Racial disparities in surgical outcomes: Does the level of resident surgeon play a role?

Navin R. Changoor, MD,[a] Gezzer Ortega, MD, MPH,[a] Mina Ekladios, MS,[b] Cheryl K. Zogg, MSPH, MHS,[c] Edward E. Cornwell III, MD,[a] *and* **Adil H. Haider, MD, MPH,[c]**
Washington, DC, and Boston, MA

Background. *Despite recognition of racial/ethnic surgical disparities, few studies have considered the role of surgical residents. This study aimed to elucidate whether disparities in postoperative outcomes are associated with the presence/level of surgical residents involved in procedures.*
Methods. *Patients who were classified as having laparoscopic cholecystectomy, laparoscopic appendectomy, and open hernia repair in the 2005–2010 American College of Surgeons National Surgical Quality Improvement Program database were compared by level of provider (junior residents postgraduate year 1–2, senior residents, attending alone) for differences in patient demographics, clinical case-mix, and postoperative outcome information by the use of descriptive statistics and multivariable logistic regression.*
Results. *A total of 196,770 patients met inclusion criteria. Attendings performed 43.0% of operations alone (senior residents 37.5%, junior residents 20.1%), They operated on 44.1% white, 30.1% black, and 43.9% Hispanic patients compared with 35.5%, 48.7%, and 41.3% and 20.4%, 21.3%, and 14.8% for senior and junior residents, respectively. Compared with attendings alone, senior residents were more likely to operate on black patients (adjusted odds ratio [OR] 2.02, 95% confidence interval [95% CI] 1.95–2.09) and have major (OR 1.13, 95% CI 1.06–1.21) and minor complications (OR 1.20, 95% CI 1.11–1.31). Junior residents also were more likely to operate on black patients but did not experience significantly worse outcomes.*
Conclusion. *Greater risk-adjusted odds of complications among patients treated by senior residents need to be carefully weighed given the group's higher likelihood of operating on minority patients. (Surgery 2015;158:547-55.)*

From the Department of Surgery,[a] Howard University College of Medicine, Washington, DC; Howard University College of Medicine,[b] Washington, DC; and Center for Surgery and Public Health,[c] Harvard Medical School and Harvard School of Public Health, Department of Surgery, Brigham and Women's Hospital, Boston, MA

HEALTH DISPARITIES IN SURGICAL OUTCOMES HAVE BEEN INCREASINGLY STUDIED, helping to establish a growing body of evidence that suggests that multifactorial causes of health disparities can be broadly classified into system-, provider-, and patient-level factors.[1-3] Within surgery, various studies have demonstrated racial/ethnic disparities in use and outcomes.[1,4-7] A recent review further delved into the different factors surrounding racial disparities and poor surgical outcomes. In this review, black patients were found to have greater rates of mortality in appendectomy, gastric fundoplication, and gastric bypass operations. Greater morbidity also was seen in anterior spinal cord surgeries and vascular surgery procedures.[2] At the provider level, previous studies have considered the role of the attending surgeon.[8,9] Minority patients with rectal and ovarian cancers were found to have an increased likelihood of being operated on by low-volume attending surgeons.[8,9] Apart from attendings, however, the role of the operating surgeon

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Reprint requests: Adil H. Haider, MD, MPH, Kessler Director Center for Surgery and Public Health, Department of Surgery, Brigham and Women's Hospital, 1620 Tremont Street, One Brigham Circle, 4th Floor, Suite 4-020, Boston, MA 02120. E-mail: ahhaider@partners.org.

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on potential disparity-related differences in surgical outcomes seldom has been considered, despite an operating surgeon's direct involvement in how a procedure is performed.

In 2008, surgical residents comprised 28.3% of the general surgical workforce,[10] making them an essential part of the surgical team. Surgical residents are not independent physicians but rather operate under the supervision of an attending surgeon. They gain increased operating independence as they progress through their 5-year residency training. Although not focused on racial/ethnic disparities, previous studies have identified mixed surgical outcomes when residents are involved.[11-14] Kasotakis et al[11] reported adverse outcomes among emergency general surgery procedures that included surgical residents. They showed that resident involvement is independently associated with intra- and postoperative events, wound, pulmonary, venous thromboembolic complications, and urinary tract infections. Similarly, in evaluating the role of residents in appendectomy, Scarborough et al[12] found greater rates of postappendectomy complications. Hwang et al[13] observed no difference in complications, whereas Kiran et al[14] found resident involvement to be associated with minor complications, the majority of which were superficial wound infections.

