

# Outcomes Registries: An Untapped Resource for Use in Surgical Education

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**OBJECTIVE:** To examine the American College of Surgeons National Surgical Quality Improvement Program (ACS NSQIP) for use in profiling the aggregated resident operative experience by postgraduate training year and to demonstrate the extent to which a surgical registry could be used to examine resident exposure to adverse events.

**BACKGROUND:** Independent data regarding the operative experience and clinical effectiveness across residency programs remain elusive. In the absence of reliable data, the ability to standardize surgical education and reduce variation in practice remains an unachievable goal.

**METHODS:** We identified general surgery cases using the ACS NSQIP Participant Use File 2011. Resident participation was defined according to postgraduate year (PGY). Descriptive statistical analyses were performed regarding procedure type and clinical outcomes.

**RESULTS:** Of the total general surgery cases, a PGY 1 to 5 resident participated in 87% (45,423), and 28% ( $n = 14,559$ ) were performed with PGY 5 residents. Interns were involved with 10% ( $n = 5,448$ ) of the cases. The type of procedures performed varied by PGY, but cholecystectomy was the most common. Overall, 11% (4,773) of cases were associated with an adverse event or mortality or both, with a mortality rate of 0.8% (374). The most common adverse event was bleeding (5%).

**CONCLUSIONS:** The ACS NSQIP captures the breadth of the resident experience in operative case mix and exposure to adverse events. Although the program was originally designed to uncover areas for quality improvement, the findings of our study demonstrate the utility of an

outcomes registry as a guide for the development of future educational content in the resident curriculum. (J Surg 72:264-270. © 2014 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights reserved.)

**KEY WORDS:** surgical resident, ACS NSQIP, training, resident, adverse event, procedure

**COMPETENCIES:** Patient Care, Practice-Based Learning and Improvement, Systems-Based Practice

## INTRODUCTION

Resident participation in surgical care is a double-edged sword. A balance between quality and education must exist to ensure the safe care of today's patients and the safety of surgical care provided in the future. The effects of resident involvement on direct patient outcomes are controversial and largely described in observational studies.<sup>1</sup> Some have demonstrated improved outcomes, such as reduced rates of failure to rescue, whereas others have suggested adverse results, such as increased complications and longer operative times.<sup>2,3</sup> Regardless of the study examined, residents seldom operate independently<sup>4,5</sup> and learn in a team environment that honors a graduated level of responsibility.

To date, board eligibility is, partly, reliant on residents' self-reported operative case logs.<sup>6</sup> Although dependence on resident reporting is necessary to ensure a minimum breadth and depth of experience, the accuracy of the case log system is not validated.<sup>7</sup> Furthermore, the resident fulfillment of the operative experience fails to inform us on the exposure to clinical experience in the management of postoperative occurrences or adverse events. The American College of Surgeons Quality In-Training Initiative (ACS QITI) recently introduced clinical outcomes reports for use in graduate surgical education.<sup>8</sup> Currently, these reports do not include comparative information on operative breadth and volume across institutions.

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There is a national effort to standardize the delivery of surgical care. As surgical practice patterns are learned during the residency period, understanding the variation in case progression by postgraduate year (PGY) of training and exposure to adverse events may help us begin to develop evidence-based training guidelines. The objectives of this study were to examine the ACS National Surgical Quality Improvement Program (ACS NSQIP) as a robust registry for use in profiling the aggregated resident operative experience by postgraduate training year and to demonstrate the extent to which a surgical registry could be used to examine resident exposure to adverse events.

## MATERIALS AND METHODS

Patients who underwent a general surgery operation with resident participation were identified for inclusion in the study from the ACS NSQIP Participant Use File (PUF) 2011 using common procedural terminology codes (Appendix A). Laparoscopic procedures were further categorized as basic or complex according to the Accreditation Council of Graduate Medical Education (ACGME) case log definition.<sup>9</sup> Laparoscopic basic operations included laparoscopic cholecystectomy and laparoscopic appendectomy. Laparoscopic complex cases included laparoscopic hernia repair, laparoscopic bariatric procedure, laparoscopic colectomy, and laparoscopic splenectomy.

