Assessing the Impact of Resident Participation in Emergency General Surgery in the Older Adult Population

Yasmin Arda, MD, May Abiad, MD, Wardah Rafaqat, MBBS, Emanuele Lagazzi, MD, Jefferson P. Zamudio, MD, Dias Argandykov, MD, George C. Velmahos, MD, PhD, Michael P. DeWane, MD, Charudutt N. Paranjape, MBBS, and John O. Hwabejire, MD, MPH

Division of Trauma, Emergency Surgery, and Surgical Critical Care, Department of Surgery, Massachusetts General Hospital and Harvard Medical School, Boston, Massachusetts

OBJECTIVE: Although data concerning resident involvement in emergency general surgery (EGS) procedures is abundant, its impact on outcomes in the vulnerable older adult population has not been explored. This study aimed to assess the impact of resident involvement on postoperative outcomes in older adult patients undergoing EGS.

DESIGN: Propensity-score matched cohort study.

SETTING: The 2007−2012 American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database.

PARTICIPANTS: Patients aged ≥65 years who underwent one of eight EGS procedures were included. Patients were stratified based on resident participation (RES vs. NO-RES). After propensity-score matching, each group included 2,796 patients with comparable baseline characteristics.

RESULTS: Among 24,452 patients identified, 14,381 (58.8%) underwent procedures with resident involvement. Patients in the RES group were more likely to be Black (11.3% vs. 6.1%) and have pre-existing comorbidities, such as ventilator dependence (7.7% vs. 4.0%), and were less likely to be admitted from home (84.3% vs. 88.4%) (all $p<0.001$). After matching, 30-day mortality was not different between the two groups. However, patients in the RES group demonstrated higher 30-day morbidity (38.8% vs. 36.0%, $p = 0.031$), likely driven by a greater incidence of superficial surgical site infection (5.6% vs. 3.9%, $p = 0.003$) and unplanned reoperation (11.0% vs. 7.4%, $p<0.001$). Operative time was significantly longer in the RES group ($p<0.001$).

CONCLUSIONS: Participation of residents in EGS procedures is associated with increased operative time, rate of surgical site infection, and unplanned reoperation. However, resident involvement had no effect on patient mortality. Efforts to improve surgical education while not compromising patient safety are needed. (J Surg Ed 82:103626. © 2025 Association of Program Directors in Surgery. Published by Elsevier Inc. All rights are reserved, including those for text and data mining, AI training, and similar technologies.)

KEY WORDS: resident participation, emergency general surgery, postoperative outcomes, older adults

ACGME COMPETENCIES: Patient Care, Medical Knowledge

INTRODUCTION

Data from the 2020 Census Demographic and Housing Characteristics (DHC) showed that the population in the US was older.[1] Considering the swift rise in the older adult demographic, the volume of emergency general surgery (EGS) procedures performed on older adults has also witnessed a dramatic increase in recent years.[2,3] Such surgeries pose unique challenges, considering the time-sensitive nature of the conditions as well as the age-related physiological changes, multiple comorbidities, and decreased functional capacity with increasing age.[4-6] Consequently, older adults are more susceptible to complications, prolonged hospital stays, and increased mortality rates compared to their younger counterparts.[7-9]

Funding: There was no funding available for this study.

Correspondence: Inquiries to John O. Hwabejire, MD, MPH, Division of Trauma, Emergency Surgery and Surgical Critical Care, Massachusetts General Hospital, 165 Cambridge St Suite 810, Boston, MA, 02114; e-mail: jhwabejire@mgb.org

