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Association of Resident Independence With Short-term Clinical Outcome in Core General Surgery Procedures

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IMPORTANCE Prior studies evaluating the effect of resident independence on operative outcome draw from case mixes that cross disciplines and overrepresent cases with low complexity. The association between resident independence and clinical outcome in core general surgical procedures is not well defined.

OBJECTIVE To evaluate the level of autonomy provided to residents during their training, trends in resident independence over time, and the association between resident independence in the operating room and clinical outcome.

DESIGN, SETTING, AND PARTICIPANTS Using the Veterans Affairs Surgical Quality Improvement Program database from 2005 to 2021, outcomes in resident autonomy were compared using multivariable logistic regression and propensity score matching. Data on patients undergoing appendectomy, cholecystectomy, partial colectomy, inguinal hernia, and small-bowel resection in a procedure with a resident physician involved were included.

EXPOSURES Resident independence was graded as the attending surgeon scrubbed into the operation (AS) or the attending surgeon did not scrub (ANS).

MAIN OUTCOMES AND MEASURES Outcomes of interest included rates of postoperative complication, severity of complications, and death.

RESULTS Of 109 707 patients who met inclusion criteria, 11 181 (10%) underwent operations completed with ANS (mean [SD] age of patients, 61 [14] years; 10 527 [94%] male) and 98 526 (90%) operations completed with AS (mean [SD] age of patients, 63 [13] years; 93 081 [94%] male). Appendectomy (1112 [17%]), cholecystectomy (3185 [11%]), and inguinal hernia (5412 [13%]) were more often performed with ANS than small-bowel resection (527 [6%]) and colectomy (945 [4%]). On multivariable logistic regression adjusting for procedure type, age, body mass index, functional status, comorbidities, American Society of Anesthesiologists class, wound class, case priority, admission status, facility type, and year, factors associated with a complication included increasing age (adjusted odds ratio [aOR], 1.19 [95% CI, 1.16-1.22]), emergent case priority (aOR, 1.41 [95% CI, 1.33-1.50]), and resident independence (aOR, 1.12 [95% CI, 1.03-1.22]). On propensity score matching, AS cases were score matched 1:1 to ANS cases based on the variables listed above. Comparing matched cohorts, there was no difference in complication rates (817 [7%] vs 784 [7%]) or death (91 [1%] vs 102 [1%]) based on attending physician involvement.

CONCLUSIONS AND RELEVANCE Core general surgery cases performed by senior-level trainees in such a way that the attending physician is not scrubbed into the case are being done safely with no significant difference in rates of postoperative complication.

Supplemental content

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As minimally invasive approaches to common procedures have been developed, the technical variability of surgical approaches to these procedures and the sophistication of the technology used in the operating room have increased dramatically. Over the same period, external socioeconomic pressures have worked to limit the number of hours residents spend training and have forced attending physicians to have greater involvement in cases. The upshot is that current surgical trainees must learn more with less time and with fewer opportunities for independent practice.[1-3]

The Accreditation Council for Graduate Medical Education and American Board of Surgery (ABS) have made recent substantive efforts to define learning objectives more clearly in hopes of allowing surgical training programs to develop more effective curricula that might mitigate such effects. The Accreditation Council for Graduate Medical Education has set standards for case numbers thought to reflect minimum thresholds required for trainee proficiency. The ABS has proposed a system by which residents are graded on 19 core clinical competencies (entrustable professional activities [EPAs]).[4,5] However, there is very little empirical data evaluating the association between proficiency or clinical outcome and case number or resident independence as it relates to cases within this core now defined by the ABS and the Accreditation Council for Graduate Medical Education. Studies that do attempt to evaluate such associations tend to draw from case mixes that overrepresent simple procedures for which postoperative complications are rare and differences in clinical outcome difficult to measure.[6]

In the current study, we select 5 core general surgical procedures that we believe closely reflect the EPAs proposed by the ABS and for which there are measurable potential postoperative complications and established expectations for acceptable rates of these complications. We used the Veterans Affairs Surgical Quality Improvement Program (VASQIP) database to evaluate trends in resident operative independence over time and the association between resident independence and outcome. Our hypothesis was that residents operating with increased independence would be able to achieve acceptable short-term clinical outcomes.

