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Do hospital factors impact readmissions and mortality after colorectal resections at minority-serving hospitals?

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Abstract

Background—Minority-serving hospitals have greater readmission rates after operative procedures including colectomy; however, little is known about the contribution of hospital factors to readmission risk and mortality in this setting. This study evaluated the impact of hospital factors on readmissions and inpatient mortality after colorectal resections at minority-serving hospitals in the context of patient and procedure-related factors.

Methods—More than 168,000 patients who underwent colorectal resections in 374 California hospitals (2004–2011) were analyzed using the State Inpatient Database and American Hospital Association Hospital Survey data. Sequential logistic regression analyses were performed to determine the associations between minority-serving hospital status and 30-day, 90-day, and repeated readmissions.

Results—Thirty-day, 90-day, and repeated readmission rates were 11.2%, 16.9%, and 2.9%, respectively. Odds for 30-day, 90-day, and repeated readmissions after colorectal resections were 19%, 20%, and 38% more likely at minority-serving hospitals versus non-minority-serving hospitals, respectively ($P < .01$), after controlling for age, sex, comorbidities, year, and procedure type. Patient factors accounted for up to 65% of the observed increase in odds for readmission at minority-serving hospitals while hospital-level factors contributed roughly 40%. Inpatient mortality was significantly greater at minority-serving hospitals versus non-minority-serving

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SUPPLEMENTARY DATA

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hospitals (4.9% vs 3.8%; $P<.001$). Risk factors significantly associated with readmissions and inpatient mortality included Medicaid/Medicare primary insurance, emergent operation, and ostomy creation. Low procedure volume was significantly associated with increased odds for inpatient mortality.

Conclusion—Patient-level factors seemed to dominate the increased readmission risk after colorectal resections at minority-serving hospitals while hospital factors were less contributory. These findings need to be further validated to shape quality improvement interventions to decrease readmissions.

Colorectal operations are performed across a wide variety of hospitals in the United States from the academic tertiary referral setting to rural communities. Colon and/or rectal resections are indicated for a number of pathologic conditions including colorectal cancer, inflammatory bowel disease, and diverticulitis. In particular, colorectal cancer is a serious health burden and remains a leading cause of US cancer mortality.¹ Barriers to cancer screening and treatment include various socioeconomic factors such as insurance status, income, and race.² Additionally, there is increasing evidence of rural-urban disparities³ with regard to colorectal cancer outcomes highlighting areas of weakness in the US healthcare system.⁴ Moreover, little is known about outcomes for colorectal cancer and other colorectal conditions in vulnerable patient populations such as those treated in minority-serving institutions.

Colorectal surgery patients are at great risk for postoperative morbidity and 30-day readmissions. Complications after colorectal resection are reportedly as great as 30% including operative site infection (SSI), dehydration, and bowel obstruction.⁵ Thirty-day readmission rates range from 8–25%⁶ and are historically greater than other surgical specialties. For example, Greenblatt et al⁷ found that 65% of patients >65 years old were readmitted after colorectal cancer resections for gastrointestinal complications and infection. Complications, particularly intra-abdominal or organ space SSI, drive readmissions leading to invasive interventions⁵ with estimated costs per readmission at \$9,000.⁸ Prevention of readmissions after colorectal operation could amount to >\$300 million in annual cost savings.⁸

Hospital readmissions are a focal part of the 2010 Patient Protection and Affordable Care Act, specifically the Hospital Readmissions Reduction Program (HRRP) penalizing hospitals with greater-than-benchmark readmissions.^{9,10} Recent studies have found that certain minority-serving hospitals (MSH) such as safety-net hospitals that provide health care to a large proportion of uninsured minorities and Medicaid patients are more commonly penalized under the HRRP program.^{10–12} There is additional evidence demonstrating that Medicare patients are at significantly increased risk for 30-day readmissions after major operative procedures, including colectomy, at MSH versus non-MSH institutions.¹³ Currently, there is a paucity of research exploring outcomes in the MSH setting among colorectal surgery patients. Understanding patient-, procedure, and hospital-level factors unique to the MSH environment is critical to reducing readmissions after colorectal operation. To address this knowledge gap, we performed a study to analyze the extent to which hospital factors drive readmissions after colorectal resections performed at MSH in

the context of patient- and procedure-related factors. Understanding the relative contribution of these determinants may help guide targeted quality improvement interventions aimed at reducing hospital readmissions.

METHODS

Patient selection and data source

We identified 168,590 adult patients who underwent colon and/or rectal resections as primary inpatient procedures in California between January 2004 and September 2011 using International Classification of Diseases, Ninth Revision (ICD-9) procedure codes (Supplementary Table I) from the State Inpatient Database (SID) of California. SID is a part of the Healthcare Cost and Utilization Project (HCUP) sponsored by the Agency for Healthcare Research and Quality.¹⁴ The California SID encompasses all discharge records from all non-federal community hospitals in California. The rationale behind using the California SID is mainly due to the fact that California is one of the largest and most diverse states in the United States in terms of race, ethnicity, age, and insurance coverage.