In an effort to address the lack of what is known about how the role of surgical residents, as a provider-level factor, may influence postoperative outcomes among minority patients, we elucidated, via the use of a nationally validated, outcomes-based surgical research database, whether disparities in postoperative outcomes are associated with the presence and/or level of surgical residents involved in procedures.

METHODS

Dataset. A retrospective analysis of the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database from 2005 to 2010 was conducted. Since 2004, the ACS-NSQIP has provided validated clinical outcomes data after general and select subspecialty surgical procedures at collaborating hospitals. ACS-NSQIP uses a systematic sampling strategy that permits detailed qualitative comparisons between procedures and among participating institutions. Data items collected comprise patient risk factors and comorbidities, preoperative and operative information, and perioperative and postoperative outcomes that occur within 30 days of the index procedure. On-site audit programs standardize data collection and ensure data consistency and reliability.[15] Dedicated Surgical Clinical Reviewers use a coding convention that permits identification of surgical procedures that are initiated laparoscopically and subsequently converted to open; a primary Current Procedural Terminology (American Medical Association) code for the open procedure is accompanied by additional codes indicating the laparoscopic equivalent.[16]

Case selection criteria and data abstraction. Procedures selected for analysis were laparoscopic cholecystectomy (LC), laparoscopic appendectomy (LA), and open hernia repair (OHR)—the most frequently encountered procedures in the ACS-NSQIP.[17] These procedures were identified using Current Procedural Terminology for LA (44,970), LC (47,562, 47,563, and 47,564), and OHR (49,525, 49,505, and 49,520). All 3 procedures are performed commonly by attending surgeons and surgical residents at various levels of training.[18] Patient demographic and clinical case characteristic data, including age at surgery, sex, race/ethnicity, and preoperative comorbidities and risk factors, were collected (Table I). For each case, various intraoperative and postoperative data also were collected, including the level of operating attending/resident surgeon and information on postoperative complications. Patients were categorized into ACS-NSQIP-defined racial/ethnic groups (white, Hispanic, black, Asian, American Indian or Alaska Native, and Native Hawaiian or Pacific Islander) and by the level of training of the operating surgeon (junior-level postgraduate year [PGY] 1−2, upper level/senior residents [PGY 3−PGY 10], or the attending alone).

Patients with unknown race/ethnicity, emergency cases, and cases without information on resident level involvement were excluded. Postoperative complications were grouped into major complications, minor complications, and wound infections. Major complications included organ space surgical-site infection (SSI), sepsis, shock, reintubation, pulmonary embolus, cardiac arrest, myocardial infarction, cardiovascular accident, renal failure, and return to the operating room. Minor complications included superficial SSIs, deep incisional SSI, dehiscence, and urinary tract infections. Wound infections included superficial SSI, deep incisional SSI, organ space SSI, and dehiscence. The primary outcome of interest was occurrence of a major complication. Secondary outcomes included minor complications, postoperative wound infections, 30-day mortality, and return to the operating room.

Data analysis. A descriptive analysis of patient demographics and clinical case information was performed in which we compared patients

Table I. Patient demographics and clinical case characteristics (n = 196,770)

Demographic & Clinical Factors	
Median age, y	47
Sex, %	
Male	49
Female	51
Race/ethnicity, %	
White	74
Black	9
Hispanic	12
Asian	3
American Indian or Alaska Native	1
Native Hawaiian or Pacific Islander	0.3
Comorbidities and risk factors, %	
Any comorbidity	33.2
Hypertension	29.7
Smoker	20.6
Diabetes	6.6
Chronic obstructive pulmonary disease	2.2
History of congestive heart failure	0.3
History of myocardial infarction	0.2
Pneumonia	0.1
Wound classification %	
Clean	22
Clean/contaminated	49
Contaminated	23
Dirty/infected	6
Procedures, %	
Laparoscopic cholecystectomy	47
Laparoscopic appendectomy	30
Open hernia repair	23
Postgraduate year level, %	
Attending alone	43
Junior level	20
Senior level	37

operated on by surgeons with varying levels of training (attending/resident involvement). Summary statistics were calculated by the use of Pearson χ^2 tests for categorical variables and the Kruskal-Wallis test for non-normally distributed continuous age. Analogous assessments were conducted for differences in postoperative outcomes among patients operated on by surgeons with varying levels of training and differences in patient race/ethnicity. We performed multivariable logistic regressions to assess the association of attending/resident involvement with racial/ethnic differences in postoperative outcomes, adjusting for potential confounding attributable to significant differences in patient demographics, comorbidities, and clinical case characteristics. Models yielded adjusted odds ratios (ORs) and corresponding 95% confidence intervals (95% CI). Attendings alone served as the reference group.