Key Points

Question Are resident physicians receiving progressive autonomy, are these opportunities becoming scarcer over time, and when provided with these opportunities, are residents able to safely perform core general surgery procedures?

Findings In this cohort study, opportunities for resident independence in Veterans Affairs training facilities were found to be progressively eroded. Cases performed by senior trainees without the attending surgeon scrubbed were being done safely with almost no measurable difference in rates of postoperative complication.

Meaning This study found that opportunities for independence are decreasing over time but also demonstrated the safety of providing residents with progressive autonomy.

Methods

Data Source and Patient Population

We queried the VASQIP database to identify patients undergoing the following operations at level 1 VA facilities between January 2005 and December 2021: appendectomy, cholecystectomy, partial colectomy, inguinal or femoral hernia, and small-bowel resection (see the eTable in the Supplement for *Current Procedural Terminology* codes). Cases for which the highest-level trainee participating in a case was a postgraduate year 1 or 2 level resident were excluded. Cases for which patients were identified as having American Society of Anesthesiologists class of 5 and cases for which there were missing data were also excluded (eFigure in the Supplement). For ease of interpretation, the following variables were categorized: patient-identified race, body mass index class, and year of operation. Race categorized as other included Asian or Pacific Islander, American Indian or Alaska Native, Hispanic or Latino, Native Hawaiian, and not specified. This work was approved by the Edwards Hines, Jr. Veterans Affairs Institutional Review Board. An exemption for informed consent was granted.

Exposure Variable

The VASQIP database identifies the level of attending surgeon involvement for each operation captured in a synoptic data field for which the value of the field is selected from a list by the operating room nurse at the time that the surgical package is closed. For purposes of the study, a case was categorized as attending surgeon scrubbed (AS) if it was scored by the operating room nurse as any of the following values in the synoptic field: attending surgeon doing the operation, attending surgeon assisting the resident, attending surgeon in the operating room scrubbed. Cases were categorized as attending surgeon not scrubbed (ANS) if the case was initially scored as attending surgeon in the operating room not scrubbed or in the operating room suite and immediately available.

Outcomes Measures

Our primary outcome of interest was the occurrence of any postoperative complication within 30 days of the index operation. Secondary outcomes were operative time, death within 30 days of index operation, and a compositive variable for severe complications. Complication severity was graded according to the Clavien Dindo classification with data available in the VASQIP database used to approximate grades defined in the Clavien Dindo system.[7] Grade I complications included superficial surgical site infection, grade II urinary tract infection and deep vein thrombosis, grade III organ space surgical site infection and return to the operating room, grade IV cardiac arrest, reintubation, dialysis, and sepsis, and grade V death. Severe complication was defined as a Clavien Dindo grade of III, IV, or V complication.

Statistical Analysis

Demographic, case characteristic, and short-term outcomes for patients undergoing operations with ANS were compared with

those for patients undergoing operations with AS using *t* test, Pearson χ^2 test, and Wilcoxon rank sum test as appropriate. Proportions of cases done with ANS over time were compared using an analysis of variance. A series of multivariable logistic regression analyses adjusting for other factors thought to be potential determinates of outcome were used to evaluate the association between resident independence and clinical outcome. Variables initially included in these analyses were chosen a priori. Variables included in the final models were determined using backward stepwise regression: attending surgeon involvement, age, body mass index class, functional status, chronic obstructive pulmonary disease, tobacco use, alcohol use, American Society of Anesthesiologists class, admission status, emergent nature, procedure type, wound class, facility level, surgical approach, and year of procedure. The outcomes evaluated using multivariable logistic regression were occurrence of any postoperative complication and occurrence of a severe complication. Outcomes were evaluated for each type of procedure individually and with all procedures grouped into a core general surgical aggregate category.