The ACS NSQIP PUF 2011 includes data from 315 academic and community-based hospitals located around the United States.<sup>10</sup> A trained surgical clinical reviewer collects data on 252 variables, including patient demographics and comorbidities, resident participation, and 30-day postoperative morbidity and mortality outcomes. Patients aged 18 years or older undergoing major surgical procedures (both inpatient and outpatient) are included using an 8-day cycle sampling procedure. All variables collected in the ACS NSQIP are predefined in the NSQIP PUF 2011 user guide.

Resident participation in the care of the surgical patient was determined using the PGY as assigned in the PUF. For each operation, the surgical clinical reviewer assigned the PGY of the highest level resident who scrubbed in for the case.<sup>11</sup> The American Board of Surgery requires that residents complete a minimum of 5 years of progressive residency education for general surgery, with at least 48 weeks of full-time clinical activity a year with an option for an educational hiatus.<sup>6</sup> In many programs, residents may opt for additional academic and research times during their training; however, these are not counted toward the clinical time. In addition, a significant number of residents go on to complete advanced training beyond residency (i.e., fellowships). Therefore, although we included all cases where the PGY level was known, the procedure-specific analyses only included data for residents classified as PGY 1 to 5 to minimize misclassification of fellows as residents.

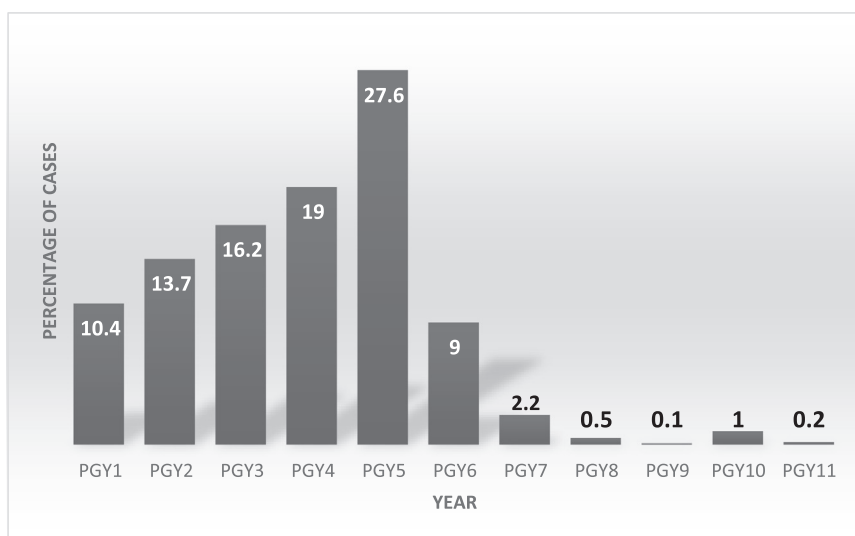
For the purposes of describing the rate of adverse events by PGY, patients were classified by the presence or absence of any adverse event (morbidity) and 30-day mortality. Postoperative adverse events of interest included superficial surgical site infection (SSI), deep SSI, organ space SSI, fascial dehiscence, sepsis, renal failure, deep vein thrombosis, pulmonary embolism, pneumonia, intubation for more than 48 hours or reintubation, bleeding, stroke, coma, myocardial infarction, and cardiac arrest requiring resuscitation.

Descriptive statistics were performed regarding procedure type and adverse events by PGY. All analyses were performed using Stata, version 12.1 (StataCorp, College Station, TX). This study was deemed exempt from continuing review by the University of Pennsylvania Institutional Review Board.

