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# Impact of Residents on Surgical Outcomes in High-Complexity Procedures



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- BACKGROUND:** There are different views on the effects of resident involvement on surgical outcomes. We hypothesized that resident participation in surgical care does not appreciably alter outcomes.
- STUDY DESIGN:** We analyzed an American College of Surgeons NSQIP subset of inpatients having procedures with high complexity, including 4 surgical specialties (general surgery, cardiothoracic surgery, neurosurgery, and vascular surgery) with the highest mean work relative value units. We evaluated surgical outcomes in patients having procedures performed by the attending surgeon alone, or by the attending surgeon with assistance from at least one surgical resident (PGY1 to PGY $\geq$ 6). Outcomes measures included operative mortality, composite morbidity, and failure to rescue (FTR). Propensity-score matching minimized the effects of nonrandom assignment of residents to procedures.
- RESULTS:** In 266,411 patients, unmatched comparisons showed significantly higher operative mortality and composite morbidity rates, but decreased FTR, in operations performed with resident involvement. After propensity-score matching, there were small but significant resident-related increases in composite morbidity, but significant improvement in FTR. Senior-level resident involvement translated into improved outcomes, especially in cardiothoracic surgery procedures where >63.6% of procedures had PGY $\geq$ 6 resident involvement. Resident involvement attenuated the significant worsening of operative mortality and FTR associated with multiple serious complications in individual patients. Measures of resource use increased modestly with resident involvement.
- CONCLUSIONS:** We found substantial improvement in FTR with resident involvement, both in unmatched and propensity-matched comparisons. Senior-level resident participation seemed to attenuate, and even improve, surgical outcomes, despite slightly increased resource use. These results provide some reassurance about teaching paradigms. (J Am Coll Surg 2016;222:545–555. © 2016 by the American College of Surgeons. Published by Elsevier Inc. All rights reserved.)
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Disclosures outside the scope of the current work: Dr Ferraris has performed CME events for CMEology/Baxter Healthcare and is on the advisory board of the Acelity division of KCI. Dr Saha has performed a research trial for CVRx.

Disclaimer: American College of Surgeons NSQIP and the hospitals participating in the ACS NSQIP are the source of the data used herein; they have not verified and are not responsible for the statistical validity of the data analysis or the conclusions derived by the authors.

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The form and substance of resident engagement in surgical care changed dramatically during the last decade, especially with the advent of restricted duty hours. Reports surfaced that suggest benefit,<sup>1</sup> risk,<sup>2-4</sup> and no effect<sup>5-7</sup> from resident involvement with surgical patients. Neither teaching faculty nor the residents themselves seem happy with all of the changes that occurred. There is a suggestion that residents think they are unprepared for independent practice and, in most cases, teaching faculty agree.<sup>8-11</sup>

Because of divergent physician perceptions and conflicting literature reports, we wondered how resident involvement impacted surgical care, especially in high-complexity patients. If differences exist between procedures done with and without resident involvement, we

### Abbreviations and Acronyms

ACS = American College of Surgeons  
 FTR = failure to rescue  
 wRVUs = work-related relative value units

hypothesize that high-complexity procedures would be most likely to expose these differences. We used the American College of Surgeons (ACS) NSQIP database to identify patients with high complexity based on work-related relative value units (wRVUs). We selected the 4 surgical specialties with high wRVUs to obtain a high-complexity patient dataset. From this dataset, we assessed differences in operative mortality, morbidity, and failure to rescue (FTR) in procedures done with and without surgical resident involvement.

We were particularly interested in ability of residents to manage patients with complications, believing that duty hour limits and new teaching paradigms might have the biggest impact on the care of the sickest patients, especially those requiring constant bedside care, often after normal duty hours. Importantly, postoperative mortality that follows development of perioperative complications is termed *failure to rescue*, and several authors suggest that FTR rates reflect hospital and provider quality.<sup>12-15</sup> If resident involvement does alter surgical outcomes, we suspected that FTR might be a sensitive indicator of any resident-related benefit or deficit, if it exists.

## METHODS

### Study population

We used the ACS NSQIP database to identify patients having major operations with inpatient postoperative stays. The ACS NSQIP database contains patient deidentified information available to participants who sign and comply with the ACS NSQIP Data Use Agreement. The Data Use Agreement uses the data protections of the Health Insurance Portability and Accountability Act of 1996. We analyzed the ACS NSQIP participant use file containing surgical cases submitted by >300 acute care hospitals throughout the United States between 2008 and 2012. This database excludes trauma and pediatric patients. We excluded database patients with CPT codes listed as "procedure not otherwise specified" because of uncertainty about the type of procedures performed and because of the lack of associated wRVUs with the unspecified procedures. The study group included patients from the 4 surgical specialties in the database (ie, general surgery, cardiothoracic surgery, neurosurgery, and vascular surgery) with the high mean

total wRVUs. Additional exclusions from the analysis included patients with missing values in resident involvement database fields.

### Study design

We evaluated surgical outcomes in patients having procedures performed by the attending surgeon alone, or by the attending surgeon with assistance from at least one surgical resident (PGY1 to PGY>7). Outcomes measures included operative mortality, composite morbidity, and FTR. Propensity-score matching minimized the effects of nonrandom assignment of residents to procedures. Measurement of effect sizes of outcomes differences estimated the clinical importance of significant group differences. We used total wRVUs, as recorded in ACS NSQIP, as an index of operation complexity.<sup>16</sup>

### Outcomes measures

We analyzed outcomes recorded in ACS NSQIP, including mortality within 30 days of operation or within the same hospitalization, individual morbidities (1 or more of 7 serious adverse events defined by the ACS NSQIP), composite morbidity consisting of any combination of the 7 serious individual morbidities, and FTR defined as death after development of any of the following 7 serious complications:

1. Wound complications: deep organ space surgical site infection, deep surgical wound infection, and wound dehiscence;
2. Pulmonary complications: pneumonia, unplanned intubation, pulmonary embolism with deep vein thrombosis, or mechanical ventilation exceeding 48 hours;
3. Renal complications: acute kidney injury or new renal failure requiring dialysis;
4. Central nervous system complications: new postoperative transient ischemic attack, stroke, or coma;
5. Cardiac complications: postoperative myocardial infarction or cardiac arrest;
6. Sepsis: postoperative systemic inflammatory response syndrome, septic shock, or blood-borne sepsis; and
7. Unplanned return to the operating room within 30 days of the initial procedure.

### Statistical comparisons

Comparisons between operations done with and without resident involvement included assessment of differences in operative mortality, composite morbidity, FTR, resource use, and type of surgical specialty. Univariate statistics (chi-square and Student's *t*-test) assessed differences between outcomes with and without resident involvement.

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