Propensity score matching was then used to attempt to measure the magnitude of the association between attending surgeon involvement and outcome. Cases done with AS were 1:1 propensity score matched to those completed with ANS using the same variables included in our multivariable logistic regression. Standardized mean differences were used to ensure appropriate score matching. This analysis was done for the procedures grouped into the core general surgery category and for individual procedure types separately. All analyses were completed using R version 4.0 (R Foundation). Two-sided *P* values were statistically significant at .05.

Results

Univariate Comparison of Demographics and Trends in Resident-Supervised Independence Over Time

A total of 109 707 cases met criteria for inclusion. Of those, 11 181 (10%) were completed with ANS and 98 526 (90%) were completed with AS (**Table 1**). On univariate comparison, the cohorts were similar regarding rates of emergent priority (1283 [11%] vs 11 879 [12%]); the ANS cohort did have a slightly higher rate of open approach (6793 [61%] vs 57 906 [59%]). The procedures that had the highest proportion of cases completed with ANS were appendectomy (1112 [17%]), followed by inguinal hernia (5412 [13%]), and cholecystectomy (3185 [11%]). Relatively smaller proportions of small-bowel resection (527 [6%]) and colectomy (945 [4%]) were completed with ANS. The proportion of cases performed with ANS decreased markedly over the period under study across all procedure types (**Figure 1**). The proportion of appendectomies and hernia done with ANS decreased most markedly (81 [23%] in 2005 to 5 [7%] in 2021 and 596 [28%] in 2005 to 57 [8%] in 2021, respectively).

Unadjusted Comparison of Short-term Clinical Outcomes

On unadjusted comparison, procedures performed with ANS seemed to be associated with better clinical outcome. The rate of complication following procedures completed with ANS was lower than that for procedures completed AS (784 [7%] vs 11 878 [12%]). The rates of severe complication and death were lower for procedures performed with ANS than for procedures performed with AS (622 [6%] vs 9944 [10%]; 102 [2%] vs 1605 [1%], respectively). When procedures were evaluated by type, appendectomies, and cholecystectomies performed with ANS were less likely than those performed with AS to have a complication (80 [7%] vs 546 [10%]; 171 [5%] vs 1605 [7%], respectively).

The mean operative time for cases performed with ANS was also 18 minutes shorter than those performed with AS (mean [SD], 106 [54] minutes vs 123 [79]; $P < .001$) when cases were considered collectively. When case types were evaluated independently, operative times for hernia repairs completed with ANS were longer than for those done with AS (6 minutes; mean [SD], 95 [34] vs 89 [41] minutes; $P < .001$), but times for small-bowel resection and colectomy performed with ANS were significantly shorter (13 minutes; mean [SD], 131 [77] vs 145 [95] minutes; $P = .002$ vs 8 minutes; mean [SD], 183 [83] vs 191 [91] minutes; $P = .005$, respectively) than those performed with AS. There were no significant differences in operative time between groups in appendectomy and cholecystectomy.

Adjusted Comparison of Outcomes: Multivariable Regression

In attempt to control for the possibility that selection bias was affecting outcomes comparisons made above, we performed several analyses adjusted for patient characteristics and operative factors that would be expected to be associated with clinical outcome. In our final multivariable model for risk of any postoperative complication with procedure type included as an independent variable (**Table 2**), the attending physician not being scrubbed into the case was associated with a small increased likelihood of postoperative complication (adjusted odds ratio [aOR], 1.12 [95% CI, 1.03-1.22]). Older age, higher body mass index class, emergent status, and open surgical approach were also associated with higher odds of a complication. In this analysis including procedure type as an independent variable, colectomy and small-bowel resections had higher odds (aOR, 2.51 [95% CI, 2.27-2.78]; aOR, 2.22 [95% CI, 1.99-2.48], respectively), and hernia repair had lower odds of a complication (aOR, 0.35 [95% CI, 0.30-0.41]) than appendectomy. When each procedure type was modeled individually (**Figure 2**), there was no notable association between level of resident independence and likelihood of a postoperative complication in any of the procedure types evaluated.

