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ORIGINAL ARTICLE

Training robotic community surgeons: our experience implementing a robotics curriculum at a rural community general surgery training program

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Abstract
Robotic-assisted surgical procedures are being increasingly used in general surgery, including in the rural and community setting. Although there is no requirement, general surgery residency programs have begun to incorporate curriculums to train residents in this discipline. As a small rural community program, we recently instituted a voluntary and structured curriculum, and our initial experience is shared here. Our curriculum was voluntary for all general surgical residents for the academic years 2016–2017. The curriculum consisted of online training, bedside training, console simulation, bedside assisting, and operating at the console. During the fiscal year of 2016, 193 robot-assisted surgeries performed within the General Surgery Department. Fourteen of fifteen residents participated in the curriculum, with the exception being a resident new to our program. A survey was sent to the residents to evaluate their opinions towards robotic surgery and the curriculum, with 12/15 residents responding. Overall, residents' impressions were very favorable, with all reporting being either very or mostly satisfied with the curriculum and most, 58.4%, reporting there participating level on the robot to be appropriate. Importantly most, 91.7% did not think that the curriculum put an undue stress on their time or that it was detrimental to other aspects of their training. This study shows that a community rural general surgery program can incorporate a voluntary robotic curriculum effectively with high resident participation and satisfaction.

Keywords General surgery · Residency · Training · Robotics

Background/introduction

Surgery has evolved over the years and incorporated new technologies that have improved the ability of the operating room surgeon to execute his or her craft. The first laparoscopic cholecystectomy was done in 1985 by Professor Erich Mühe, and the advantages of a minimally invasive approach were immediately evident [1, 2].

The new frontier of minimally invasive surgery includes robotic assisted procedures. Robotic assisted surgery has advantages in improved dexterity, stable camera platform and improved three-dimensional imaging. These advantages have also led to improved outcomes for certain general surgery procedures [3]. Robotic general surgery is being implemented at an increasing number of hospitals across the country, and although less common in rural areas, smaller community hospitals have been no exception [4].

Graduating residents may be expected to have the skills to perform common general surgery procedures using robotic surgical technology. It is imperative that residency programs have a robust plan and curriculum for teaching residents to be safe and effective with these instruments. Community general surgery programs are sometimes slower to adapt to new technologies and do not have the same resources compared to larger academic programs, but the graduates of these programs will still be expected to be competent in them. We believe that it is important that community general surgery programs not lag behind their academic counterparts in training future surgeons in these necessary skills.

There is currently no national or accredited robotics curriculum for surgery programs to follow, and residents are not required to be trained in robotics to take their boards. However, general surgery residents are expected to be trained and get certified in laparoscopic and endoscopic procedures,

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prior to being able to take their boards. The Society of American Gastrointestinal and Endoscopic Surgeons have released a consensus document on robotic surgery in which they recommend that "specialty training programs include exposure to therapeutic robotic interventions as part of their curriculum. A structured curriculum on therapeutic robotic procedures should be included in programs providing clinical experience to their trainees" [3]. Academic programs have implemented robotic curriculums with good results [5].

The goal of this study is to determine the outcomes of the implementation of a robotics curriculum in a community general surgery program. With the purpose of training safe and effective community/rural general surgeons, in 2016, the Marshfield Clinic General Surgery department adopted a voluntary robotic curriculum for training resident surgeons. We believe that by employing this curriculum, we will be able to train general surgery residents to become familiar with the technology. We further believe that community/rural general surgery programs can effectivity incorporate a robotic curriculum into their training programs without adding undue burden onto the already valuable time of the residents. The trained residents will subsequently become comfortable enough with the technology and be able to incorporate it into their future practice.

Research design/methods

Our program

Our program is a community-based program situated in a rural community in Marshfield WI, with a local population of 18,000 and catchment population of 750,000. We train three graduating chief residents per year. We have a busy robotic assisted general surgery practice, performing over 190 robotic general surgery cases in 2016, with two operating surgeons. Residents rotate on their service 3–4 months every year. The DaVinci robotic surgical system is the only FDA approved program for general surgery procedures, and is what is used at our institution, using both Si and Xi models.

Our robotic curriculum

Our robotic curriculum first involves online modules, hands-on learning with the technology, simulation and assisting on procedure before the resident is allowed to operate on the console. It is consistent with other curriculums used throughout the country. This is a voluntary curriculum, because we recognize that not all residents may be interested in investing their already valuable time in this and certification is not required the ABS or ACGME. A large portion of the curriculum is completed by the residents on their own time, outside of dedicated teaching time.

