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Does implementing a general surgery residency program and resident involvement affect patient outcomes and increase care-associated charges?

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ABSTRACT

Background: Variable results regarding general surgery residency program (GSRP) impact on patient outcomes and charges are reported. The aim of this study was to determine any significant differences in patient outcomes and cost with a new GSRP.
Methods: We analyzed all laparoscopic appendectomies (lap-ap), cholecystectomies (lap-chole), and inguinal hernia repairs (IHR) performed before and after implementing a GRSP.
Results: Operative time significantly increased for lap-ap ($p < 0.0001$), lap-chole ($p < 0.0001$) and IHR ($p = 0.03$). Time to close the incision significantly increased for lap-ap ($p < 0.0001$), lap-chole ($p = 0.006$) and IHR ($p = 0.03$). Length of stay only increased for lap-ap ($p = 0.04$). Complication rates did not increase for any procedure. However, charges significantly increased for lap-ap ($p < 0.0001$), lap-chole ($p < 0.0001$), and IHR ($p = 0.03$).
Conclusions: Although a newly implemented GSRP caused increases in overall operative times, times to close incisions, and charges, it did not negatively impact patient outcomes.

1. Introduction

Performing surgery is an imperative component of surgical education. Along with this long-term educational benefit, surgical residencies also raise concern about increasing hospital charges and/or diminishing quality of patient care due to the residents' inexperience. To address these issues and to ensure the best patient outcomes, much recent medical literature has been devoted to improving general surgery residency programs (GSRP). The focus of these studies has been to improve specific methods of operative training and educational techniques.[1,2]

There are far fewer studies that address the financial impacts of the surgical training programs. Existing data pertain mainly to non-surgical residencies and present widely varied results. It has been shown that the implementation of an Emergency Medicine Residency Program (EMRP) may result in decreased charges.[3] It has also been demonstrated that Family Medicine Residency Programs (FMRP) can cause hospital charges to slightly exceed revenues. This observation, however, is largely inconclusive because charge outcomes were shown to depend largely on FMRP quality and mean patient outcome.[4] From a surgical standpoint, it has been observed that operative times of otolaryngology procedures significantly increase when residents are present. This increase in operative times translated to several hundred additional dollars charged per case.[5] Conversely, it was also observed that the presence of an orthopedic surgery training program does not negatively impact arthroplasty outcomes.[6] Numerous other studies investigating the health charges and implications of training programs for various other surgical specialties also show that such programs do not adversely affect patient care.[7–10] Not all current literature, however, yields the same positive conclusion about surgical education. Some papers have shown that hands-on training can be detrimental to patient outcomes.[11]

These widely varied results demonstrate that the care-related charges of a residency program are largely inconclusive and depend mainly upon specialty. Thus, no valid conclusions can be drawn about the charges of a training program in a specialty where there is little related literature. The data pertaining to the care-related and financial charges of implementing a GSRP are extremely scarce and examine only explicit charges.[12,13] Therefore,

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no accurate conclusion can be drawn regarding the care-related charges of a GSRP. In order for an accurate analysis to be done, data must be collected using both general and specific metrics for breadth and depth.

2. Methods

After IRB approval, data were collected from the General Surgery Department at Cleveland Clinic Florida (CCF) 11 months prior and 11 months after instituting a GSRP. All primary laparoscopic appendectomies (lap-ap), laparoscopic cholecystectomies (lap-chole), and inguinal hernia repairs (IHR) during this time period were evaluated. These basic procedures were included as they are operations traditionally performed by residents under staff supervision and with staff assistance. Operations from August 2011 through July 2012 (prior to GSRP) were the pre-residency group (pre-RG) while procedures performed between July 2012 and June 2013 (with GSRP) in which a resident participated were the post-residency group (post-RG), where residents participated in the procedure. In all instances, the residents were the surgeons supervised and assisted by staff surgeons. Patients who had undergone surgery within two weeks prior to the date of the index operation and/or who underwent a synonymous procedure were excluded. There were no changes to nursing or other protocols. The groups were compared within each operation by the following metrics:

1. *Operative time (OT):* The mean OT in pre-RG and post-RG were separately calculated. The two means were then compared to determine the impact of the GSRP on OT.
2. *Time to close incision:* Closing the incision is the portion of any operation in which surgical residents are most consistently involved. Therefore, any increase in OT with the GSRP would most likely be correlated to an increase in closing time. The mean closing times (CT) in the two groups were separately calculated. The two means were then compared.
3. *Length of stay in hospital (LOS):* A major contributor to hospital charges that is largely affected by surgical outcomes is LOS. Thus, any impact of the GSRP on surgical outcomes would also impact LOS.
4. *Complication rate (CR):* An effective metric for assessing the quality and charge of an operation is postoperative complication rate. The postoperative complication rates of pre-RG and post-RG were separately calculated. The events classified as "complications" included readmission to the emergency room (ER) and/or reoperation within 30 days. Only these metrics were used as complications because they are the most consistently measured and most directly related to operation quality. Also, failed laparoscopies and cholangiograms were included as additional indicators of operative success.
5. *OR time monetary charges:* To more accurately understand the financial implications of any change in OT between the two groups, the difference in OT was converted to a difference in charge. Using the hourly OR charge at CCF, the per minute charge was derived (average charge of 1 h in OR undergoing surgery is $11,728.00, an average of $195.47 per minute. This monetary value was then applied to the difference between pre-RG and post-RG for each operation to find the difference in operative charge with a GSRP. Calculated prices were not adjusted for inflation since all final charges were derived from the same initial per hour value in the OR. The new GSRP included six first year, 6 s year, three third year, and three fourth year trainees. Unfortunately, cost data were unavailable.

The first four aforementioned variables (OT, CT, LOS, and CR) provide general information of a GSRP on care-related outcomes. The fifth metric translates care-quality into a specific monetary value that can be quantified to estimate the charge of a GSRP. For all variables, the null hypothesis (H_0) was that the GSRP has no impact. We did not undertake any subgroup analyses to compare outcomes among residency years and/or to evaluate any changes in results during individual residency years.

2.1. Data collection

The data for this retrospective study were collected from the IRB approved CCF Department of General Surgery database. Data were recorded in a Health Insurance Portability and Accountability Act (HIPAA)-compliant manner.

2.2. Statistical analysis

The sample size equals the population for this study to ensure the greatest possible statistical accuracy; data were collected from June 2013 through July 2013.

Statistical analysis was performed with SAS software version 9.2 (SAS Institute, Cary, NC, USA). Categorical variables were analyzed with Fisher's exact test, and continuous variables were analyzed with Wilcoxon test, reported either by mean ± standard deviation (SD) or median (range).

3. Results

3.1. Demographics

The pre and post RG populations included 437 patients and 430 patients, respectively. As shown in Table 1, the two groups who underwent lap-ap were similar in both size and demographic composition. The 112 patients in pre-RG and the 108 patients in post-RG each consisted of approximately half females and half males (±5.36%), had a mean body mass index (BMI) of 27 kg/m^2, and had an equal American Society of Anesthesiologist (ASA) classification within 0.16 units. The ASA class distributions were similar, with post-RG having 16% more ASA 1 patients and 16% less ASA 2 patients. The mean age of the population in post-RG was 4.3 years younger than in the pre-RG. Demographic similarities also existed in both groups for laparoscopic cholecystectomies. As illustrated in Table 2, pre-RG and post-RG consisted of 228 and 214 lap-chole, respectively. The two populations each had nearly 47.7%

Table 1
Summary of laparoscopic appendectomies. Values are summarized as N (%), mean ± standard deviation (SD) or median (range). BMI: body mass index; ASA: American Society of Anesthesiologist Score.