## RESULTS

We identified 52,257 patients who underwent a general surgical operation with resident participation. Figure 1 depicts the percentage of cases covered by each PGY. Of these 52,257 general surgery cases, a PGY 1 through 5 resident participated in 87% (45,423). Cases including PGY 5 residents were the most common in this cohort (14,402, 32%), followed in decreasing order by PGY, such that PGY 1 residents participated in 12% (5441) of the cases (Fig. 1). The case distribution varied by PGY (Table 1). The most commonly performed procedure with PGY 1 to 5 involvement was cholecystectomy (7612, 17%), followed by appendectomy (5404, 12%) and inguinal hernia repair (4921, 11%) (Fig. 2). Hernia repairs were performed with residents of all PGYs (1, *n* = 2153; 2, *n* = 2120; 3, *n* = 2057; 4, *n* = 2243; and 5, *n* = 2812), whereas mastectomies involved more junior residents (1, *n* = 1018; 2, *n* = 1112; 3, *n* = 868; 4, *n* = 557; and 5, *n* = 655) and pancreatic resections were performed with more senior residents (1, *n* = 19; 2, *n* = 25; 3, *n* = 102; 4, *n* = 258; and 5, *n* = 805) (Fig. 3 and Tables 1 and 2).

Of all patients operated on with PGY 1 to 5 participation, 11% (4773) were associated with an adverse event, including mortality, with an overall mortality rate of 0.8% (374). The most common adverse event identified was bleeding (5% of cases; *n* = 2063), which occurred at a median of 0 days postoperatively (interquartile range [IQR]: 0-1; mean = 0.75 d, standard deviation = 1.48). A superficial or deep SSI occurred in 3% (1417) of patients at a median of 19.5 days (IQR: 14-23.5) and an organ space SSI in 2% (*n* = 712) at a median of 11 days (IQR: 7-17). Sepsis/septic shock was diagnosed in 2% (*n* = 996) of patients, but its time to development could not be determined because of missing data. A urinary tract infection was noted in 1% (646) of patients at a median of 9 days (IQR: 5-17) and a venous thromboembolism in 0.7% (312) at 10 days (IQR: 6-16). There were 216 instances of wound dehiscence (0.5%) that occurred at a median of 12 days (IQR: 8-19).



**FIGURE 1.** The percentage of resident participation in general surgery cases by postgraduate year ( $n = 52,257$ ).

Overall, 99% ( $n = 396$ ) of deaths occurred as outpatients, and half of all adverse events were diagnosed following hospital discharge (53% inpatient vs 47% outpatient). See [Table 2](#) for data on other adverse events.

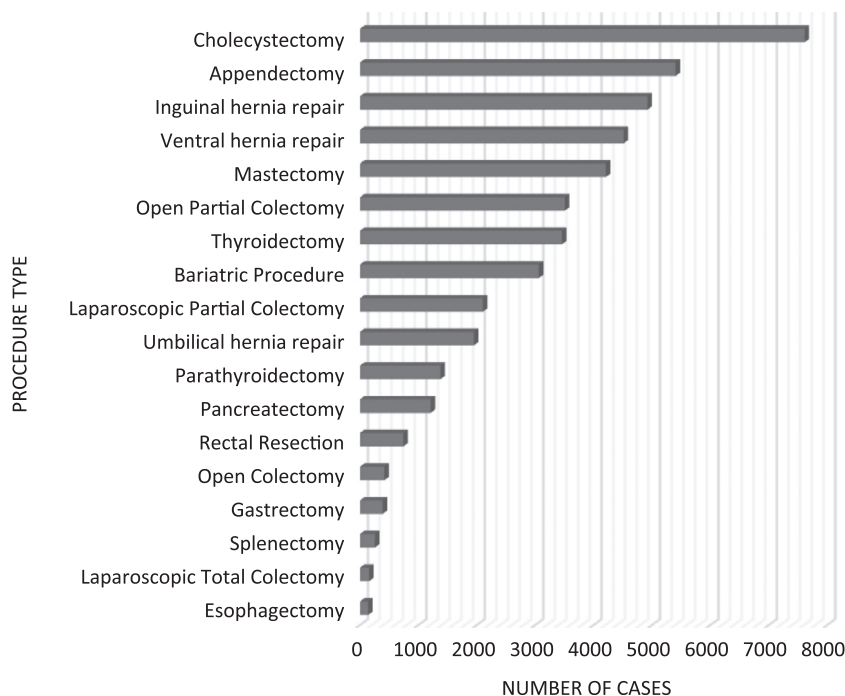
## DISCUSSION

We have documented that the ACS NSQIP registry is a repository of information with significant value to the

process of surgical education. Using the objectively obtained data on case distribution and postoperative occurrences, we were able to demonstrate the association between PGY and the type of operations performed, while highlighting the progression in technical case complexity by PGY. As residents train to become independent surgeons, they must also learn to manage adverse events. The ACS NSQIP registry is the most valid and reliable outcomes registry for use in general surgery.<sup>12</sup> As such, its use in documenting the resident exposure to adverse events may be a valuable