We also performed adjusted analyses structured as they were above attempting to identify factors associated with a severe (Clavien Dindo grade III, IV, V) complication. In this analysis, with procedure type included as an independent variable, cases done with ANS had a higher adjusted odds risk of a severe postoperative complication than those performed with AS (aOR, 1.18 [95% CI, 1.08-1.30]). When analyses were performed for procedure types individually, this trend was noted for appendectomy and cholecystectomy (aOR, 1.37 [95% CI, 1.01-1.85]; aOR, 1.40 [95% CI, 1.13-1.72]) but not colectomy, hernia, or small-bowel resection (aOR, 1.03 [95% CI, 0.87-1.22];

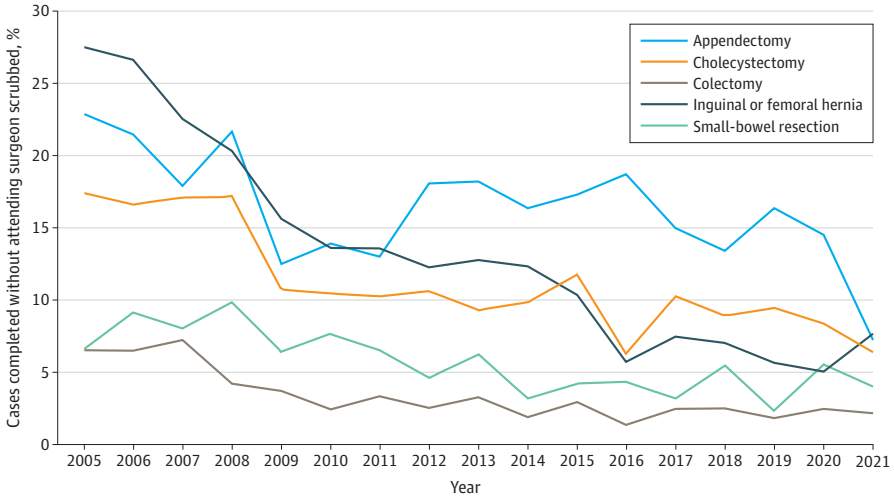
Table 1. Patient Demographics and Case Characteristics by Attending Surgeon Involvement

Characteristic	No. (%)		*P* value
	Attending not scrubbed	Attending scrubbed	
No. (%)	11 181 (10)	98 526 (90)	NA
Age, mean (SD), y	61 (14)	63 (13)	<.001
Male	10 527 (94)	93 081 (99.5)	.16
Female	654 (6)	445 (0.5)	
Race			
Black	2561 (23)	20 580 (21)	<.001
White	8359 (75)	75 733 (77)	
Other[a]	261 (2)	2213 (2)	
BMI class			
Normal	3569 (32)	28 995 (29)	<.001
Overweight	4268 (38)	36 585 (37)	
Obese	3129 (28)	30 796 (31)	
Underweight	215 (2)	2150 (2)	
Functional status			
Independent	10 727 (96)	92 440 (94)	<.001
Dependent	454 (4)	6086 (6)	
COPD	1824 (16)	19 060 (19)	<.001
Active tobacco use	3788 (34)	30 946 (31)	<.001
Active alcohol use	720 (6)	7566 (8)	<.001
Inpatient admission	3981 (36)	48 648 (49)	<.001
Emergent	1283 (11)	11 879 (12)	.07
ASA class			
1	372 (3)	1860 (2)	<.001
2	3683 (33)	24 906 (25)	
3	6374 (57)	62 236 (63)	
4	752 (7)	9524 (10)	
Wound class			
Clean	5777 (52)	38 487 (39)	<.001
Clean contaminated	4230 (38)	46 824 (48)	
Contaminated	844 (8)	8735 (9)	
Infected	330 (3)	4480 (5)	
Procedure			
Appendectomy	1112 (10)	5511 (6)	<.001
Cholecystectomy	3185 (28)	24 663 (25)	
Colectomy	945 (9)	24 594 (25)	
Inguinal, femoral hernia	5412 (48)	35 483 (36)	
Small-bowel resection	527 (5)	8275 (8)	
Mode			<.001
Laparoscopic	4388 (39)	40 620 (41)	
Open	6793 (61)	57 906 (59)	
Facility level			
1a	7079 (63)	51 332 (52)	<.001
1b	2504 (22)	26 908 (27)	
1c	1598 (14)	20 286 (21)	
PGY			
3	1976 (18)	24 995 (25)	<.001
4	1388 (12)	18 437 (19)	
5	7817 (70)	55 094 (56)	
Year			
2005-2009	4940 (44)	29 015 (29)	<.001
2010-2015	4189 (37)	41 078 (42)	
2016-2021	2052 (18)	28 433 (29)	