As PGY1 and PGY2 residents, they first learn about the technology in Phase 1 of the curriculum. This includes completion of the online resources provided by Intuitive Surgical Inc. These include interactive modules that have been designed to familiarize the learner with the technology, how it is commonly used and how to trouble shoot problems. These modules include questions at the end to assess the trainee's retention, and at the completion of the modules, a certificate is awarded. These resources are available free online to anyone associated with a surgical training program.

During this phase, the resident also completes their simulation time on the robot. The system has programmed simulations that instruct the trainee on how to use the various aspects of the console, such as camera movement, wrist manipulation, and multiple arm manipulation. They also teach basic surgical principles applicable to the system including needle control and application of energy devices. At the completion of each simulation, the trainee is scored based on their performance, which is measured by how well and efficiently they use the technology. For our curriculum, residents are required to complete 10 h of simulation time and six specific modules scoring greater than or equal to 90% on each. The modules were selected to show that the trainee has a broad range of skill and proficiency with the system.

Prior to being able to assist on a procedure, the residents are required to undergo a hands-on training session with an Intuitive representative. This bedside teaching includes console setup, docking, instrument exchange, and trouble shooting. This is done to help familiarize the resident with the technology prior to using the robot in a real-life operative experience.

Once properly trained in the technology the residents are then allowed to assist at the bedside on cases. This is done to help them further familiarize themselves with the technology and its applications in a real-life environment. They are required to assist on five cases prior to being allowed to sit at the console.

In Phase 2 of our curriculum, the residents are allowed to sit on and operate with the console. For this, they must have completed the aforementioned requirements and must be a PGY3 or above. Once on the Surgeon console, the residents are then guided through completing portions of the procedure concordant with their skill level and at the direction of the attending surgeon. This starts off with completing basic portions of the procedure, and as the resident displays proficiency, they advance to complete the majority of the cases independently on the console.

Survey

To evaluate the opinions of residents on the robotic curriculum, an anonymous and voluntary survey was given to them. All residents had at least completed a portion of the curriculum, so it was distributed to all of them. The resident survey consisted of six questions to gauge their satisfaction of the curriculum, how important they think robotics will be in their future and if the curriculum is affecting their training. The questions are listed in Table 1 with the results of the survey. The staff was also encouraged to give their opinion of the curriculum and on resident involvement in cases.

Statistical analysis

Categorical data were summarized using frequency and percentages.

Results

In 2016, there were 193 robotic general surgery procedures performed by our two MIS surgeons. We had 15 residents for the academic year, and all residents with exception of one resident who was new to our program reported completing a portion of the curriculum, with the majority of them completing the portion of the curriculum consistent with their PG year.

The results from the survey are shown in Table 1 in which 12 of our 15 residents responded to the voluntary and anonymous survey. The robotic curriculum was thought on vary favorably by the residents. Half of the respondents were very satisfied with the curriculum and the remainder of residents reported still being mostly satisfied. The majority 58.4% (7/12) thought that their participation level on the robot was appropriate for their training level. The large majority, 91.7% (11/12), did not think that the curriculum put an undue stress on their time or that it was detrimental to other aspects of their training. Most of the responding residents, 75% (9/12), believed that robotic surgery would very likely have a practical application in their future careers.

Interestingly, most of the respondents, 58.4% (7/12), did think that their lack of participation in the voluntary curriculum would at least somewhat affect their standing in the program, with a large amount, 33.4%, also believing that it would negatively affect their standing a decent amount.

Discussion

The goal of the study was to show that implementing a voluntary robotic surgery curriculum in a community rural general surgery program is feasible and can be accomplished with good results. Rural general surgery programs do not have the same resources of their academic counterparts, and thus may have difficulty adapting to new technology. Despite these challenges, it has been shown that rural residency programs have been able to instruct their residents in advanced laparoscopy with great success [6] and that graduates of independent programs are more confident in their surgical skills compared to their university peers [7]. It is important that rural programs continue this trend of training confident and effective surgeons.