All statistical analyses were performed using Stata MP, version 12 (College Station, TX). The study was deemed exempt from ethical review by the Howard University Institutional Review Board.

RESULTS

In the ACS-NSQIP (2005−2010), 196,770 cases met inclusion criteria. The median age was 47 years, and 51% were female. The majority was white (74%), followed by Hispanic (12%), black (9%), Asian (3%), American Indian or Alaskan Native (1%), and Native Hawaiian or Pacific Islander (0.3%). The percentage of the population who had any comorbidity or risk factors was 33.2%, with the majority being hypertensive (29.7%), and smokers comprising 20.6%. Approximately 50% of the surgical wounds were classified as clean/contaminated with approximately equal proportions of clean (22%) and contaminated (23%) cases. There were 92,593 (47.1%) patients who underwent LC, 58,923 (29.9%) who underwent LA, and 45,254 (23%) who underwent OHR. Residents were involved in a majority of the cases; 20.1% were junior-level residents and 37.4% were senior-level residents (Table I).

In evaluation of cormorbid conditions and risk factors, black patients had the greatest percentage of any comorbidity (41.9%), followed by Native Hawaiian/Pacific Islander (37.1%), white (34.5%), Asian (29.3%), American Indian/Alaskan Native (23.7%), and Hispanic (21.2%) patients. A similar trend was observed for hypertension, with black patients reporting the greatest percentage (39.0%), followed by Native Hawaiian/Pacific Islander (36.1%), white (30.7%), and Asian (26.8%) patients. Native Hawaiian/Pacific Islander and black patients had the greatest percentages of diabetic patients at 13.1%, and 12.3%, respectively. American Indians/Alaskan Natives (35.9%) were the most likely to smoke, whereas white (2.5%), American Indian/Alaskan/Native (2.1%), and black (1.9%) patients were the most likely to present with chronic obstructive pulmonary disease. The prevalence of pneumonia (<0.1%), history of congestive heart failure (0.0–0.5%), and history of myocardial infarction (0.0–0.2%) were low, regardless of race/ethnicity. Complete results stratified by race/ethnicity are presented in Table II.

When comparing cases by resident level involvement, we found that attending physicians alone operated on the greatest percentages of white (44.1%), Hispanic (43.9%), and Alaskan Native/Pacific Islander patients (47.4%). Senior residents, in

Table II. Patient comorbidities/risk factors, stratified by patient race/ethnicity (n = 196,770)

Comorbidity	*White* (n = *145,633*)	*Black* (n = *18,124*)	*Hispanic* (n = *23,965*)	*Asian* (n = *6,070*)	*American Indian/ Alaskan Native* (n = *2,488*)	*Native Hawaiian/ Pacific Islander* (n = *490*)
Any comorbidity	34.5	41.9	21.2	29.26	23.7	37.1
Hypertension	30.7	39.0	18.5	26.8	20.9	36.1
Diabetes	7.3	12.3	7.7	9.2	6.3	13.1
Chronic obstructive pulmonary disease	2.5	1.9	0.6	0.6	2.1	0.6
History of congestive heart failure	0.3	0.5	0.2	0.4	0.2	0.0
History of myocardial infarction	0.2	0.2	0.1	0.2	0.0	0.0
Smoker	20.7	27.4	15.7	11.71	35.9	15.5

Values are in percentages.

contrast, operated on the greatest percentage of black patients (48.7%) compared with attending physicians alone (30.1%) and junior-level residents (21.3%). Junior residents operated on the greatest percentage of American Indian/Alaska Native patients (40.3%). Attendings alone operated on a greater proportion of patients with comorbidities (44.5%) and smokers (41.2%) relative to the other 2 groups. Senior residents were involved in a greater percentage of contaminated cases (43.0%) and the least amount of clean cases (27.3%), in contrast to attending physicians, who were involved in a greater percentage of clean and clean/contaminated cases (43.0% and 44.1%, respectively). The majority of cases performed by attending physicians was LCs (n = 39,969), followed by LAs (n = 24,196) and OHRs (n = 19,437), a pattern consistent for senior-level residents. Junior residents were involved in relatively more OHRs than LAs (Table III).