Abbreviations: ASA, American Society of Anesthesiologists; BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); COPD, chronic obstructive pulmonary disease; NA, not applicable; PGY, postgraduate year.

[a] Race categorized as other included Asian or Pacific Islander, American Indian or Alaska Native, Hispanic or Latino, Native Hawaiian, and not specified.

Figure 1. Proportion of Cases Completed Without the Attending Surgeon Scrubbed by Procedure Over Time



aOR, 1.20 [95% CI, 0.95-1.50]; aOR, 0.91 [95% CI, 0.74-1.13], respectively).

Adjusted Comparison of Outcomes: Propensity Score–Matched Analysis

To estimate the magnitude of the association of independence with outcome, propensity score matching was used to create matched cohorts of patients undergoing surgery with AS and ANS within the aggregate of procedures and within subcohorts for each procedure type. In the first match, 11 181 patients identified as having AS were 1:1 matched to the 11 181 cases performed with ANS. Standardized mean differences for this analysis were less than 10% for those included in the match. On comparison of matched cohorts for all core procedures considered in aggregate, there were no significant differences in rates of complication, rates of severe complication, or mortality (**Table 3**). The mean operative time for cases done with ANS was 2 minutes longer than that for those done with AS (mean [SD], 106 [54] vs 104 [63]). On comparison of matched cohorts for procedure types evaluated separately, there were, again, no differences in complication rates between matched cohorts. There was some variation in operative time by procedure. Colectomies and small-bowel resections performed with ANS were marginally shorter than those done with AS (mean [SD], 183 [83] vs 194 [96] minutes; $P = .004$; 131 [77] vs 142 [88] minutes, $P = .03$, respectively). For the remaining procedures, cases done with ANS had mean operative times that were marginally longer (less than 10 minutes) than those done with AS.

Discussion

We present, to our knowledge, the most well-powered evaluation of temporal trends in resident autonomy for core general surgery procedures and of the association between graded autonomy and clinical outcome for these procedures done to date. We find that opportunities for resident independence in VA training facilities are decreasing markedly over time but that cases performed by senior-level trainees in such a way that the attending physician is not scrubbed into the case are being done safely with no significant increase in rates of postoperative complication and operative time. These findings have relevance in the context of recent trends in US health care where external forces continue to limit the opportunities that residents have to be independent. Our findings identify little downside to allowing for what are judged, by experienced surgical attending physicians, to be reasonable degrees of resident autonomy.

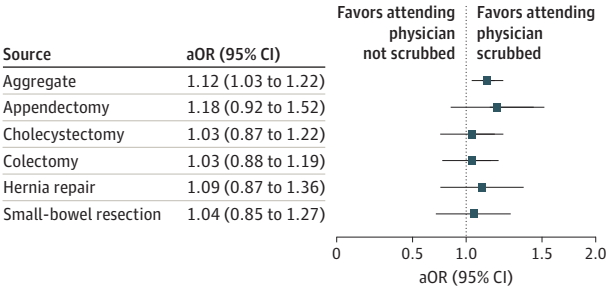
Our view on the results as a whole is that there is no significant increase in risk with increased resident independence. However, there is some inconsistency in the results with several analyses suggesting that there is a statistical increase in risk and others clearly showing no increase in risk. In our univariate comparison, we identified higher rates of postoperative complication when cases were done with AS. This almost certainly reflects selection bias with cases of increasing complexity being done with higher levels of attending surgeon involvement. When we attempted to adjust for case complexity within the confines of the VASQIP data set, we found the opposite association: a slight increase in risk of any complication for cases done with ANS when core general surgical procedures were evaluated together. Subsequent adjusted analysis found that there were no significant differences in risk of any complication when case types were evaluated individually and no increase in rate of complication when propensity-matched cohorts were evaluated. In our analysis of association between resident independence and rates of severe complication, we found again a slight increase in risk with cases done independently when cases were considered in aggregate and marginal increase in risk when cholecystectomy and appendectomy were considered individually but no increase in risk for colectomy, small-bowel resection, and hernia. We point out that the aOR for risk of any complication with ANS in the aggregate multivariable logistic regression was 1.12, an increase that we would consider marginal. Other factors in the

