level of robotic training general surgery residents receive. The purpose of our study was to assess the variation in robotic surgery training amongst general surgery residency programs in the United States. **Methods:** A web-based survey was sent to 277 general surgery residency programs to determine characteristics of resident experience and training in robotic surgery.

**Results:** A total of 114 (41%) programs responded. 92% (n = 105) have residents participating in robotic surgeries; 68% (n = 71) of which have a robotics curriculum, 44% (n = 46) track residents' robotic experience, and 55% (n = 58) offer formal recognition of training completion. Responses from university-affiliated (n = 83) and independent (n = 31) programs were not significantly different.

**Conclusions:** Many general surgery residencies offer robotic surgery experience, but vary widely in requisite components, formal credentialing, and case tracking. There is a need to adopt a standardized training curriculum and document resident competency.

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### Introduction

Robotic surgery is being increasingly employed into surgical practice. In 2017, there was a 16% increase in the use of the da Vinci Surgical System in the United States, with the general surgery robotic procedure volume nearly doubling from 140,000 cases in 2015 to 246,000 cases in 2017.<sup>1</sup> Despite the relatively fast-paced adoption of robotic surgery, it remains unclear what level of robotic training general surgery residents receive as there has not been widespread implementation of a standardized robotic training curriculum to date.

In 2000, a survey of general surgery program directors showed that 14% of programs provided resident exposure to robotic technology and 65% felt robotics will play important role in future.<sup>2</sup> In 2013, a survey of 192 general surgery residents reported that 63% participated in robotic cases, but 74% had not received any formal or

informal robotic surgery training.<sup>3</sup> Most recently, a study from a single institution also showed high resident interest in improving robotic skills, but only 18% voluntarily completed the robotics curriculum.<sup>4</sup> While these studies have provided valuable information regarding the residents' perspective of robotic surgery, they were limited by small sample sizes or a lack of insight into the objectives and intentions of the residency program administration for robotic surgery training. Furthermore, there are no studies addressing methods to track or recognize residents' robotic experience for fellowship programs or credentialing assessments.

The goal of our study was to survey general surgery residency program administrators to further evaluate the current status of resident training and experience in robotic surgery in order to determine if there is an emerging consensus toward a standardized curriculum and certification of competency.

### Materials and methods

This study was approved by the Institutional Review Board at the Los Angeles Biomedical Research Institute. A web-based 13-question survey was sent to program administrators at all 277

\* Corresponding author. Department of Surgery, Harbor-UCLA Medical Center, 1000 West Carson Street, Box 25, Torrance, CA, 90502, United States.

E-mail address: [CDauphine@dhs.lacounty.gov](mailto:CDauphine@dhs.lacounty.gov) (C. Dauphine).

Accreditation Council for Graduate Medical Education (ACGME)-accredited general surgery residency programs in the United States listed in the FREIDA Online<sup>®</sup> AMA Residency and Fellowship Database<sup>®</sup>.<sup>5</sup> Survey questions examined program demographics and characteristics of resident training and experience in robotic surgery (Table 1). Responses were collected into an electronic database over an 8-month period from September 2017 to March 2018. Descriptive statistics and Pearson's chi-squared or Fisher exact tests were used to compare and analyze responses between university-affiliated and independent residency programs. *P* values < 0.05 were considered significant.

## Results

A total of 114 out of 277 (41% response rate) ACGME-accredited general surgery residency programs responded to the survey. Program demographics are summarized in Table 2 with overall responses from programs and responses categorized between university-affiliated and independent residency programs. The median number of categorical residents per program was 5 per postgraduate year (range 1–13). Overall, 92% (*n* = 105) of responding programs reported that their residents participate in robotic surgeries, and 96% (*n* = 107) believe robotic surgery training is important for residents.

Characteristics of the 105 programs with resident participation in robotic surgery cases are shown in Table 3. Of these programs, 84% (*n* = 85) had residents actively operating at the console. Fig. 1 depicts the types of robotic-assisted cases performed by residents. Of the 16 programs with no active resident participation at the operating console, 12 indicated plans to include this opportunity for residents within 3 years.

A formal robotic surgery training curriculum for residents was implemented in 67% of the programs with residents participating in robotic surgery. The components of robotic surgery curricula utilized by general surgery residency programs are depicted in Fig. 2. Of the 34 programs that did not have a formal robotic surgery curriculum in place despite having resident participation in robotic surgeries, 23 programs endorsed plans to institute a curriculum within 3 years.

Our survey demonstrated that 44% (*n* = 46) of general surgery residency programs specifically track their residents' experience with robotic surgery cases (Table 3). Only 55% (*n* = 58) offered

formal recognition for their residents' robotic expertise in the form of an industry or residency-administered certificate (79%) or letter of attestation from the program (20%).