  1931-7204/$30.00

https://doi.org/10.1016/j.jsurg.2025.103626

While an essential element of their training, resident participation in surgical procedures can profoundly impact outcomes in older adult patients undergoing EGS. Although the impact of resident involvement on postoperative outcomes has been extensively studied for a variety of procedures,[10-17] current literature on outcomes following EGS provides contrasting findings. One nationwide analysis of the impact of resident participation in general surgical procedures found that resident involvement is generally safe, with no impact on patient mortality.[18] Another study by Kasotakis et al. found that trainee participation in EGS procedures is associated with adverse outcomes, including wound, pulmonary, and venous thromboembolic complications.[19] A study published by Iannuzzi et al. showed that resident involvement was associated with worse outcomes in patients with major lower extremity amputation.[20] Commonly cited risk factors for poor outcomes in graduate surgical education include a lack of autonomy or inexperience.[19,21-23]

The effect of surgical resident participation in EGS procedures in older adults has yet to be clearly defined. The unique demographic and clinical characteristics of this population undergoing time-critical interventions provide a complex teaching environment. This study aims to evaluate the impact of resident participation in short-term outcomes in older adult patients undergoing EGS procedures.

METHODS

Data Source

Data was extracted from the American College of Surgeons National Quality Improvement Program (ACS-NSQIP) database for the years 2007-2012. The ACS-NSQIP database is a validated, outcome-based, and risk-adjusted source containing patient and procedure information from over 700 centers nationwide.[24]

Patient Population

The study population includes patients aged 65 years and older undergoing 1 of 8 EGS procedures previously found to account for more than 80% of the operative volume, death, and complications within the EGS specialty[25]: Appendectomy, cholecystectomy, hernia repair (ventral, inguinal, femoral), colectomy, small bowel resection, lysis of adhesions. Procedures were identified using the current procedural terminology codes corresponding to the operation. Only patients with emergency procedure status were included. Patients were stratified according to resident participation (RES vs. no-RES). Patients with missing resident participation information were excluded.

Patient Characteristics

Patient characteristics were extracted from variables provided in the ACS-NSQIP database. Variables included baseline demographic characteristics (age, sex, race, ethnicity, admission origin) and clinical characteristics (BMI, pre-existing comorbidities, preoperative laboratory results, preoperative state, ASA class). Patient preoperative state included the following variables: preoperative sepsis, preoperative septic shock, preoperative delirium, preoperative functional health status, and preoperative transfusion of packed red blood cells within 72 hours. Surgical approach (open vs. laparoscopic) and surgical complexity were assessed. Based on previously validated literature,[26] surgical complexity was defined as low risk for appendectomies and cholecystectomies and high risk for other surgical operations.

Outcomes

Primary study outcomes were 30-day mortality and 30-day morbidity, defined as any postoperative complication. Secondary outcomes were operative time and postoperative complications, which were divided into surgical complications (any surgical site infection, type of surgical site infection, wound dehiscence, unplanned re-operation, bleeding requiring transfusion) and medical complications (sepsis, septic shock, urinary tract infection, pneumonia, pulmonary embolism, deep vein thrombosis (DVT), acute kidney injury, stroke, cardiac arrest requiring cardiopulmonary resuscitation, myocardial infarction).

Statistical Analysis

Categorical variables were presented as totals and percentages and continuous variables as mean and standard deviation or median values and interquartile ranges as indicated. For univariate analysis, Pearson's chi-square test or Fischer's exact test was used for the comparison of categorical variables, and Student's t-test or Mann-Whitney U test was used for the comparison of continuous variables. A 1:1 propensity score matching was used to match patients based on clinical relevance and potential impact on resident involvement, including demographic characteristics (e.g. age, sex), clinical characteristics (e.g. BMI, admission origin, comorbidities), preoperative state (e.g. sepsis, transfusion), ASA class, surgical approach, and surgical complexity. A difference of <0.05 between pre- and postmatching standardized differences was considered balanced. Statistical analysis was performed using the STATA 17.0 (Stata Corp, College Station, Texas) statistical software package.

Statistical significance was declared at a 2-sided p-value of < 0.05. This study was deemed exempt by our Institutional Review Board due to the de-identified nature of the dataset.

