

Effect of Resident Involvement on Operative Time and Operating Room Staffing Costs [☆]

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OBJECTIVE: The operating room (OR) is a major driver of hospital costs; therefore, operative time is an expensive resource. The training of surgical residents must include time spent in the OR, but that experience comes with a cost to the surgeon and hospital. The objective of this article is to determine the effect of surgical resident involvement in the OR on operative time and subsequent hospital labor costs.

DESIGN: The Kruskal-Wallis statistical test is used to determine whether or not there is a difference in operative times between 2 groups of cases (with residents and without residents). This difference leads to an increased cost in associated hospital labor costs for the group with the longer operative time.

SETTING: Cases were performed at Greenville Memorial Hospital. Greenville Memorial Hospital is part of the larger healthcare system, Greenville Health System, located in Greenville, SC and is a level 1 trauma center with up to 33 staffed ORs.

PARTICIPANTS: A total of 84,997 cases were performed at the partnering hospital between January 1st, 2011 and July 31st, 2015. Cases were only chosen for analysis if there was only one CPT code associated with the case and there were more than 5 observations for each group being studied. This article presents a comprehensive retrospective analysis of 29,134 cases covering 246 procedures.

RESULTS: The analysis shows that 45 procedures took significantly longer with a resident present in the room. The average increase in operative time was 4.8 minutes and the cost per minute of extra operative time was determined

to be \$9.57 per minute. OR labor costs at the partnering hospital was found to be \$2,257,433, or \$492,889 per year.

CONCLUSIONS: Knowing the affect on operative time and OR costs allows managers to make smart decisions when considering alternative educational and training techniques. In addition, knowing the connection between residents in the room and surgical duration could help provide better estimates of surgical time in the future and increase the predictability of procedure duration. (J Surg Ed ■■■-■■■. © 2016 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

KEY WORDS: surgical resident, training, operative time, staffing costs

COMPETENCY: Systems-Based Practice

INTRODUCTION

Operating room (OR) time is a very expensive yet precious resource in every hospital. In teaching hospitals, programs must provide resident surgeons adequate OR experiences so that they may be qualified after their residency program. One item worth noting is that the resident's surgical experience is primarily a cost that is owned by the attending surgeon.^{1,2} Although the increase in operative time because of resident training is an inherent inefficiency in the OR, it is also a necessity in improving outcomes performed by resident surgeons.¹ Knowing the effect of resident training on operative time and the effect of increased operative time on hospital costs allows management to better understand and potentially address financial and educational opportunities at a teaching hospital.³ Such educational opportunities could include exploring the need for a surgical simulator as a possible alternative to operative training.^{4,5}

The "time cost" of resident training has been well studied in the past, but primarily for large volume cases or specialty procedures. Babineau et al.¹ studied 4 common surgical procedures (hernia repair, laparoscopic cholecystectomy, carotid endarterectomy, and partial colectomy) and found

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that there is an increased “time cost” associated with the training of surgical residents with each. Hwang et al.⁶ found OR time was significantly longer in patients with common procedures (laparoscopic appendectomy, open appendectomy, laparoscopic cholecystectomy, mastectomy, and elective colon resection) involving residents. Kazzaure et al.⁷ found similar results for cholecystectomy, appendectomy, and hernia repair. They also report that the presence of a resident also increases complication rates. Lee et al.⁸ found that operative times and costs were significantly higher when procedures (appendectomy, gastrotomy, and inguinal hernia repair) were performed by a resident. Sasor et al.² found that resident participation significantly affects cleft lip repair and palatoplasty. Shabtai et al.⁹ concluded that resident involvement resulted in an increase in surgical times for laparoscopic appendectomies. Chamberlain et al.¹⁰ showed that the mean OR time was increased for nearly all mastectomy cases involving residents. Similarly, Von Strauss et al.¹¹ concluded that resident training increased operative time for laparoscopic cholecystectomies, and Puram et al.³ found that resident participation increases procedure length for pediatric otolaryngology cases.

The effect of resident experience on operative times has also been researched in the past, but with varying results.

Advani et al.¹² noted that regardless of the resident year, resident involvement resulted in not only increased operative time and but also occasional complications for uncomplicated laparoscopic appendectomies. Hosler et al.⁴ showed that resident experience was an important factor for length of procedure for resident training programs. Kim et al.¹³ also showed that resident experience was correlated with longer operative times, but no difference in complication rates for open and laparoscopic appendectomies. In contrast, Papandria et al.¹⁴ showed that resident participation was associated with higher operative times with no difference between junior and senior level experience for laparoscopic appendectomy, laparoscopic cholecystectomy, and inguinal hernia repair. Wang et al.¹⁵ found that resident post graduate year (PGY) does not affect operative time in performing laparoscopic cholecystectomies.

Although a lot of research shows that operative times increase when residents are involved, those articles tend to look only at a handful of procedures. Those procedures are usually picked for analysis because either those procedures are longer when a resident is involved or those procedures are the highest volume cases. There is far less research that addresses a broader set of cases when assessing the effect of resident training. The last study known to the authors was completed by Bridges and Diamond¹⁶ in 1999 and was a review of 62 case categories. This article considers 246 procedures and aims at presenting a comprehensive statistical analysis of the affect of resident involvement on operative time and hospital costs at Greenville Memorial Hospital, a level 1 trauma center in Greenville, SC.

This study was reviewed and approved by Greenville Health System’s Institutional review board (Pro00048253) under an expedited review because the study poses no more than minimal risks to participants.

MATERIALS AND METHODS

Retrospective case data from January 1, 2011 to July 31, 2015 was used to identify the effect of resident involvement on operative time. Data were collected using existing data collection methods at the partnering hospital. Staff roles data were used to determine the personnel in the room during the surgery and is recorded by the circulating nurse in the room. These data also indicated to which group (with resident or without resident) the data point belonged. Operative times for the procedure were also collected using existing methods. Milestone data are recorded by the certified registered nurse anesthetist (CRNA) as milestones occur during the surgery. In our case, operative time refers to the time that is documented between procedure start (incision) and procedure finish (patient is closed and dressings are put on). Both roles and process related data collection methods are well established and highly accurate. The data collected are also spot-checked for quality purposes and is used by the perioperative services billing department. Thus, the level of data integrity is high, and this enabled us to safely use the information for research purposes.

A total of 84,997 cases were performed between the dates above, and 49,143 of those cases were performed with at least one resident present. Cases with only one current procedure terminology code were used to reduce confounding effects of case and patient complexity. This reduced the set of cases to 44,280. Of those cases, 251 specific procedures were picked for analysis if and only if the procedure had at least 5 observed cases in each group (with resident and without resident). Some operative procedures were performed solely with or without residents; therefore, at least 5 cases were needed for each group to facilitate the Kruskal-Wallis statistical test. We use the Kruskal-Wallis statistical test to determine whether or not the 2 observed groups are from different populations. Operative times are known to be a better fit of the log normal distribution; hence, the use of student *t*-test is not recommended.¹⁷ In addition, the data fail to conform to the assumptions of analysis of variance.

Case acuity was checked to determine variance of case complexity. Case acuity between groups was not a significant factor. In fact, 184 of the 251 procedures (or 73% procedure types) had the same acuity for every case. Of the cases where acuity was different, those differences were not statistically significant. Overall, the average acuity for the group with residents was smaller than the average acuity for the group without residents. This means that cases were more complex on average when a resident was not present.

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