Comparisons of the responses from university-affiliated and independent programs are also depicted in Tables 2 and 3. University-affiliated programs were more likely to be large programs with more than five residents graduating per year (64% vs 16%, *p* < 0.001). There was a higher proportion of independent programs from the West (36% vs 16%, *p* = 0.021). Independent programs were less likely to specifically track residents' robotic experience (27% vs 49%, *p* = 0.045) and were slightly less likely to utilize certificates as a method of recognition of resident robot expertise (73% vs 80%, *p* = 0.045). University-affiliated programs were more likely to incorporate online courses into their robotic training curriculum for residents (55% vs 25%, *p* = 0.022). Independent programs trended towards lower rates of resident participation in robotic surgery cases (84% vs 95%, *p* = 0.060). Additionally, there was a trend towards independent programs disagreeing with the statement "Do you think training in robotic surgery training is important for general surgery residents" (10% vs 1%, *p* = 0.054).

Out of the programs that did not respond to the survey, 83% (*n* = 135) were university-affiliated programs. The median number of graduating residents per year per program was five. The majority of the programs that did not respond were located in the Midwest, Northeast, and South.

## Discussion

In concordance with the rapid growth in the use of surgical robots within general surgery, our survey results revealed that 92% of the responding general surgery residency programs have incorporated robotic surgery into residency training, and 84% reported having residents actively operating at the robot console. The most commonly performed cases by residents were hernia repairs and colorectal, biliary, and gastric procedures, but a quarter of programs also reported experience in more complex robotic cases, such as esophageal, thoracic and pancreatic procedures. We did not find a significant difference between university-affiliated and independent residency programs. Overall, 96% of responding programs believed that robotic surgery experience was an important aspect of training for general surgery residents.

**Table 1**  
Survey questions sent to general surgery residency program administrators.

Question (Answer Choices)
1 How many categorical residents graduate your general surgery residency training program per year?
2 In what area of the country is your training program located? (West, Northeast, South, Midwest)
3 Which best describes your surgery residency program? (University-affiliated or Independent)
4 Do you think training in robotic surgery is important for general surgery residents? (Yes/No)
5 Do residents at your training program participate in robotic surgery cases? (Yes/No) If no → Is there a plan to initiate resident participation in the next 3 years? (Yes/No)
6 Is there a formal robotic surgery curriculum in place for residents? (Yes/No) If no → Is there a plan to institute one in the next 3 years? (Yes/No)
7 Please select from the list below what that curriculum entails. (Time on simulator, case observation, videos, formal industry-sponsored training course, faculty-directed time at console, live animal lab, cadaver lab, online courses, other) If other → What additional curriculum features are there? (Free text response)
8 At what training level do residents begin robotic training curriculum? (R-1, R-2, R-3, R-4, R-5)
9 Do general surgery residents participate in robotic cases actively at the console? (Yes/No) If no → Is there a plan to include residents in robotic cases at the operating console within the next 3 years? (Yes/No)
10 What types of cases do residents complete as the console surgeon? (Biliary, hernia/soft tissue, gastric, colorectal, pancreatic, hepatic, esophageal, thoracic, endocrine, renal, gynecologic, pediatric, other) If other → What other types of cases? (Free text response)
11 Do you specifically track resident experience in robotic surgery in your residency program? (Yes/No)
12 How many robotic cases has each graduating chief resident participated in? (0, 1–20, 21–40, > 40)
13 Does your program offer any formal recognition of resident robot expertise? (Yes/No) If yes → What is the nature of this recognition? (Free text response)

**Table 2**  
Program demographics of survey respondents.

	Overall Programs (n = 114)	University-affiliated Programs (n = 83)	Independent Programs (n = 31)	p-value
Program location				
Northeast	36 (32%)	26 (31%)	10 (32%)	0.924
South	28 (25%)	22 (27%)	6 (19%)	0.430
Midwest	26 (23%)	22 (27%)	4 (13%)	0.141
West*	24 (21%)	13 (16%)	11 (36%)	0.021
Resident participation in robotic surgery cases	105 (92%)	79 (95%)	26 (84%)	0.060
No resident participation in robotic surgery cases	9 (8%)	4 (5%)	5 (16%)	
Plan to initiate resident participation within 3 years? (n = 6)	3 (3%)	1 (1%)	2 (7%)	1.000
Believe robotic surgery training important for residents (n = 111)	107 (96%)	81 (99%)	26 (90%)	0.054
Do not believe robotic surgery training important for residents	4 (4%)	1 (1%)	3 (10%)	

Values listed as number of programs (%). \*p < 0.05.

