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Put me in the game coach! Resident participation in high-risk surgery in the era of big data

Adrienne N. Cobb, MD,[a,b,*] *Emanuel Eguia, MD,*[a,b] *Haroon Janjua, MS,*[a,b] *and Paul C. Kuo, MD*[b,c]

[a] *Department of Surgery, Loyola University Medical Center, Maywood, Illinois*
[b] *Department of Surgery, One:MAP Section of Surgical Analytics, Loyola University Chicago, Maywood, Illinois*
[c] *Department of Surgery, University of South Florida, Tampa, Florida*

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ABSTRACT

Background: With the emphasis on quality metrics guiding reimbursement, concerns have emerged regarding resident participation in patient care. This study aimed to evaluate whether resident participation in high-risk elective general surgery procedures is safe.

Materials and methods: The American College of Surgeons National Surgical Quality Improvement Program database (2005-2012) was used to identify patients undergoing one of five high-risk general surgery procedures. Resident and nonresident groups were created using a 2:1 propensity score match. Postoperative outcomes were calculated using univariate statistics and multivariable logistic regression for the two groups. Predictors of mortality and morbidity were identified using machine learning in the form of decision trees.

Results: Twenty-five thousand three hundred sixty three patients met our inclusion criteria. Following matching, each group contained 500 patients and was comparable for matched characteristics. Thirty-day mortality was similar between the groups (2.4% *versus* 2.6%; $P = 0.839$). Deep surgical site infection (0% *versus* 1.6%; $P = 0.005$), urinary tract infection (5% *versus* 2.5%; $P = 0.029$), and operative time (275.6 min *versus* 250 min; $P = 0.0064$) were significantly higher with resident participation. Resident participation was not predictive of mortality or complications, while age, American society of anesthesiologists class, and functional status were leading predictors of both.

Conclusions: Despite growing time constraints and pressure to perform, surgical resident participation remains safe. Residents should be given active roles in the operating room, even in the most challenging cases.

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* *Corresponding author.* One:MAP Surgical Analytics Fellow, Loyola University Medical Center, 2160 South 1st Avenue, Maywood, IL 60153. Tel.: +1 317 332 3417; fax: +1 708 216 9000.
E-mail address: adcobb@lumc.edu (A.N. Cobb).

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Introduction

Surgical residents want to operate. More importantly, surgical residents need to operate so they can obtain the skills necessary to succeed in independent practice.[1-3] The model of surgical education has traditionally been "see one, do one, teach one" with residents earning increasing amounts of autonomy as they progress through training and demonstrate increasing levels of competency. However, Bell *et al.*[1] found that the current operative experience of general surgery residents is insufficient preparation for graduating residents to have basic competency in procedures attending surgeons believe they should be able to perform independently. It is possible that the changing health care environment has led to increased pressure on attending surgeons to heighten productivity and efficiency and improve outcomes, which have negatively affected residents' operative experience.

Questions have circulated regarding whether the inclusion of residents in patient care remains safe. Despite being several years removed from Kohn's *To Err is Human*, many of the same concerns persist.[4] Patients are now equipped with information from the lay press regarding surgeon outcomes and information regarding the long hours worked by residents.[5-7] It is not uncommon for patients to ask surgeons if residents will be involved in their case.[8] While adjustments in duty hours sought to remedy these concerns, staff and trainees worry what the impact of reduced work hours may have on trainees' ability to practice independently.[9] A study that surveyed program directors demonstrated that many felt general surgery residents were not prepared to enter the workforce as independent surgeons following their 5 y of training.[10,11]

General surgery resident participation has been and continues to be an important topic of conversation and research in resident education, particularly with the more restrictive 80-h work week[12,13] and emphasis on quality metrics guiding reimbursement. Previous literature has shown that resident participation does not negatively impact patient mortality for common elective low-risk general surgery procedures.[14] The conclusions regarding morbidity have varied, suggesting that results may vary by procedure type.[15] Studies have examined several procedures across several specialties,[16-20] but less is known about high-risk general surgery procedures. Thus, this study primarily aimed to evaluate whether resident participation in high-risk elective cases remains safe. We hypothesize that patients who have surgery with resident participation have similar morbidity and mortality than those who do not.

Materials and methods

Data sources and patient selection

The National Surgical Quality Improvement Program (NSQIP) database (2005-2012) was used to identify patients undergoing one of six high-risk procedures: esophagectomy, open abdominal aortic aneurysm repair (AAA), laparoscopic paraesophageal hernia repair (PHR) with Nissen fundoplication, pancreaticoduodenectomy (Whipple), abdominoperineal resection (APR), and hepatectomy. NSQIP is the first validated, national, outcomes-based, risk-adjusted, performance-controlled platform for the measurement and subsequent improvement of medical health care delivery.[21] It is unique in that it allows for the direct evaluation of resident involvement while correcting for potential confounders. Additional information on American College of Surgeons (ACS) NSQIP data collection and practices has been described previously and can be accessed on the ACS NSQIP website (http://www.acsnsqip.org).These procedures were deemed high risk by the American College of Cardiology/American Heart Association guidelines for cardiac risk of noncardiac surgery.[22,23] We selected these procedures as a representative sample of more difficult, high-risk procedures that potentially imply decreased resident involvement. Procedures were identified using Current Procedural Terminology codes as displayed in Table SI. The institutional review board at our institution deemed this study exempt as the data are deidentified.

Patients over the age of 90 years and pregnant patients were excluded. We also excluded patients who had emergent procedures as we focused on elective cases. Because we were interested in the impact of resident participation, those cases that did not contain information regarding resident participation were also dropped. Patient selection criteria are shown in Figure 1.

Statistical analysis

Outcomes were compared for patients who had procedures with and without resident participation, with selected outcomes evaluated by postgraduate year (PGY). Junior residents were considered as PGY 1-2, senior residents as PGY 3, 4, and 5, and participants were considered fellows if they were PGY 6 or higher. Patient groups were created using a 2:1 propensity score match based on age, sex, race, morbidity probability, American Society of Anesthesiologists (ASA) class, surgical specialty, comorbidities, and type of procedure. We performed K-nearest neighbor matching with two neighbors using both caliper and radius. The 2:1 matching refers to the use of two propensity scores per patient for matching rather than matching two resident participation patients to one nonresident patient in the groups, which would have resulted in an imbalanced number between groups. Propensity score matching was used to minimize the effect of confounding due to nonrandom assignment of residents to procedures.

Descriptive statistics were used to evaluate the baseline patient characteristics prepropensity and postpropensity score matching. Chi-square tests and Student *t*-test were then used for categorical and continuous variables, respectively, in the unmatched cohort while McNemar and paired *t*-tests were used for matched groups. Medians with interquartile ranges (IQRs) were reported for both length of stay (LOS) and operative time throughout the analysis as they were not normally distributed. Comparisons were then made with the Wilcoxon rank sum test. The primary outcome of the study was 30-d mortality with the exposure being resident involvement. Secondary outcomes included a myriad of complications (superficial and deep surgical site infection [SSI], wound disruption, bleeding requiring transfusion, return to the operating