RESULTS

A total of 24,452 patients underwent emergency general surgical procedures between 2007 and 2012. After matching, 2 equal-sized groups of 2796 patients each formed our matched cohort. The baseline characteristics of all cohorts are summarized in Table 1.

There were no significant differences in age or sex between groups. Patients who underwent procedures with resident involvement were more likely to be Black or African American (11.3% vs. 6.1%, $p < 0.001$), and less likely to be admitted from home (84.3% vs. 88.4%, $p < 0.001$). Patients undergoing EGS procedures with resident participation were more likely to have pre-existing comorbidities including congestive heart failure (4.2% vs. 3.6%, $p = 0.011$), ventilator dependence (7.7% vs. 4.0%, $p < 0.001$), and disseminated cancer (3.4% vs. 2.5%, $p = 0.011$). The resident involvement group was also more likely to have a more severe preoperative state, including preoperative septic shock, preoperative delirium, and abnormal lab values including elevated BUN, elevated creatinine, low platelet count, and hyponatremia ($p < 0.001$). Patients undergoing EGS with resident involvement were less likely to have independent functional health status (71.0% vs. 74.2%, $p < 0.001$).

After matching, baseline characteristics between the 2 cohorts were comparable. Short-term clinical outcomes in the matched cohort are presented in Table 2. Thirty-day mortality was not significantly different between the 2 groups. However, patients in the group with resident involvement demonstrated higher 30-day morbidity (38.8% vs. 36.0%, $p = 0.031$). Although the prevalence of postoperative medical complications was not different between the 2 groups, surgical complications were more prevalent in the group undergoing EGS with resident involvement (17.7% vs. 13.5%, $p < 0.001$). This seems to be driven by a greater rate of superficial surgical site infection (SSI) and unplanned re-operation ($p = 0.003$ and $p < 0.001$ respectively) in the resident presence group. Deep SSI, wound dehiscence, and bleeding requiring transfusion were not statistically different between groups. Operative time was longer in the RES group (min [IQR]: 93 [60-136] vs. 78 [52-115], $p < 0.001$). Among medical complications, only the risk of DVT was greater in the group with resident participation (3.6% vs. 2.7%, $p = 0.039$).

To further examine the observed differences in outcomes between groups undergoing specific procedures, 3 separate 1:1 propensity score matching cohorts were studied within patients undergoing the 3 most common procedures (Table 3): colectomy (32.11%), appendectomy (18.44%), and hernia repair (11.99%). Patients were matched for the same characteristics as the entire cohort, excluding surgery complexity. Thirty-day mortality was significantly decreased in the sub-group of patients undergoing hernia repair with resident involvement (3.2% vs. 7.6%, $p = 0.024$). Surgical complications and unplanned re-operation were both significantly increased in the RES subgroup of patients undergoing colectomy ($p = 0.014$ and $p = 0.002$, respectively). Medical complications only significantly differed in the appendectomy sub-group, where patients undergoing the operation with resident presence had decreased risk of morbidity compared to the NO RES group (5.9% vs. 11.0%, $p = 0.015$). Operative time was significantly increased in the RES sub-groups for all procedures ($p < 0.001$).

DISCUSSION

Our findings suggest that resident participation in emergency general surgery (EGS) procedures among older adults was not associated with increased 30-day mortality. However, resident involvement was associated with greater 30-day morbidity, which could be explained by the increased risk of superficial SSI, unplanned re-operation, and DVT. Although unmeasured confounding cannot be excluded, this effect was still found to be present despite stringent matching for pre-existing conditions, preoperative state, preoperative labs, and surgical complexity. Resident involvement was also associated with a longer operative time, an effect consistent in the 3 most performed procedures in this population. This study highlights both the areas for improvement as well as challenges associated with resident involvement in EGS among older adult patients.