Although the majority of programs described high rates of resident involvement in robotic surgery, only 68% of these programs reported having a robotics training curriculum. These curricula were largely centered around the use of a robotic simulator and faculty-directed time at the console, with nearly half relying on industry-sponsored courses, and fewer than 20% incorporating live animal or cadaver labs. Furthermore, only 44% of programs that indicated resident participation in robotic surgery actually tracked resident case experience, and only 55% provided resident graduates with formal recognition of their expertise. With such a wide variation, it is difficult to quantify residents' experience or assess their competency in the safe practice of robotic surgery.

Fellowship training programs and hospital credentialing departments often have little documentation to assess newly graduated residents' capabilities and proficiency in robotic surgery other than self-reported case numbers and experience. Gaining privileges can then be a challenge for these residents, and many may need to take an industry-sponsored course to successfully meet

credentialing requirements. Furthermore, privileging requirements vary widely between hospitals, which makes it even more difficult for residency programs to address this issue. Additional concerns include the potential legal ramifications for the residents. If a lawsuit arises out of a robotic case with resident participation, and the residency program lacks a curriculum to demonstrate the resident's competency and completion of training, the resident and supervising attending may be at legal risk. Therefore, a standardized curriculum has several important advantages for general surgery trainees. Lastly, inclusion of robotic case tracking in the ACGME case log system is recommended in order to track overall resident robotic experience and provide individual reports for credentialing.

In 2011, the need for a standardized curriculum along with high-stakes testing and certification was recognized, and work was begun on the Fundamentals of Robotic Surgery (FRS) standardized curriculum.<sup>6</sup> The curriculum is now available online and was recently updated to contain four modules that include didactic as well as psychomotor skills and team communication training.<sup>7</sup> The

**Table 3**  
Characteristics of programs with resident participation in robotic surgery.

	Overall Programs (n = 105)	University-affiliated Programs (n = 79)	Independent Programs (n = 26)	p-value
Believe resident robotic surgery training important	102 (97%)	78 (99%)	24 (92%)	0.151
Active resident participation at console (n = 101)	85 (84%)	67 (87%)	18 (75%)	0.159
No active resident participation at console	16 (16%)	10 (13%)	6 (25%)	
Plan to include resident at console within 3 years	12 (12%)	9 (12%)	3 (13%)	0.118
No plan to include resident at console	4 (4%)	1 (1%)	3 (13%)	
Presence of formal resident robotic surgery curriculum	71 (68%)	55 (70%)	16 (62%)	0.445
Training level at initiation of curriculum				
R1	39 (55%)	31 (56%)	8 (50%)	0.653
R2	20 (28%)	15 (27%)	5 (31%)	0.760
R3	10 (14%)	7 (13%)	3 (19%)	0.684
R4	1 (1%)	1 (2%)	0 (0%)	1.000
R5	1 (1%)	1 (2%)	0 (0%)	1.000
No formal resident robotic surgery training curriculum	34 (32%)	24 (30%)	10 (39%)	0.445
Plan to institute curriculum within 3 years (n = 33)	23 (22%)	16 (20%)	7 (27%)	0.980
Specific tracking of resident robot experience*	46 (44%)	39 (49%)	7 (27%)	0.045
Number of robotic cases per graduating chief (n = 44)				
0 cases	1 (2%)	1 (3%)	0 (0%)	1.000
1-20 cases	14 (32%)	12 (32%)	2 (29%)	0.841
21-40 cases	19 (43%)	15 (41%)	4 (57%)	0.443
>40 cases	10 (23%)	9 (24%)	1 (14%)	1.000
Formal recognition of resident robotic expertise	58 (55%)	46 (58%)	12 (46%)	0.282
Method of recognition (n = 56)				
Certificate from industry or residency program*	44 (79%)	36 (80%)	8 (73%)	0.045
Letter of attestation	11 (20%)	6 (13%)	5 (46%)	0.128
Case log	5 (9%)	4 (9%)	1 (9%)	1.000
Multiple methods	3 (5%)	1 (2%)	2 (18%)	0.156

Values listed as number of programs (%). \*p < 0.05.