**TABLE 1.** The Number of General Surgery Cases Performed by Procedure Type, According to Postgraduate Year

Procedure Type	PGY 1	PGY 2	PGY 3	PGY 4	PGY 5
Ventral hernia repair	538	755	869	1078	1274
Umbilical hernia repair	478	410	320	321	421
Inguinal hernia repair	1137	955	868	844	1117
Appendectomy	570	1049	1072	1309	1404
Cholecystectomy	772	1370	1514	1833	2123
Thyroidectomy	234	368	929	756	1171
Parathyroidectomy	90	129	392	301	465
Mastectomy	1018	1112	868	557	655
Gastrectomy	7	10	27	105	239
Esophagectomy	9	5	23	49	54
Pancreatectomy	19	25	102	258	805
Splenectomy	5	7	32	72	141
Bariatric procedure	245	366	391	630	1429
Rectal resection	46	46	111	195	342
Colon resection	273	530	961	1656	2762
Total	5441	7137	8479	9964	14,402
Laparoscopic basic (% of total)	1198 (22)	2186 (31)	2315 (27)	2753 (28)	3068 (21)
Laparoscopic cholecystectomy	719	1277	1387	1621	1834
Laparoscopic appendectomy	479	909	928	1132	1234
Laparoscopic complex (% of total)	433 (8)	546 (8)	863 (10)	1263 (13)	2086 (14)
Laparoscopic hernia repair	252	278	411	415	567
Laparoscopic bariatric procedure	156	254	269	446	959
Laparoscopic colectomy	117	198	346	570	1028
Laparoscopic splenectomy	3	3	15	32	77



**FIGURE 2.** The number of general surgery cases by procedure type as recorded in the ACS NSQIP Participant Use File 2011.

component in the ascertainment of the residents' ability to transition to practice.

Our findings regarding the distribution of operations covered by PGY were in line with those published by the ACGME case logs.<sup>13,14</sup> However, unlike the ACGME case log registry, the ACS NSQIP data are entered by an objective clinical reviewer and include information on clinical outcomes. Using ACS NSQIP, we were able to catalog the resident exposure to adverse events on a national scale.