Several studies have assessed the impact of resident involvement on postoperative outcomes following EGS in the general population. Resident participation in general surgical procedures has been consistently associated with longer operative time. In an analysis of the ACS-NSQIP database, Kiran et al. found that resident participation was associated with longer operative times in all general surgery procedures, but with no change in the risk of major complications postoperatively, regardless of PGY level.[18] Papandria et al. also found a significant increase in operative times in laparoscopic appendectomies, laparoscopic cholecystectomies, and open inguinal hernia repairs with resident participation.[27] Both mentioned studies showed an increased prevalence of postoperative SSI, which the authors attributed to the

TABLE 1. Baseline Characteristics of Older Adult Patients Undergoing EGS Procedures, Stratified by Resident Participation in Prematch and Postmatch Cohorts

	Prematch			Postmatch		
	NO RES N = 10,071	**RES PRES N = 14,381**	**p-Value**	**NO RES N = 2796**	**RES PRES N = 2796**	**p-Value**
Age	76 (70-82)	76 (70-82)	0.28	77 (71-83)	77 (71-83)	0.46
Female, n(%)	5659 (56.2%)	8005 (55.7%)	0.41	1553 (55.5%)	1521 (54.4%)	0.39
Race, n(%)			<0.001			0.16
White	8269 (91.0%)	11,126 (85.3%)	<0.001	2504 (89.6%)	2539 (90.8%)	
Black or African American	550 (6.1%)	1474 (11.3%)	<0.001	219 (7.8%)	203 (7.3%)	
Asian, Pacific Islander, or Native Hawaiian	271 (3.0%)	443 (3.4%)	0.085	73 (2.6%)	54 (1.9%)	
Hispanic ethnicity, n(%)	383 (4.7%)	477 (4.2%)	0.10	131 (4.7%)	116 (4.1%)	0.33
ASA class, n(%)			<0.001			0.61
ASA I	146 (1.5%)	149 (1.0%)	0.004	17 (0.6%)	15 (0.5%)	
ASA II	2485 (24.7%)	3020 (21.0%)	<0.001	436 (15.6%)	430 (15.4%)	
ASA III	4845 (48.2%)	6675 (46.5%)	0.009	1377 (49.2%)	1354 (48.4%)	
ASA IV	2382 (23.7%)	4060 (28.3%)	<0.001	902 (32.3%)	915 (32.7%)	
ASA V	200 (2.0%)	456 (3.2%)	<0.001	64 (2.3%)	82 (2.9%)	
Admission origin, n(%)			<0.001			1.00
Home	8905 (88.4%)	12,115 (84.3%)	<0.001	2561 (91.6%)	2561 (91.6%)	
Chronic care facility	620 (6.2%)	951 (6.6%)	0.15	235 (8.4%)	235 (8.4%)	
Outside emergency department	95 (0.9%)	159 (1.1%)	0.22	0 (0.0%)	0 (0.0%)	
Acute care hospital	449 (4.5%)	1152 (8.0%)	<0.001	0 (0.0%)	0 (0.0%)	
BMI categories, n(%)			0.083			0.95
Normal weight	3018 (32.6%)	4288 (32.7%)		903 (32.3%)	900 (32.2%)	
Underweight	349 (3.8%)	562 (4.3%)		114 (4.1%)	120 (4.3%)	
Overweight	3102 (33.5%)	4227 (32.3%)		908 (32.5%)	920 (32.9%)	
Obese	2796 (30.2%)	4026 (30.7%)		871 (31.2%)	856 (30.6%)	
Ascites, n(%)	512 (5.1%)	787 (5.5%)	0.18	155 (5.5%)	142 (5.1%)	0.44