Among postoperative outcomes, the proportion of patients with a major complication was greatest for senior residents (2.79%, $P < .001$), followed by attending surgeons alone (2.37%, $P < .001$) and junior-level residents (2.15%, $P < .001$). Organ-space SSIs (0.8%), systemic complications (0.8%), respiratory complications (0.7%), and renal complications (0.7%) comprised the majority of major complications for all groups. Minor complications were greatest among senior residents (1.67%, $P < .001$) and lowest with attendings (1.3%, $P < .001$). Similarly, the proportion of patients with wound infection was greatest in senior-level residents (1.92%, $P < .001$) and lowest with attending surgeons (1.37%, $P < .001$). Within the wound infections group, similar proportions of superficial SSIs and organ-space SSIs were observed across all groups. Rates of 30-day mortality were approximately the same for attendings (0.21%, P = .039) and senior residents (0.22%, P = .039), whereas the proportion of patients who returned to the operating room was greatest among senior residents (1.09%, P = .063) and lowest with junior residents (0.94%, P = .063) (Table IV).

By race/ethnicity, the greatest proportion of major complications occurred among Native Hawaiian patients (3.8%), followed by black (3.14%) and white patients (2.5%), with the lowest rate occurring in Hispanic patients (1.9%). The greatest proportion of minor complications and wound infections occurred in American Indian/Alaskan Native patients (1.8% and 1.9%, respectively), followed by black (1.7% and 1.8%, respectively) and white patients (1.5% and 1.6%, respectively). Rates of mortality were greatest for Native Hawaiian/Pacific Islanders (0.4%).The rate of return to the operating room was greatest for black patients (1.29%, $P < .001$) (Table V).

On adjusted analysis, junior-level residents were more likely to operate on black patients (OR 1.5, 95% CI 1.42–1.57) and to have patients who developed wound infections (OR 1.2, 95% CI 1.09–1.33) compared with attending physicians operating alone. Black patients were more likely to be operated on by senior-level residents (OR 2.02, 95% CI 1.95–2.09) and were more likely to develop major complications (OR 1.13, 95% CI 1.06–1.21), minor complications (OR 1.20, 95% CI 1.11–1.31), and wound infections (OR 1.29, 95% CI 1.19–1.39) compared with attending surgeons alone (Table VI).

DISCUSSION

The results of our study reveal that attending physicians alone operated on a larger proportion of white and Hispanic patients whereas senior

Table III. Patient demographics and clinical case characteristics ($n = 196,770$), stratified by level of provider training

	Attending	*Junior*	*Senior*	P *value*
Age, y, mean	48.7	48.2	46.1	
Male, % (*n*)	42.1 (40,226)	22.7 (21,655)	45.7 (33,712)	**<.001**
Ethnicity, % (*n*)				
White	44.1 (64,213)	20.4 (29,742)	35.5 (51,678)	**<.001**
Black	30.1 (5,446)	21.3 (3,857)	48.7 (8,821)	**<.001**
Hispanic	43.9 (10,525)	14.8 (3,534)	41.3 (9,906)	**<.001**
Asian	38.3 (2,325)	21.0 (1,277)	40.7 (2,468)	**<.001**
American Indian or Alaska Native	33.3 (829)	40.3 (1,002)	26.4 (657)	**<.001**
Native Hawaiian or Pacific Islander	47.4 (232)	20.0 (98)	32.7 (160)	**<.001**
Comorbidities and risk factors, % (*n*)				
Any comorbidity	44.5 (29,109)	19.7 (12,919)	35.8 (23,447)	**<.001**
Hypertension	44.6 (26,101)	19.7 (11,519)	35.7 (20,889)	**<.001**
Smoker	41.2 (16,680)	19.4 (7,841)	39.4 (15,939)	**<.001**
Diabetes	43.7 (5,672)	17.7 (2,292)	38.7 (5,021)	**<.001**
Chronic obstructive pulmonary disease	47.2 (2,007)	17.5 (743)	35.3 (1,497)	**<.001**
History of congestive heart failure	42.8 (258)	15.6 (94)	41.6 (251)	**.016**
History of myocardial infarction	42.6 (160)	16.0 (60)	41.5 (156)	.086
Pneumonia	44.2 (126)	11.2 (32)	44.6 (127)	**.004**
Wound classification, % (*n*)				
Clean	43.0 (18,844)	29.7 (13,042)	27.3 (11,975)	**<.001**
Clean/contaminated	44.1 (42,746)	17.0 (16,416)	38.9 (37,614)	**<.001**
Contaminated	38.7 (17,115)	18.3 (8,076)	43.0 (18,980)	**<.001**
Dirty/infected	40.7 (4,865)	16.5 (1,976)	42.8 (5,121)	**<.001**
Procedures, % (*n*)				
Laparoscopic appendectomy	28.9 (24,164)	27.4 (10,824)	40.7 (23,935)	**<.001**
Laparoscopic cholecystectomy	47.8 (39,969)	38.6 (15,240)	40.4 (37,384)	**<.001**
Open inguinal hernia repair	23.3 (19,437)	34.0 (13,446)	27.3 (12,371)	**<.001**

