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Adoption of robotics in a general surgery residency program: at what cost?

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ABSTRACT

Background: Robotic technology is increasingly being utilized by general surgeons. However, the impact of introducing robotics to surgical residency has not been examined. This study aims to assess the financial costs and training impact of introducing robotics at an academic general surgery residency program.

Methods: All patients who underwent laparoscopic or robotic cholecystectomy, ventral hernia repair (VHR), and inguinal hernia repair (IHR) at our institution from 2011-2015 were identified. The effect of robotic surgery on laparoscopic case volume was assessed with linear regression analysis. Resident participation, operative time, hospital costs, and patient charges were also evaluated.

Results: We identified 2260 laparoscopic and 139 robotic operations. As the volume of robotic cases increased, the number of laparoscopic cases steadily decreased. Residents participated in all laparoscopic cases and 70% of robotic cases but operated from the robot console in only 21% of cases. Mean operative time was increased for robotic cholecystectomy (+22%), IHR (+55%), and VHR (+61%). Financial analysis revealed higher median hospital costs per case for robotic cholecystectomy (+\$411), IHR (+\$887), and VHR (+\$1124) as well as substantial associated fixed costs.

Conclusions: Introduction of robotic surgery had considerable negative impact on laparoscopic case volume and significantly decreased resident participation. Increased operative time and hospital costs are substantial. An institution must be cognizant of these effects when considering implementing robotics in departments with a general surgery residency program.

Introduction

General surgery is the fastest growing specialty in the use of robot-assisted surgery (RAS) with approximately 140,000 operations performed in 2015, 31% more than in 2014.[1] With its growing popularity, there have been many studies investigating both the outcomes and costs of RAS *versus* both laparoscopic and open surgery, with fairly consistent findings of similar results at a higher cost.[1-4] The increased cost of RAS is due to the direct costs of the robotic surgery system as well as increased operative time. Most studies evaluating costs do not take into account the opportunity cost of that

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time or the value of the best alternative use of the excess operative time.[5]

Although all institutions strive to provide the best care and do well financially, those with general surgery residency programs also have the responsibility of training future surgeons. There has been concern in recent years that graduates of general surgery residency programs are not adequately prepared to operate and practice independently.[6,7] Time for hands-on learning has become increasingly scarce with duty hour restrictions limiting the time residents spend operating. Although the financial costs of RAS have been studied extensively, its effects on surgical training have not been examined. The aims of this study were to determine the financial costs and educational impact of introducing RAS at an academic general surgery residency program.

Patients and methods

Patients

All patients undergoing laparoscopic or robotic cholecystectomy, inguinal hernia repair (IHR), or ventral hernia repair (VHR) between January 1, 2011 and December 31, 2015 were identified from our institutional clinical data repository. Institutional Review Board (IRB#18801) approval was granted for this study. Operative approach (laparoscopic *versus* robotic), operative time, and resident participation were evaluated. The robot was introduced into our general surgery residency program in July 2013 with standard procedures for beside-assist and console certification for residents required prior to participating in robotic operations. These protocols include hands-on and didactic robot education sessions, completion of 10 modules on the training robot, five bedside-assist cases, and five mentored console cases. All robotic operations during the study period were performed by two attendings. Resident participation for each case was obtained by anonymous survey with 100% participation.

Cost analysis

Financial data were obtained from our institutional clinical data repository for the total hospital cost associated with each operation. Opportunity costs were calculated by multiplying per-minute operating room cost, the average difference in case duration, and the number of cases performed for each type of operation. Total hospital costs were adjusted to 2015 dollars using medical-specific inflation from the Inpatient Prospective Payment System estimations from Medicare.

Statistical analysis

The primary outcomes were case volume and resident participation in procedures over time between the laparoscopic and robotic groups. Secondary outcomes included total hospital costs and opportunity cost between the groups. Statistical analyses were performed using appropriate parametric and nonparametric tests to determine statistical differences. SAS, version 9.4, (SAS Company, Cary NC) was used for analyses.

Results

Case volume over time

A total of 2391 cases were evaluated over a 5-y period, with 162 of those being performed robotically. Figure illustrates the trend in case volume between the groups. Prior to the introduction of robotic surgery, there was a gradual decline in the volume of laparoscopic cases with a slope of −6.3; however, after July 2013, there was an inflection point with a new trajectory at the slope of −30.9 with the gradual rise in robotic volume ($P < 0.0001$).

Further evaluation of resident participation reveals a major disparity in trainee involvement seen in Table 1, with less than 20% of robotic cases being performed primarily by trainees. In addition, laparoscopic cholecystectomy and hernia repairs would typically be performed by junior residents at

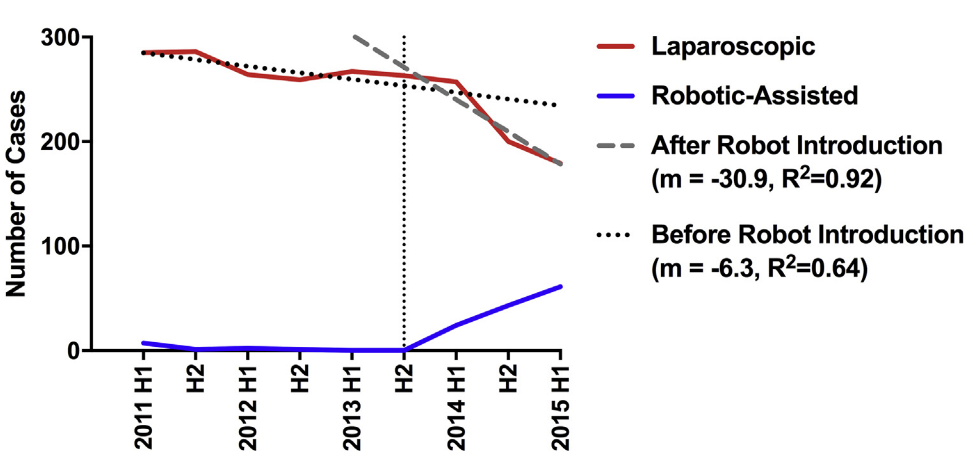

Figure – Case volume over time. The figure demonstrates volume over time (each half year [H]) for laparoscopic (red) and robotic cases (blue). Initial slope (m = −6.3, dotted line) demonstrates inflection point to introduction of RAS (m = −30.9, dashed). (Color version of figure is available online.)