Congestive heart failure, n(%)	359 (3.6%)	605 (4.2%)	0.011	144 (5.2%)	149 (5.3%)	0.76
Diabetes, n(%)	1924 (19.1%)	2858 (19.9%)	0.14	622 (22.2%)	620 (22.2%)	0.95
Smoker, n(%)	1194 (11.9%)	1709 (11.9%)	0.95	346 (12.4%)	343 (12.3%)	0.90
Dyspnea, n(%)	1640 (16.3%)	2545 (17.7%)	0.004	595 (21.3%)	611 (21.9%)	0.60
Preoperative functional health status, n(%)			<0.001			0.95
Independent	7469 (74.2%)	10,188 (71.0%)	<0.001	1886 (67.5%)	1882 (67.3%)	
Partially dependent	1793 (17.8%)	2390 (16.7%)	0.018	607 (21.7%)	616 (22.0%)	
Totally dependent	805 (8.0%)	1774 (12.4%)	<0.001	303 (10.8%)	298 (10.7%)	
Ventilator dependence, n(%)	400 (4.0%)	1107 (7.7%)	<0.001	164 (5.9%)	164 (5.9%)	1.00
History of COPD, n(%)	1331 (13.2%)	1883 (13.1%)	0.78	425 (15.2%)	433 (15.5%)	0.77
Hypertension requiring medication, n(%)	7155 (71.0%)	10,188 (70.8%)	0.73	2151 (76.9%)	2177 (77.9%)	0.41
Currently on dialysis, n(%)	252 (2.5%)	517 (3.6%)	<0.001	98 (3.5%)	103 (3.7%)	0.72
Disseminated cancer, n(%)	287 (2.8%)	493 (3.4%)	0.011	110 (3.9%)	115 (4.1%)	0.73
Open wound and/or wound Infection, n(%)	430 (4.3%)	787 (5.5%)	<0.001	151 (5.4%)	153 (5.5%)	0.91
Weight loss, n(%)	350 (3.5%)	625 (4.3%)	<0.001	129 (4.6%)	132 (4.7%)	0.85
Streoid use, n(%)	614 (6.1%)	1,096 (7.6%)	<0.001	207 (7.4%)	201 (7.2%)	0.76
Bleeding disorder, n(%)	1530 (15.2%)	2586 (18.0%)	<0.001	639 (22.9%)	631 (22.6%)	0.80
Preoperative transfusion of pRBC, n(%)	280 (2.8%)	522 (3.6%)	<0.001	134 (4.8%)	152 (5.4%)	0.27
Preoperative systemic sepsis, n(%)			<0.001			0.90
None	5558 (55.5%)	7684 (53.8%)	0.007	1416 (50.6%)	1389 (49.7%)	
SIRS	2311 (23.1%)	3409 (23.9%)	0.165	667 (23.9%)	687 (24.6%)	
Sepsis	1393 (13.9%)	1789 (12.5%)	0.001	442 (15.8%)	445 (15.9%)	
Septic shock	749 (7.5%)	1,410 (9.9%)	<0.001	271 (9.7%)	275 (9.8%)	
Delirium, n(%)	496 (4.9%)	920 (6.4%)	<0.001	182 (6.5%)	176 (6.3%)	0.74
Wound class, n(%)			<0.001			0.71
Clean	1407 (14.0%)	2046 (14.2%)	0.571	345 (12.3%)	345 (12.3%)	
Clean/Contaminated	3357 (33.3%)	4285 (29.8%)	<0.001	967 (34.6%)	1005 (35.9%)	
Contaminated	2159 (21.4%)	3200 (22.3%)	0.13	589 (21.1%)	564 (20.2%)	
Dirty/Infected	3148 (31.3%)	4850 (33.7%)	<0.001	895 (32.0%)	882 (31.5%)	
Elevated ALP, n(%)	1200 (13.8%)	1876 (15.2%)	0.004	416 (14.9%)	450 (16.1%)	0.21
Elevated total bilirubin, n(%)	2365 (27.2%)	3430 (27.9%)	0.32	768 (27.5%)	780 (27.9%)	0.72
Elevated BUN, n(%)	1334 (13.6%)	2139 (15.2%)	<0.001	479 (17.1%)	461 (16.5%)	0.52
Elevated serum creatinine, n(%)	1755 (17.9%)	2789 (19.9%)	<0.001	603 (21.6%)	592 (21.2%)	0.72
Elevated INR, n(%)	861 (15.4%)	1563 (14.6%)	0.17	416 (14.9%)	402 (14.4%)	0.60