Table 2. Multivariable Logistic Regression for Factors Associated With Risk of Any Complication

Factor	Adjusted odds ratio (95% CI)	*P* value
Attending surgeon scrub status		
Scrubbed	1 [Reference]	NA
Not scrubbed	1.12 (1.03-1.22)	.007
Age, y	1.19 (1.16-1.22)	<.001
BMI class		
Normal	1 [Reference]	NA
Overweight	1.07 (1.01-1.13)	.02
Obese	1.33 (1.26-1.41)	<.001
Underweight	1.22 (1.09-1.37)	.001
Functional status		
Independent	1 [Reference]	NA
Dependent	1.67 (1.56-1.78)	<.001
COPD	1.43 (1.36-1.50)	<.001
Active tobacco use	1.16 (1.10-1.22)	<.001
Active alcohol use	1.13 (1.04-1.21)	.002
Inpatient admission		
Outpatient	1 [Reference]	NA
Inpatient	1.46 (1.38-1.56)	<.001
Emergent	1.41 (1.33-1.50)	<.001
ASA class		
1	1 [Reference]	NA
2	1.21 (0.91-1.62)	.19
3	1.67 (1.25-2.23)	.001
4	2.47 (1.84-3.32)	<.001
Wound class		
Clean	1 [Reference]	NA
Clean contaminated	1.42 (1.30-1.56)	<.001
Contaminated	1.93 (1.74-2.14)	<.001
Infected	2.15 (1.92-2.41)	<.001
Procedure		
Appendectomy	1 [Reference]	NA
Cholecystectomy	0.90 (0.81-1.00)	.052
Colectomy	2.51 (2.27-2.78)	<.001
Inguinal, femoral hernia	0.35 (0.30-0.41)	<.001
Small-bowel resection	2.22 (1.99-2.48)	<.001
Mode		
Laparoscopic	1 [Reference]	NA
Open	1.88 (1.78-1.99)	<.001
Facility level		
1a	1 [Reference]	NA
1b	0.89 (0.85-0.94)	<.001
1c	0.83 (0.79-0.88)	<.001
Year		
2005-2009	1 [Reference]	NA
2010-2015	0.77 (0.74-0.81)	<.001
2016-2021	0.45 (0.43-0.48)	<.001

Abbreviations: ASA, American Society of Anesthesiologists; BMI, body mass index; COPD, chronic obstructive pulmonary disease; NA, not applicable.

Figure 2. Results of Multivariable Logistic Regression for Attending Physician Involvement and Occurrence of a Postoperative Complication by Procedure



Adjusted for age, body mass index class, functional status, chronic obstructive pulmonary disease, tobacco use, alcohol use, American Society of Anesthesiologists class, admission status, emergent nature, procedure type (entire cohort only), wound class, facility level, surgical approach, and year of procedure. aOR indicates adjusted odds ratio.

model (type of operation, surgical approach, American Society of Anesthesiologists class, and chronic obstructive pulmonary disease) conferred considerably more risk of postoperative complication. The absolute difference in rate of severe complication observed on matched cohort comparison was also, in an absolute sense, very small (6% vs 6%). There were no notable differences in length of operation in any of our analyses. Some of the apparent discrepancy in our adjusted analyses (increased risk in aggregate but not when individual case types are modeled) is likely associated with statistical power (higher case numbers in the analyses demonstrating increased risk). Taken together, we feel these findings would support efforts to preserve opportunities for residents to operate with graded independence and could potentially be used by faculty members to argue for deference in this regard from hospital administrators, patients, and clinical partners working to improve efficiency in our operating rooms.