With this goal in mind, our study was able to show that a voluntary robotic curriculum could be implemented at a community general surgery program with good results. With the exception of one new senior resident to our program, all reported at least completing a portion of the curriculum, and of the residents that responded to the survey, they all felt at least mostly satisfied with the curriculum. Importantly, most also felt that they were also able to participate in the procedure at a level appropriate for their training year, as there is often a concern with robotic training that the residents are just bedside assisting and not participating on the console

Table 1 Resident survey

	% (*n*)				
How satisfied are you with the robotic curriculum?	Very 50 (6)	Mostly 41.7 (5)	Somewhat 0	Not at all 0	N/A 8.3 (1)
Do you think that your participation in the robotic cases is appropriate for your training level?	Very 58.4 (7)	Mostly 25 (3)	Somewhat 8.3 (1)	Not at all 0	N/A 8.3 (1)
Do you think the voluntary robotic curriculum puts an undue stress on your time?	Not at all 91.7 (11)	A little bit 0	A decent amount 8.3 (1)	Yes, a lot 0	
Do you think lack of participation in the robotic curriculum would impact your standing within the residency program?	Not at all 8.3 (1)	A little bit 58.4 (7)	A decent amount 33.3 (4)	Yes, a lot 0	
Do you think that robotic training during your residency will have a practical application in your future practice?	Not at all 0	A little bit 16.7 (2)	A decent amount 8.3 (1)	Yes, a lot 75 (9)	
Do you think that surgical robotic training might be detrimental to other aspect of your training?	Not at all 91.7 (11)	A little bit 8.3 (1)	A decent amount 0	Yes, a lot 0	

[8]. While the lower level residents are just able to bedside assist, as is outlined in the curriculum, the more senior residents were completing significant portions or often even the entire case as the console surgeon.

One important finding of our study is that most of the residents reported that the curriculum did not put an undue stress on their time or took away from other parts of their training. This is especially important in the current residency training model, with work hour restrictions. There is a current emphasis on burn-out and attrition of general surgery residents; thus, it is important that their personal time is respected. The time of a general surgery resident is very valuable, as they have many duties including research, clinical responsibilities, and teaching, and thus any new additions to their responsibilities must be evaluated very thoroughly by a program to ensure maximum benefit for both residents and program. Voluntary curriculums have been criticized for being ineffective with low participation [9]. However, our curriculum was optional and we still had good results with most residents at least completing a portion of the curriculum. Furthermore, even though all the residents did not complete all of the training, most completed a portion, giving them at least a familiarity with the technology.

Even though the curriculum was voluntary, the survey did show that residents may have felt pressure to participate in the robotic curriculum, as most reported that a lack of participation would affect their standing in the program. It is unknown the exact reasons why they felt their standing would be affected, but it may be because they felt they would be judged for not showing the same initiative as their peers. It was often emphasized that this curriculum was voluntary and would not affect their standing, but this may be a point of emphasis as we implement the curriculum going forward.

With regard to the future of robotic general surgery, all of our residents thought that it would have some practical application in their careers, with a majority believing that it would have a significant impact on their future practice. This is consistent with a 2015 survey, where most general surgery attendings and residents agreed that robotic should be incorporated in their training, especially early on [10]. It is unknown how much robotics will play in the future of general surgery, there are some concerns about its increased costs [11] or lack of better results, but it also is becoming more widely used and accepted as many of these issues are being addressed [12]. Technology rarely regresses, and it may be a fair assumption that this trend of increased use of robotic surgery will continue, further confirming the importance of a general surgery program to have an effective robotic surgery curriculum.

This study has several limitations, but a major limitation is that the survey data if from our single institution over a short time course with a small sample size of residents. In addition, the survey was only conducted using a limited number of questions with limited analysis. Only time will tell if our curriculum is successful on the long term and that will be dependent on both faculty and resident engagement which is currently very high. Our institution has a busy minimally invasive robotic surgery practice, making a robotic curriculum relatively easy to incorporate, and we recognize that other programs, especially other community rural programs, may not have this ability to reproduce our results. However, we do believe with the increasing prevalence of robotic general surgery procedures, programs do have an obligation to at least introduce their trainees to this technology.

Conclusion

There are many benefits of rural surgical training, and it is an important component of our healthcare system as they provide an invaluable resource for care to rural communities with limited access [13]. The training residents are integral to this access issue, as many of them go on to practice in rural areas. We believe that a community rural general surgery program can effectivity incorporate a voluntary robotic curriculum into their training program and teach residents to be safe and effective with the technology. Furthermore, we also believe that it is the responsibility of rural general surgery programs, to at least familiarize their residents with these newer technologies as they may be vital to their future practice.

Compliance with ethical standards

Conflict of interest William Krause WD and Julio Brid MD declare that they have no conflict of interest.

Ethical standards All procedures followed were in accordance with the ethical standards of the responsible committee on human experimentation (institutional and national) and with the Helsinki Declaration of 1975, as revised in 2000 (5).

Informed consent Informed consent was obtained from all patients for being included in the study.

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