(continued)

TABLE 1 (*continued*)

	Prematch			Postmatch		
	NO RES N = 10,071	**RES PRES N = 14,381**	**p-Value**	**NO RES N = 2796**	**RES PRES N = 2796**	**p-Value**
Low platelet count, n(%)	1266 (12.8%)	1966 (13.9%)	0.016	468 (16.7%)	428 (15.3%)	0.14
Elevated SGOT, n(%)	1369 (15.9%)	2290 (18.7%)	<0.001	485 (17.3%)	539 (19.3%)	0.062
Hyponatremia, n(%)	2295 (23.2%)	2955 (21.0%)	<0.001	623 (22.3%)	578 (20.7%)	0.14
WBC count, n(%)			<0.001			0.59
4.5-11	4286 (43.6%)	6082 (43.3%)	0.609	1,240 (44.3%)	1202 (43.0%)	
<4.5	461 (4.7%)	750 (5.3%)	0.025	157 (5.6%)	149 (5.3%)	
11-15	2515 (25.6%)	3411 (24.3%)	0.02	671 (24.0%)	665 (23.8%)	
15-25	2174 (22.1%)	3124 (22.2%)	0.843	579 (20.7%)	627 (22.4%)	
>25	388 (3.9%)	681 (4.8%)	0.001	149 (5.3%)	153 (5.5%)	
Surgical approach, n(%)			<0.001			0.59
Open approach	7159 (71.1%)	11,273 (78.4%)		2163 (77.4%)	2146 (76.8%)	
Laparoscopic approach	2912 (28.9%)	3108 (21.6%)		633 (22.6%)	650 (23.2%)	
Surgical complexity, n(%)			<0.001			0.61
Low-risk	2986 (29.6%)	3553 (24.7%)		646 (23.1%)	662 (23.7%)	
High-risk	7085 (70.4%)	10,828 (75.3%)		2150 (76.9%)	2134 (76.3%)	
Year of admission, n(%)			<0.001			0.003
2007	1792 (17.8%)	2755 (19.2%)		8 (0.3%)	4 (0.1%)	
2008	2258 (22.4%)	3591 (25.0%)		803 (28.7%)	919 (32.9%)	
2009	2967 (29.5%)	3968 (27.6%)		1028 (36.8%)	933 (33.4%)	
2010-2012	3054 (30.3%)	4067 (28.3%)		957 (34.2%)	940 (33.6%)	

NO RES, No resident involvement during procedure; RES PRES, Resident involvement during procedure; ASA class, American Society of Anesthesiologists' Classification; BMI, Body mass index; COPD, Chronic obstructive pulmonary disease.

TABLE 2. Clinical Outcomes of Older Adult Patients Undergoing EGS Procedures, Stratified by Resident Participation in a Matched Cohort