Laparoscopic appendectomies	Pre-RG	Post-RG	*P* value
Number of patients	112 (50.9)	108 (49.1)	
Gender			0.05
Males	51 (55.4)	54 (50)	
Females	61 (44.6)	54 (50)	
Age (yrs)	42.6 ± 15.8	38.2 ± 15.8	0.05
BMI (kg/m^2)	27.2 ± 5.9	26.7 ± 5.5	0.48
ASA I	27 (24.1)	43 (39.8)	0.05
ASA II	72 (64.3)	53 (49.1)	
ASA III	13 (11.6)	12 (11.1)	
Operative time (min)	36.4 ± 11.8	46.9 ± 18.8	<0.0001
Closing time (min)	12.0 ± 4.1	14.3 ± 4.9	<0.0001
Length of stay (hrs)	33.8 (7.8–260)	39.8 (6.9–250)	0.04
Readmission	8 (7.1%)	11 (10.2%)	0.48
Charges ($)	7111.9 ± 2313.5	9170.8 ± 3672.6	<0.0001

of operations with intraoperative cholangiograms (±2.06%), a mean age of exactly 50 years, a mean BMI of exactly 29 kg/m^2, a mean ASA classification of 2 (±0.11 units), a similar ASA class distribution (error ≤ 4.9% for each class), and a roughly 2/3 to 1/3 female to male ratio. Such characteristic parallels also extended to IHR. As shown in Table 3, the 97 hernia repair patients in the pre-RG and the 108 in the post-RG had very similar percentages of unilateral and bilateral repairs (±5.91%) as well as laparoscopic and open operations (±7.52%). Additionally, the two pools had mean ages only 2 years apart, mean BMIs that were within 1 kg/m^2, nearly equal mean ASA classifications (±0.09 units), similar ASA class distributions (error ≤ 6.52% for each class), and approximately 95% male populations.

3.2. Procedural charges

Lap-ap in the post-RG took, required a mean, of 10.5 min longer per appendectomy, which translated to an additional $2060.25 in charges per patient. Lap-chole in post-RG took, on mean, 11.0 min longer per cholecystectomy, resulting in a $2154.08 charge increase. IHR in post-RG took, on average, 4.3 min longer per hernia repair, resulting in an additional $832.70 in charges per patient.

3.3. Comparison of outcomes

The operative time (OT): There was an increase from pre-RG to post-RG in each operation. These increases were statistically significant in lap-ap (+10.54 min, p < 0.0001), lap-chole (+11.02 min, p < 0.0001) and IHR (+4.26 min, p = 0.03).

Time to close incision: There was also an increase from pre-RG to post-RG in lap-ap (+2.24 min, p < 0.0001), lap-chole (+1.28 min, p = 0.006) and IHR (+0.84 min, p = 0.03).

Length of stay (LOS): There was a significant change from pre-RG to post-RG in the lap-ap (p = 0.04), but not in the lap-chole (p = 0.89) and IHR (p = 0.09).

Complication rate (CR): The rates were not significantly different between the two groups for lap-ap (p = 0.48), lap-chole (p = 0.22), or IHR (p = 0.45).

Charges: Increased charges included $2060.25 (16.1%) in lap-ap (p < 0.0001), $2154.08 (14.9%) in lap-chole (p < 0.0001), and $832.70 (5.3%) in IHR (p = 0.03) from pre-RG to post-RG. These figures translate to increases in charges, respectively. Although statistically significant, we do not feel that these increases were clinically meaningful.

Table 2
Summary for laparoscopic cholecystectomies. Values are summarized as N (%), mean ± standard deviation (SD) or median (range). BMI: body mass index; ASA: American Society of Anesthesiologist Score; IOC: intraoperative cholangiogram.