Prior analyses of resident autonomy have either focused on a single procedure or include a wide variety of procedures with low case complexity.[8-13] The most notable is a recent paper using VA data to evaluate the association between resident autonomy and clinical outcome for the most common procedures performed within the VA health care system.[6] This study included cases from multiple specialties and found that resident autonomy did not result in increased mortality or morbidity.[6] By design, as a study evaluating the most common VA surgeries, it included a preponderance of cases that were of low complexity and had limited potential for postoperative complication. Instead, we selected 5 procedures that residents should be comfortable completing at the end of their training, each of which had significantly higher potential for postoperative complication, established benchmarks for acceptable rates of complication, and thus the potential to discern differences in rates of poor outcome. Such a study of general surgery core operations has not been completed in a nationwide contemporary cohort, to our knowledge.[14,15] This study represents the first empirical evaluation of resident independence within what would be considered categories consistent with EPAs designed by the ABS. Our findings would be expected to be more easily applied to the practice of general surgery and would be expected to support continuance of the training programs within the VA system.

Table 3. Univariate Comparison of Selected Outcomes for Propensity-Matched Groups[a]

Factor	No. (%)		*P* value
	Attending physician not scrubbed	Attending physician scrubbed	
No.	11 181	11 181	NA
Operative time, mean (SD)	106 (54)	104 (63)	.009
Complication	784 (7)	817 (7)	.41
Severe complication	622 (6)	689 (6)	.06
Death	102 (1)	91 (1)	.47

Abbreviation: NA, not applicable.

[a] Cohorts were created using propensity score matching for attending surgeon involvement, age, body mass index class, functional status, chronic obstructive pulmonary disease, tobacco use, alcohol use, American Society of Anesthesiologists class, admission status, emergent nature, procedure type, wound class, facility level, surgical approach, and year of procedure. All standardized mean differences were less than 10%.

Limitations

Our study has several limitations that warrant recognition. It is by nature a retrospective evaluation of a large administrative data set and it is subject to omitted variable and selection bias. We have very limited ability to adjust for case complexity. In our multivariable regression and propensity match, we adjust for factors such as body mass index, degree of contamination, and case priority, but we cannot adjust for the severity of inflammation or difficult anatomy as these factors are not captured in VASQIP. In light of this, the observed statistical parity might be interpreted to suggest that residents are actually underperforming expectations. We would counter this argument by stating that operative times and complication rates for the ANS cohort are well within nationally accepted ranges. Similarly, we cannot determine the exact nature of attending surgeon involvement. It is entirely possible that many attending surgeons are offering significant guidance when not scrubbed. We aimed to select a measurement of autonomy that is clearly delineated within the data set and is likely a break point reflecting a substantial increase in resident independence. There is no question that readers would have alternative views on how best to characterize resident independence. Our findings are also subject to the possible variability between institutions in their recording of attending surgeon involvement. In our own institution, considerable effort is made on the part of the teams in the operating room to identify the role of the attending relative to that of the resident in each case. However, there is undoubtedly considerable variation in how this variable is scored across the country. The variable as it exists in VASQIP has several possible values: attending doing the operation, attending physician assisting the resident, attending physician not scrubbed, among others. We attempted to use the status of the attending physician being scrubbed yes/no as our exposure variable in effort to minimize potential for misscoring. In the end, we cannot eliminate the potential. We do believe that there is less potential for subjective error in coding of the AS status than would be the case if operating room nurses were simply asked to describe the amount of help being given while the attending physician was scrubbed into a case and that residents have considerably more autonomy in any given case when the attending physician does not scrub.

Conclusions

Despite noted limitations, we report the largest evaluation of the association between resident independence and clinical outcome for core general surgery procedures. We demonstrate that opportunities for independence are decreasing significantly over time but also demonstrate the safety of providing residents with progressive autonomy.

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Drafting of the manuscript: Tonelli, Abdelsattar, Luchette, Baker.
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