	NO RES N = 2796	**RES-PRES N = 2796**	**p-Value**
30-d mortality, n(%)	436 (15.6%)	409 (14.6%)	0.31
30-d morbidity, n(%)	1007 (36.0%)	1085 (38.8%)	0.031
Surgical complications, n(%)	378 (13.5%)	494 (17.7%)	<0.001
Medical complications, n(%)	769 (27.5%)	742 (26.5%)	0.42
Total operation time, min (IQR)	78 (52-115)	93 (60-136)	<0.001
Surgical complications, n(%)			
Any surgical site infection, n(%)	156 (5.6%)	193 (6.9%)	0.041
Superficial SSI, n(%)	109 (3.9%)	156 (5.6%)	0.003
Deep SSI, n(%)	49 (1.8%)	38 (1.4%)	0.23
Organ-space SSI, n(%)	0 (0.0%)	0 (0.0%)	
Wound dehiscence, n(%)	55 (2.0%)	63 (2.3%)	0.46
Bleeding requiring transfusion, n(%)	173 (6.2%)	200 (7.2%)	0.27
Unplanned reoperation, n(%)	207 (7.4%)	308 (11.0%)	<0.001
Medical complications, n(%)			
Sepsis, n(%)	178 (6.4%)	183 (6.5%)	0.79
Septic shock, n(%)	216 (7.7%)	210 (7.5%)	0.76
Urinary tract infection, n(%)	121 (4.3%)	123 (4.4%)	0.90
Pneumonia, n(%)	251 (9.0%)	225 (8.0%)	0.21
Pulmonary embolism, n(%)	25 (0.9%)	37 (1.3%)	0.13
Deep vein thrombosis, n(%)	75 (2.7%)	102 (3.6%)	0.039
Acute kidney injury, n(%)	78 (2.8%)	78 (2.8%)	1.00
Stroke/CVA, n(%)	22 (0.8%)	28 (1.0%)	0.39
Cardiac arrest requiring CPR, n(%)	76 (2.7%)	67 (2.4%)	0.45
Myocardial infarction, n(%)	47 (1.7%)	56 (2.0%)	0.37

NO RES, No resident involvement during procedure; RES PRES, Resident involvement during procedure.

TABLE 3. Clinical Outcomes in 3 Most Common EGS Procedures, Stratified by Resident Participation in Matched Cohorts

	Colectomy			Appendectomy			Hernia Repair		
	NO RES N = 1026	RES-PRES N = 1026	p-Value	NO RES N = 354	RES-PRES N = 354	p-Value	NO RES N = 277	RES-PRES N = 277	p-Value
30-day mortality, n(%)	244 (23.8%)	222 (21.6%)	0.25	5 (1.4%)	6 (1.7%)	0.76	21 (7.6%)	9 (3.2%)	0.024
30-day morbidity, n(%)	502 (48.9%)	528 (51.5%)	0.25	53 (15.0%)	51 (14.4%)	0.83	57 (20.6%)	60 (21.7%)	0.75
Surgical complications, n(%)	199 (19.4%)	245 (23.9%)	0.014	18 (5.1%)	25 (7.1%)	0.27	28 (10.1%)	24 (8.7%)	0.56
Medical complications, n(%)	383 (37.3%)	369 (36.0%)	0.52	39 (11.0%)	21 (5.9%)	0.015	31 (11.2%)	38 (13.7%)	0.37
Unplanned reoperation, n(%)	104 (10.1%)	150 (14.6%)	0.002	10 (2.8%)	14 (4.0%)	0.41	19 (6.9%)	10 (3.6%)	0.086
Total operation time, min (IQR)	101.5 (75-137)	125 (92-165)	<0.001	45 (34-64)	56 (41-72)	<0.001	56 (37-82)	73 (48-105)	<0.001

NO RES, No resident involvement during procedure; RES PRES, Resident involvement during procedure.

observed increase in operative times. Mortality remained unaffected in both analyses, which aligns with our findings. We can thus conclude that longer operative times are an "essential trade-off" to prepare future surgeons with the appropriate level of skill and technique to perform well.

Our study found that the risk of 30-day morbidity was increased with resident involvement in EGS procedures among older adult patients, with an increased risk of superficial SSI, unplanned re-operation, and DVT. Multiple studies have established that longer operative times can be linked to a greater risk of superficial SSI.[27-31] Khuri et al. used the VA-NSQIP dataset to compare postoperative outcomes between teaching and nonteaching hospitals, identifying an association between teaching hospitals and increases in operative time and risk-adjusted morbidity rate.[32] The educational environment in which residents operate necessitate a greater time commitment, which is essential for training.