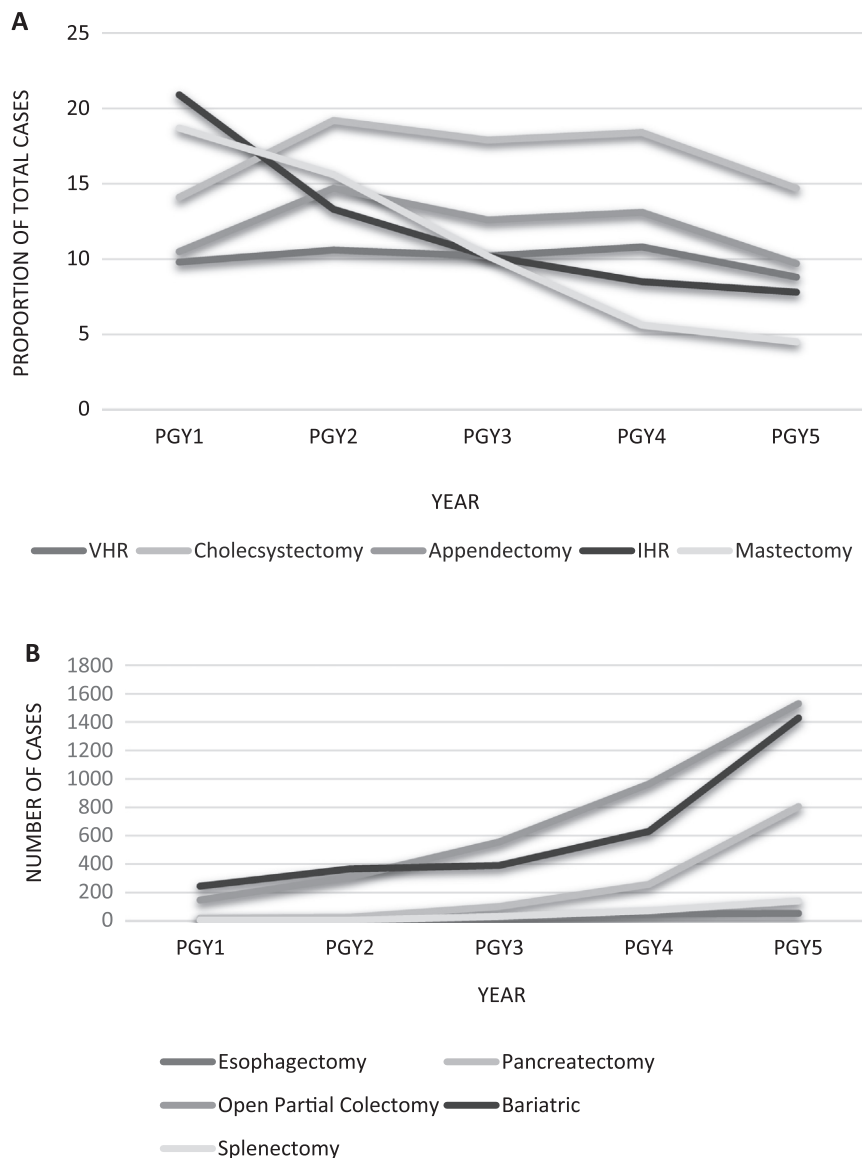
The transition from thinking exclusively about the technical aspects of an operation to reflecting on the consequences of the care delivered and potential adverse events represents a critical step in the maturation process of the surgeon in-training. These principles are the foundation for the time-honored morbidity and mortality conference. However, variability of the conference across institutions and competing priorities often limit exposure to national data on clinical outcomes.

Reliable resident-specific outcomes data allow trainees to view the clinical results of their patients in the broader context of the surgical community. This information can be useful in benchmarking the clinical experience and surgical outcomes of individual programs against peer institutions. Future refinements using the ACS QITI infrastructure will move beyond PGY alone and enable individual resident reporting along with the ability to capture team-specific outcomes. Team reports can be used as the focus of team-building exercises. The ACS QITI outcomes reports can be used in concert with the milestones at the resident semiannual meetings so that program directors can inform residents on

their experience relative to the national "norm" while observing each resident's ability to reflect on outcomes and troubleshoot suboptimal results. Furthermore, the identification of local or national areas of strength and weakness in operative exposure and clinical outcomes could be used to drive subsequent education reform and direct program structuring.

The framework for the ACS NSQIP QITI is already established and permits the independent, deidentified collection of resident case logs along with 30-day outcomes. Our results demonstrate the breadth of information available for use in surgical education. Furthermore, as practice patterns are established during residency training, surgical educators need to be able to evaluate the quality of the care provided in the hospitals in which they train future surgeons. This information needs to be examined across programs to benchmark the quality of the training environment in which we practice, and we have shown that these data exist. In working toward this end, surgeons will be able to identify best practices for education, which in turn will result in the dissemination of best practices across all future trainees. Through the standardization of educational practices, we may be able to standardize surgical practice and minimize variation and waste.

There are a few limitations of this study that bear discussion. General surgeons commonly perform endoscopy, and the American Board of Surgery has mandated the completion of the Fundamentals of Endoscopy Course as a requirement for board certification.<sup>15</sup> Yet, we could not examine this aspect of the resident experience because it is not collected in the ACS NSQIP data set. It is important to



**FIGURE 3.** (A) The proportion of cases by postgraduate year represented by the top 5 most commonly scrubbed cases in the overall cohort. (B) The number of cases performed according to postgraduate year for select 5 complex cases.