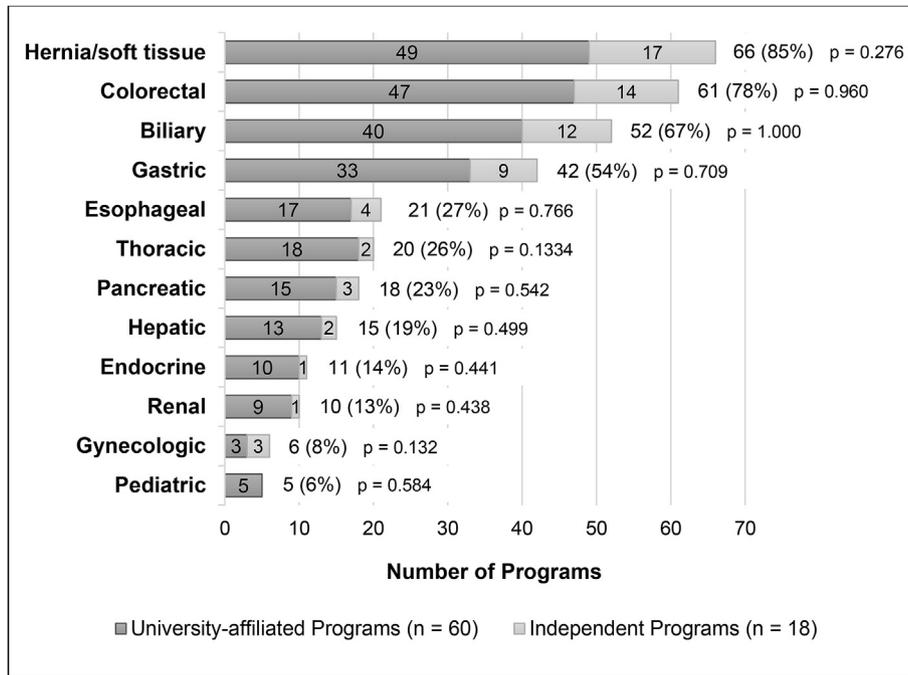
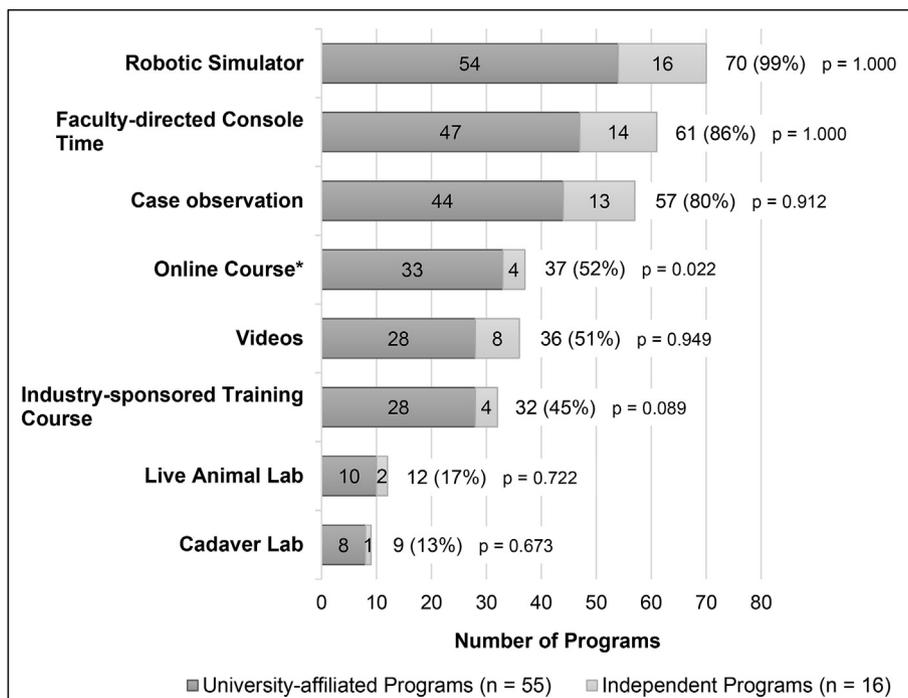


Fig. 1. Types of resident robotic surgery cases (n = 78).

FRS offers a single standard of minimal skills training required to perform safe robotic surgery. However, increased participation and further validation of this curriculum<sup>6,7</sup> and other emerging robotics curricula<sup>8,9</sup> are still needed. Furthermore, assessment of residents' competency and provision of certification of resident robotic expertise is an important aspect of robotic training that still needs to be addressed.

The limitations of this study are mainly associated with the use of a survey-based research methodology. Our survey response rate was only 41% and may have been biased toward residency programs that already participate in robotic surgery training. Programs that did not respond to the survey may have different views on the importance of robotic surgery in general surgery residency compared to the programs that did respond. However, our study's



\* p < 0.05

Fig. 2. Features of robotic surgery curricula for general surgery residents (n = 71).

response rate is higher than previously published national studies in this area. Additionally, we had a fairly even geographical distribution of responding programs, with only a slightly higher response from the northeast over other regions. Another potential limitation is that responses were predominantly skewed toward university-affiliated programs, but statistical analysis of the survey responses showed that there were similar responses between university-affiliated and independent programs.

### Conclusions

In summary, many general surgery residents participate in robotic surgery cases with increasing opportunities for involvement. However, there continues to be a wide variation in robotic training requirements amongst programs and a lack of formal tracking and recognition of resident robot expertise, which presents several disadvantages to the resident trainee. The implementation of a national, standardized robotics curriculum and formal credentialing system with case tracking for residents should be highly considered to address this variation.

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### Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.amjsurg.2018.11.006>.

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