Our analysis of the 3 most common EGS procedures could explain the remainder of our findings. For the group of patients undergoing colectomy, surgical complications were significantly greater in the RES group, which was driven by the increased proportion of patients who underwent an unplanned re-operation. Colectomy is a high-risk EGS procedure, particularly in older adults.[26,33] A recent study found that increasing frailty in older adult EGS patients was associated with significantly higher rates of 30-day complications, re-operation, and mortality.[6] Another retrospective analysis examining more than 2500 cases found that increasing patient age and a history of cognitive decline are significantly correlated with an increased risk of 30-day readmission following colectomy.[34] Older adults have more complex physiology, which, along with their greater burden of comorbidities, increases their overall surgical risk. Thus, in combination with the vulnerable nature of our selected population, it is expected that more fragile patients may need readmission after an emergency colectomy. Nevertheless, resident participation in high-risk surgery is crucial for their comprehensive education. Similar to our findings, Cobb et al. found that resident participation in high-risk general surgery procedures did not affect 30-day mortality.[35] Furthermore, Hernandez-Irizarry et al. concluded that resident involvement did not affect the complication rate in laparoscopic inguinal hernia repair, which is in line with our findings.[36] We also found that in patients undergoing hernia repair, mortality was significantly lower in the RES group, which aligns with a prior analysis showing reduced mortality with resident participation in general and vascular procedures.[37] Additionally, we observed a significantly lower rate of medical complications with resident involvement in appendectomy.

This study has several limitations. The first lies in the retrospective nature of the database, compounding its inability to account for detailed patient information. Although resident participation was associated with increased risk of DVT in both the matched cohort and the appendectomy sub-group, this could not be further explored due to the lack of data concerning anticoagulant use during admission. Additionally, the ACS-NSQIP database does not report the extent of resident participation or attending supervision, particularly whether the resident was the primary operating surgeon. Such information could potentially improve our understanding of the relationship between resident's involvement and postoperative outcomes and account for residual confounding. While ACS-NSQIP employs standardized definitions to reduce variability, documentation practices may vary depending on resident involvement, potentially influencing complication reporting. Furthermore, the level of resident or attending experience and the degree of resident's autonomy in postoperative patient care -not tracked in ACS-NSQIP- likely also influence outcomes. Malangoni et al. found that, despite an increase in the cumulative operative volume of graduating surgical residents, common general surgical procedures are performed infrequently.[38] To strengthen our analysis, extensive matching was employed to reduce the influence of potential confounding factors. However, despite our extensive efforts to include relevant variables in the propensity score model, there may still be unaccounted variables that could influence outcomes and introduce bias. Finally, hospital factors, such as hospital type, teaching status, and pattern of referral might impact outcomes but could not be accounted for due to the lack of provider- and hospital-specific identifiers in the database.[39-41]

The implications of our study concern the balance between resident education and patient safety, particularly in the older adult population. Resident training and participation are integral aspects of both health system sustainability and patient care. The findings underscore the delicate balance that needs to be maintained between the educational needs of young medical professionals and the immediate well-being of older adults undergoing surgical interventions. This balance is particularly intricate in emergency situations, where the urgency of medical care intersects with the imperative of teaching and learning. As the prevalence of the older adult population increases, research must identify the potential difficulties encountered in the field, which is necessary for the optimization of resident training while maintaining patient safety. Early integration of surgical simulations in surgical education has been shown to lower technical error rates. Zendejas et al. found that simulation-based learning improves patient outcomes in laparoscopic hernia repair.[42] This approach might be especially beneficial for training in minimally invasive surgical techniques. Our findings add to the growing evidence of the impact of resident involvement on patient outcomes in older adults.

CONCLUSION

The present study utilized a large nationwide database to examine the association between resident involvement in EGS procedures and postoperative outcomes among older adults. Participation of residents in EGS procedures is associated with increased operative time, rate of surgical site infection, and unplanned reoperation. However, resident involvement had no effect on patient mortality. The results of our study provide crucial insight into the fine balance between patient well-being and surgical education, which remains necessary for the advancement of surgical training.

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