Bold values indicate statistical significance.

residents were involved/operated on larger proportion of black patients. Junior residents were more likely to be involved/operate on black patients and were more likely to develop wound infections. Black, Hispanic, and Asian patients were more likely to be operated on by senior residents than attending surgeons alone. Black patients, in particular, were more than twice as likely (adjusted OR 2.02; 95% CI 1.95–2.09) to receive treatment from senior residents. Given that surgeries involving residents have been associated with greater rates of complications[11,12,14]—a finding corroborated by our results—increased treatment of minority patients by surgical residents may reflect an important provider-level factor that needs to be carefully considered. Surgical residents, particularly senior trainees, are granted increasing operative independence as they progress through their residency years. Greater exposure to minority patients has the potential to propagate surgical disparities if appropriate safeguards and training are not put in place. Further studies are needed to more fully elucidate the extent of the apparent association between surgical residents as a provider-level factor and the known link between race/ethnicity and disparate outcomes experienced by surgical patients.

Racial/ethnic disparities in surgical outcomes and resident involvement have not been well studied. Limited data on the topic suggest mixed postoperative outcomes by surgical residents performing multiple surgical procedures.[14,19,20] The concern, however, is that by relying on inclusion of a wide array of general surgery procedures, the reported results may reflect underlying differences in patient populations and operative techniques (residual confounding) rather than the specific associations that the authors sought to address. Work by Tseng et al[21] takes an important step, restricting the included patient population to selected procedures as did work by Hwang et al.[13] Moving from complex procedures such as laparoscopic Nissen fundoplications, Roux-En-Y gastric bypasses, and total thyroidectomies[21] or bowel resections and mastectomies[13] in which the role of a surgical resident may not be clear, the

Table IV. Proportions of postoperative outcomes (n = 196,770), stratified by level of provider training

	Attending	*Junior*	*Senior*	P *value*
Major complications, % (n)	**2.37 (1983)**	**2.15 (848)**	**2.79 (2053)**	**<.001**
Organ-space surgical-site infections	0.5 (440)	0.6 (229)	0.8 (615)	**<.001**
Respiratory complications	0.6 (485)	0.5 (200)	0.7 (503)	**<.001**
Cardiovascular complications	0.1 (100)	0.1 (41)	0.1 (93)	.578
Central nervous system complications	0.1 (40)	0.04 (17)	0.06 (42)	.557
Systemic complications	0.6 (485)	0.5 (185)	0.8 (549)	**<.001**
Renal complications	0.6 (501)	0.5 (195)	0.7 (522)	**<.001**
Minor complications, % (n)	**1.3 (1113)**	**1.37 (541)**	**1.67 (1228)**	**<.001**
Superficial surgical-site infections	0.7 (576)	0.8 (322)	0.1 (706)	**<.001**
Wound infections	1.4 (1141)	1.5 (602)	1.9 (1418)	**<.001**
Dehiscence	0.1 (66)	0.1 (28)	0.1 (41)	.207
UTIs	0.005 (412)	0.004 (160)	0.006 (409)	**.003**
Wound infections, % (n)	**1.37 (1141)**	**1.52 (602)**	**1.92 (1418)**	**<.001**
Superficial surgical-site infections	0.7 (576)	0.8 (322)	0.1 (706)	**<.001**
Deep surgical-site infections	0.1 (93)	0.1 (38)	0.1 (90)	.459
Dehiscence	0.1 (66)	0.1 (28)	0.1 (41)	.207
Organ space surgical site infections	0.5 (440)	0.6 (229)	0.8 (615)	**<.001**
Mortality, % (n)	**0.21 (172)**	**0.14 (55)**	**0.22 (140)**	**.039**
Return to operating room, % (n)	**1.03 (862)**	**0.94 (372)**	**1.09 (803)**	.063

Bold values indicate statistical significance.
UTIs, Urinary tract infections.