Laparoscopic cholecystectomies	Pre-RG	Post-RG	*P* value
Number of patients	228 (51.6)	214 (48.4)	
Gender			
Males	79 (34.6)	83 (38.8)	
Females	149 (65.3)	131 (38.8)	0.38
Age (yrs)	49.8 ± 14.7	497 ± 15.5	0.91
BMI (kg/m^2)	28.7 ± 6.1	29.1 ± 5.8	0.17
ASA			0.29
I	28 (12.3)	32 (15.4)	
II	140 (61.7)	133 (63.9)	
III	58 (25.6)	43 (20.7)	
IV	1 (0.4)	0	
Number of IOC	104 (45.6)	102 (47.7)	0.78
Operative time (min)	49.4 ± 15.6	60.4 ± 20.9	<0.0001
Closing time (min)	12.6 ± 4.5	13.9 ± 5.1	0.0006
Length of stay (hrs)	30.8 (4.5–215.9)	31.2 (5.15–201.1)	0.89
Reoperation	5 (2.2)	1 (0.5)	0.22
Complications	15 (6.6)	17 (7.9)	0.22
Readmission	5 (2.2)	9 (4.2)	0.28
Charges ($)	9647.5 ± 3043.6	11,801.3 ± 4097.6	<0.0001

Table 3
Summary for inguinal hernia repairs. Values are summarized as N (%), mean ± standard deviation (SD) or median (range). BMI: body mass index; ASA: American Society of Anesthesiologist Score.

Inguinal hernia repairs	Pre-RG	Post-RG	*P* value
Number of patients	97 (47.3)	108 (52.7)	
Gender			0.18
Males	95 (97.9)	101 (93.6)	
Females	2 (2.1)	7 (6.5)	
Age (yrs)	55.3 ± 16.1	56.6 ± 16.4	0.80
BMI (kg/m^2)	26.7 ± 3.8	26.4 ± 3.9	0.36
ASA			0.33
I	18 (18.6)	14 (12.9)	
II	58 (59.8)	68 (62.9)	
III	20 (20.6)	24 (22.2)	
IV	1 (1.0)	2 (1.9)	
Side			0.29
Unilateral	76 (78.4)	91 (84.3)	
Bilateral	21 (21.7)	17 (15.7)	
Approach			0.33
Laparoscopic	43 (44.3)	56 (51.9)	
Open	54 (55.7)	52 (48.2)	
Operative time (min)	61.9 ± 17.8	66.2 ± 18.4	0.03
Closing time (min)	12.6 ± 6.4	13.5 ± 5.5	0.13
Length of stay (hrs)	8.7 (4.9–125)	9.0 (5.7–160)	0.09
Complications	3 (3.1)	7 (6.5)	0.45
Readmission	2 (2.1)	5 (4.6)	0.45
Reoperation	1 (1.0)	0	0.47
Charges ($)	12,105.0 ± 3488.0	12,939.0 ± 3591.7	0.03

4. Discussion

Surgical education programs are necessary to train surgeons. While this scholarly benefit for the trainees is indisputable, the performance of surgery by trainees may affect hospital charges and quality of care. Both of these factors have become even more pressing to healthcare providers since the Affordable Care Act implemented a value-based purchasing system that translates diminished quality of care into reduced compensation.[14] In an effort to help settle this controversy, this study aimed to investigate the effect of instituting a GSRP on care-related charges.

Patient demographics were similar between the groups. In accordance with prior publications, the results were somewhat mixed.[15–17] Although the GSRP was associated with a significant increase in operative time and time to close each of the 3 operations, and an increased length of stay for lap-ap, there was no increase in the complication rate. Logic might suggest that these increases in OT stem from an elongation of the portion of an operation in which residents are the primary surgeons closing an incision. The results, however, only partially agreed with this hypothesis. Lap-ap, lap-chole, and IHR had an increase in closing time that corresponded to an increase in OT. An extended operation can, thus, only partially be attributed to residents' inexperience closing incisions. Other outside factors such as more hands-on resident involvement in the operation or pauses by the attending for didactic explanation must also play a role.

While the study showed an adverse effect of the GSRP's on time in the OR, its results for operative quality were unequivocal. The presence and participation of residents in the OR did not affect complication rate, and only increased LOS in the lap-ap. These outcomes indicate that the institution of a GSRP did not adversely impact patient quality of care.