note that the use of the 2011 PGY definition may have resulted in the misclassification of residents who completed research during the training period. However, as guidelines exist regarding the definition of PGY for Medicare reimbursement of graduate medical education, chart abstractors likely assigned PGY using these standards. Our results were found to be in keeping with the ACGME case logs, and we obtained 87% of cases despite excluding cases covered by PGY 6+. This study was designed as a descriptive study, and we did not perform risk adjustment of the adverse events. Therefore, we cannot use these data as a type of resident report card for individual PGY levels. However, we feel strongly that clinical care is a team sport. Therefore, it would be inappropriate to use these data to evaluate an individual trainee's performance. In addition, the list of

adverse events recorded is not comprehensive but is meant to represent the most common and most detrimental of the possibilities. Finally, as the ACS NSQIP is a convenience sample, the time to accrue complete data would require resources beyond what is reasonable. However, in this convenient sample, we can see that the aggregated trends nicely demonstrate the same findings regarding the case distribution as seen with the complete ACGME general surgery case logs.

In summary, the ACS NSQIP data permit an assessment of the operative case mix and adverse events by PGY. This information can be used in resident education to examine the similarities across programs, inspire healthy competition among residents, and benchmark programs relative to one another in an effort to better balance the quality scale both

**TABLE 2.** The Number, Proportion, Median Time to Event, and Hospitalization Status at the Time of Diagnosis of Adverse Events Following General Surgery Procedures Involving PGY 1 to 5 residents

Adverse Event	Number (% of Cases)	Median Time to Event (d) (IQR)	Diagnosed as an Outpatient Number (% of Cases)
Death	399 (0.9)	10 (4-18)	396 (99)
Any adverse event	4773 (11)	–	2508 (53)
Postoperative bleeding	2063 (5)	0 (0-1)	45 (2)
Wound dehiscence	215 (0.5)	12 (8-19)	104 (49)
Return to operating room	1219 (3)	–	–
Infectious event(s)			
Superficial/deep SSI	1417 (3)	19.5 (14-23.5)	913 (66)
Organ space SSI	712 (2)	11 (7-17)	349 (50)
Pneumonia	486 (1)	5 (3-10)	72 (15)
Urinary tract infection	646 (1)	9 (5-17)	309 (50)
Sepsis/septic shock	996 (2)	–	327 (32)
Other event(s)			
Reintubation	462 (1)	4 (1-10)	69 (15)
Ventilator dependence > 48 h	627 (1)	–	–
Pulmonary embolus	130 (0.3)	10 (5-17)	66 (52)
Deep venous thrombosis	206 (0.5)	10 (6-16)	85 (42)
Cerebrovascular accident	56 (0.1)	6.5 (2-14.5)	21 (38)
Coma	12 (0)	5 (4-10.5)	1 (8)
Cardiac arrest	113 (0.3)	7 (2-16)	69 (62)
Myocardial infarction	103 (0.2)	3 (1-6)	17 (17)
Renal failure	245 (0.5)	6 (2-12)	61 (25)
30-d Readmission	2744 (6)	–	–

at the level of the trainee experience and at the patient level. Although the program was originally designed to uncover areas for quality improvement to better serve our surgical patients, the findings of our study demonstrate the utility of an outcomes registry as a guide for the development of future educational content in the resident curriculum.

## AUTHOR CONTRIBUTIONS

Hoffman contributed to conception and design, analysis and interpretation, data collection, and article writing. Bartlett contributed to analysis and interpretation, and critical appraisal and revision. Sakran contributed to analysis and interpretation, and critical appraisal and revision. Medbery contributed to analysis and interpretation, and critical appraisal and revision. Morris contributed to critical appraisal and revision. Kelz contributed to conception and design, analysis and interpretation, data collection, article writing, and critical appraisal and revision.

## ACKNOWLEDGMENTS

American College of Surgeons National Surgical Quality Improvement Program 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. Rebecca Hoffman, MD, and Rachel Kelz, MD, MSCE, had full access to all of the data in the study and

take responsibility for the integrity of the data and the accuracy of the data analysis.

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## SUPPORTING INFORMATION

Supplementary material cited in this article is available online at [doi:10.1016/j.jsurg.2014.08.014](https://doi.org/10.1016/j.jsurg.2014.08.014).