Table V. Proportions of postoperative outcomes (n = 196,770), stratified by patient race/ethnicity

Race/ethnicity, % (n)	*Major complications*	*Minor complications*	*Wound infections*	*30-day mortality*	*Return to operating room*
White	2.5 (3,646)	1.5 (2,158)	1.6 (2,329)	0.2 (284)	1.1 (1,533)
Black	3.1 (569)	1.7 (303)	1.8 (326)	0.2 (44)	1.3 (234)
Hispanic	1.9 (455)	1.2 (291)	1.5 (351)	0.1 (19)	0.8 (186)
Asian	2.1 (130)	1.3 (78)	1.7 (100)	0.2 (12)	0.9 (52)
American Indian/Alaskan Native	2.6 (65)	1.8 (45)	1.9 (49)	0.2 (6)	1.1 (27)
Native Hawaiian/Pacific Islander	3.8 (19)	1.4 (7)	1.8 (9)	0.4 (2)	1.0 (5)
P value	**<.001**	**.002**	**.131**	**.001**	**<.001**

Bold values indicate statistical significance.

results of the present analysis specifically considered patients in a surgical outcomes research database undergoing the 3 most common general surgical procedures across all resident training levels as identified by the surgery resident national case log data.[18]

Heightened odds of complications for junior and senior residents similarly were reported by Kiran et al.[14] They found a slightly lesser rate of complications for junior residents compared with senior residents.[14] Evaluating the residents as a group, Raval et al[20] also found greater morbidity with resident involvement across multiple surgical procedures. With select procedures, Tseng et al[21] likewise reported increased 30-day morbidity. In contrast to our findings, Hwang et al[13] found no differences in outcomes when they compared resident involvement and attending surgeons alone in a single institution study conducted by Southern Illinois University. Itani et al[19] further evaluated resident supervision and outcomes. They found that slightly fewer white patients and slightly more black patients were among the group in which the attending was not present in the operating room but available. This was attributed to the finding that emergent surgeries were required more frequently in minorities[19] and further supported by Schwartz et al,[22] who found that emergent operations were more likely in black and Hispanic men.

The surgical resident's impact on racial/ethnic disparities in surgical outcomes is significant and the reasons why need to be considered to effect change and influence patient care. Are senior

Table VI. Risk-adjusted odds ratios (95% confidence intervals) for postoperative outcomes, stratified by level of provider training

	Attending	*Juniors*	*Seniors*
Age, y (reference: 18−29 y)			
30–39	Reference	0.97 (0.93–1.02)	0.94 (0.91–0.98)
40–49	Reference	0.90 (0.86–0.94)	0.88 (0.86–0.91)
50–59	Reference	0.91 (0.86–0.95)	0.88 (0.85–0.91)
>60	Reference	0.82 (0.78–0.86)	0.79 (0.76–0.82)
Sex (reference: male)			
Female	Reference	0.94 (0.91–0.97)	0.95 (0.93–0.98)
Race/Ethnicity (reference: white)			
Black	Reference	1.50 (1.42–1.57)	2.02 (1.95–2.09)
Hispanic	Reference	0.69 (0.66–0.73)	1.09 (1.05–1.12)
Asian	Reference	1.16 (1.07–1.25)	1.25 (1.18–1.32)
American Indian/Alaskan Native	Reference	3.05 (2.74–3.39)	0.93 (0.83–1.03)
Native Hawaiian/Pacific Islander	Reference	0.91 (0.66–1.27)	0.81 (0.66–0.99)
Comorbidities			
Any comorbidity	Reference	0.92 (0.89–0.95)	0.97 (0.95–1.00)
Wound classification (reference: clean)			
Clean/contaminated	Reference	0.54 (0.52–0.56)	1.34 (1.30–1.38)
Contaminated	Reference	0.66 (0.63–0.69)	1.68 (1.63–1.74)
Dirty/infected	Reference	0.58 (0.54–0.62)	1.62 (1.55–1.70)
Outcomes			
Major complications	Reference	0.99 (0.91–1.07)	1.13 (1.06–1.21)
Minor complications	Reference	1.10 (0.99–1.22)	1.20 (1.11–1.31)
Wound infections	Reference	1.20 (1.09–1.33)	1.29 (1.19–1.39)
30-day mortality	Reference	0.78 (0.58–1.06)	0.95 (0.76–1.20)