The GSRP did, however, cause an increase in the charges for each operation due to increased OT. The program brought significant increases of $2060.25 for lap-ap, $2154.08 for lap-chole and $832.70 for IHR. However, since payment may be based upon contractual agreements, increased charges may not result in an increased financial burden to the patient or to the payer. Instead they represent a commitment by the healthcare facility and its surgical faculty to dedicate additional time and resources to provide education to trainees.

These mixed quality of care results are largely in accordance with present literature. Numerous studies across various surgical disciplines also demonstrated increased OT with no change in complication rate or LOS when residents were present.[8,18–20] Similarly, other data investigated only patient outcomes and concurred that training programs do not negatively affect quality of care. Some studies even showed that the presence of residents reduces complications and morbidity.[21]

While there are extensive data to support the results of this study, some investigations have yielded contrary findings. Several studies have shown that trainees' participation in operations does, in fact, increase complication rates in various surgical specialties.[22,23] These studies, however, refer largely to programs other than general surgery.

Recently, Kasotakis et al.[24] utilized the American College of Surgeons National Surgery Quality Improvement Program (ACS NSQIP) database to analyze emergency surgeries in academic institutions and reported that resident's involvement was a predictor for adverse outcomes, though mortality was not affected. In contrast to this publication, in our analysis both groups' demographics were similar, cases were elective and adequately supervised, and most importantly we analyzed objective variables associated with the procedure and that can be impacted by resident's participation. In our study, residents impacted closure time as well and charges but did not affect mortality or morbidity rates.

Ultimately, a training program's impact on care-related charges depends largely on specialty and program quality. When reviewing the results of this study in conjunction with other data, it can be concluded that proper implementation of a GSRP causes a slight increase in OT without adversely affecting quality of care. The rise in OT also translates to a slight appreciation in procedural charges of up to 16%. Surgical residents have correlated to physician satisfaction[25] in addition to higher rates of research.[26]

Not only do surgical residencies bring these hospitals benefits as well as explicit educational advantages, but they also are requisite to train surgeons. In 2014, clinical and physician spending in the United States is expected to grow at 8.9% because of Medicare coverage expansions. From 2015 through 2020, that spending is expected to increase at a mean annual rate of 5.6%.[27] Additionally, the United States' population 65 years and older is projected to grow 4% in the next decade.[28] This increased physician spending and aging population indicates that a sharp increase in demand for physician and surgical services will occur in the next 10 years. This demand must be met by an increase in supply and productivity of surgeons. This rise in the supply of well-trained surgeons can only occur from hospitals' surgical training programs.

Simulation has played an increasingly important role in surgical education.[29] Simulation has been shown to improve performance, shorten "learning curves," and result in improved outcomes.[30–32] In addition, skills validation examinations such as Fundamentals of Laparoscopic Surgery (FLS) can also be used to help determine proficiency.[33–36]

The main limitations of this study include its retrospective nature, population size, and data collection time frame. Despite the two well-matched groups, the investigation still has the potential deficits of any retrospective study. Because the GSRP at CCF has only existed for 11 months, data may only be collected for the 11-month period prior to and after its institution. This limited timeline could possibly inhibit a certain degree of precision that could otherwise be ascertained from a longer duration study. Moreover, we only analyzed three of the many commonly performed basic surgical procedures. The results may have been different were more complex procedures included. Furthermore, the use of costs rather than charges could have been more useful. In addition, tracking any changes in these results during each residency year and comparing variables among years could have been interesting. Follow-up research with a larger time frame, more comprehensive case inclusion, and possible multi-institutional involvement would be needed to validate these results.

5. Conclusions

The introduction of a GSRP caused an increase in the OT of some general surgery operations that translated to increased charges but did not adversely impact patient outcomes.

Disclosure information

None of the authors have any relevant financial disclosures.

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