residents more likely to develop complications because they were operating more independently? This explanation is very plausible because the very premise of surgical residency training involves graduated operating independence under supervision. The surgical resident should be likened to a low-volume operating surgeon and, as such, more prone to poorer surgical outcomes. There have been several studies in which authors evaluated the impact of surgeon volume and quality on surgical outcome disparities. Morris et al[9] found that black patients undergoing rectal cancer surgery were more likely to be treated by low-volume surgeons. Similar findings were seen in both Hispanic and black patients undergoing thyroidectomy.[23] Castellanos et al[24] found that Hispanic patients were more likely to be operated on by cardiac surgeons with greater rates of mortality, all of which contributed to poor surgical outcomes in these patients. Residents were more likely to operate on minority patients because those patients were most likely to seek health care at academic medical centers where the majority of surgical residents practice. Minority patients account for approximately 80% of discharges from academic medical centers when compared to approximately 20% from nonteaching hospitals.[25]

The implications of our study should to be carefully considered. The finding that surgical residents treat more minority patients emphasizes the role of cultural competency training. This has long been the recommendation of Institute of Medicine's report entitled "Unequal Treatment: Confronting Racial and Ethnic Disparities in Health Care,"[1] but lack of buy-in by surgical residents continues to be a problem.[26,27] To achieve equitable and optimal patient care, surgeons and surgical residents alike must adapt to the growing diversity of the US population. Increased postoperative complications by residents may warrant the need for resident specific surgical care improvement project checklists. Our study reiterates the need to fully understand the role of provider-level factors in disparities for surgical care. These factors go beyond the attending surgeon and, as seen in our study, also can extend to other members of the surgical team, such as the surgical residents. Consideration should be given for mandatory skills simulation training for residents to help refine their skills and improve efficiency and outcomes.

There are several limitations to our study. Although use of the ACS-NSQIP database allows access to nuanced comorbidity and patient-level data in a national sample of surgical patients intended for research purposes, it does not include information on the type of hospital (academic medical center, community or Veterans' Administration facility) in which a patient receives care, nor are we able to distinguish potential regional differences in race/ethnicity. Information regarding teaching status, hospital volume, and regional information may help to explain part of the results observed. Data on differences in case complexity and corresponding resident involvement were limited, hampering our ability to fully account for how case severity influences the type of surgeon providing care. The level of resident participation and, in turn, the degree of attending supervision and/or assistance is not recorded. Similarly, we cannot accurately determine what percentage of any given case was performed by a resident versus completed with attending assistance. For example, we do not know at what time the attending scrubbed out of the case or if the resident was left to finish the case by himself/herself. ACS-NSQIP only documents the greatest PGY level of the resident scrubbed in. As such, we are further unable to accurately account for senior resident teaching cases, wherein greater-level residents guide junior residents through a procedure. Patient−provider racial/ethnic concordance may also have been involved but was beyond the scope of the data to assess. Finally, the ACS-NSQIP dataset classifies the level of resident training according to PGY levels, presenting a problem for classifying resident trainee levels in a 7-year residency and subsequent fellowship programs. We, therefore, chose to group PGY 3–10 into the senior group, protecting comparability of the data at the expense of conducting nuanced analyses. Future studies would do well to consider how the effects reported in the present results potentially change as a resident progresses from intern through fellowship experience levels. Future studies are needed to further clarify the role of the surgical resident on health disparities.

Our study highlights the impact of surgical residents on health disparities among surgical outcomes. Surgical residents provide a significant percentage of the surgical workforce and must be considered when assessing provider-level factors for health disparities. Surgical residents are more likely to interact and treat minority patients and, therefore, cultural competency training during surgical residency should be a priority. Our study serves to emphasize the complexity of racial disparities in health care outcomes, and further studies are needed to evaluate the impact of residents.

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