The inpatient database was supplemented by hospital structural data from the 2009 cycle of the American Hospital Association (AHA) Annual Survey. The California SID is a rich repository for patient- and procedure-level data in a racially diverse cohort across a wide range of ages which is further strengthened by linking hospital-level data from the AHA.

Variables

The predictor of primary interest was the minority-serving status of the operative hospital, which was defined as being in the top decile for the proportion of black or Hispanic patients. Out of 491 hospitals in the SID dataset, 49 were classified as MSH. Overall, 374 (76%) hospitals performed colon and/or rectal resections of which 47 (13%) were classified MSH.

Outcomes

We evaluated 3 primary readmission measures or outcomes after colorectal resections as follows: readmissions within 30 days and 90 days of index hospitalization and repeated readmission within 60 days of discharge from the first 30-day readmission. Given the positive correlation between hospital readmissions and mortality rates,¹⁵ we evaluated inpatient mortality during index admission as our secondary outcome. While the 30-day readmission rate has been a widely used measure in the literature and adopted by HRRP, the 90-day and repeated readmissions are also clinically relevant and enabled us to capture delayed effects of the operation. Primary readmission diagnosis codes were classified using the Clinical Classification System provided by HCUP.¹⁶

Covariates

Four sets of covariates were utilized in this study including hospital-level factors in addition to patient- and procedure-related factors. The first set was chosen to imitate the risk-adjusting scheme in the Medicare HRRP and included the patient's age at index admission, sex, Charlson comorbidity score, year of admission, and procedure type (colon versus rectal resection). The second set included patient-related factors as follows: race, quartile of zip

code-level income (ie, the median income of the patient's zip code area), and primary insurance coverage. The third set of covariates, hospital-level factors, included bed size, nurse-to-bed ratio, teaching hospital (ie, presence of a residency training program), cancer program approved by American College of Surgeons, intensive care unit, wound management services, physical rehabilitation facilities, and procedure volume. The fourth set of covariates included procedure-related factors: emergency status of the index operation, laparoscopic approach, and whether an ostomy was created during the index operation. Laparoscopic procedures were identified using the primary ICD-9 procedure code. Secondary ICD-9 procedure codes were used to identify whether an ostomy was performed.

Statistical methods

Rates of 30-day, 90-day, and repeated readmissions and inpatient mortality were calculated and compared by MSH status via χ^2 tests. Patient- and procedure-related factors were compared on the patient level and hospital-related factors on the hospital level also by MSH status via χ^2 tests. Four logistic models were constructed for each outcome adjusting for different sets of covariates. Model 1 used a minimal risk adjustment scheme by including only the HRRP variables; models 2 through 4 each incorporated an additional set of predictors (respectively, patient-, hospital-, and procedure-related factors) in a parallel, noncumulative fashion. Generalized linear mixed models were used to fit the regression with hospital-level random effect. Estimated odds ratios of non-MSH versus MSH were compared between model 1 and each of models 2 through 4; the percentage change in in OR was calculated as $(OR_{\text{Model 2-4}} - OR_{\text{Model 1}})/(OR_{\text{Model 1}} - 1)$. Finally, a full model was constructed for each outcome that included all 4 sets of covariates as predictors to identify risk factors for readmissions and inpatient mortality. A sensitivity analysis using the top quartile as the definition for MSH was conducted; similar conclusions were drawn, so only the results from analysis with the top decile were presented. All analyses were performed with SAS version 9.4 (Cary, NC). All tests were 2-sided and used an α of 0.05. This study was deemed exempt from review by the MedStar Health Research Institute Institutional Review Board given the de-identified nature of the California SID and AHA databases.

RESULTS

The 30-day, 90-day, and repeated readmission rates among patients who underwent colorectal resections at non-MSH were 11.6%, 17.4%, and 3.0%, respectively (Table I). Thirty-day, 90-day, and repeated readmission rates among colorectal surgery patients at MSH were 13.6%, 20.1%, and 4.0%, respectively. Twenty-five percent of non-MSH patients compared with 29% of MSH patients readmitted within 30 days of index admission had a repeated readmission. All rates reported above were significantly greater among MSH patients than non-MSH patients (all $P < .0001$).

Table II represents the distribution of patient- and procedure-level factors by MSH status. MSH patients were generally younger; 56% of MSH patients were in the 18- to 64-year-old age group compared with 54% of non-MSH patients who were ≥ 65 years older ($P < .001$). Greater than 50% of all patients in the MSH and non-MSH settings, respectively, had a Charlson comorbidity index score of zero. In addition, 43.7% of MSH patients were

Hispanic and 19.2% non-Hispanic black compared with 71.9% non-Hispanic whites in the non-MSH setting. Forty percent of MSH patients lived in the lowest income areas zip code compared with 16% in non-MSH patients ($P < .0001$). MSH served a significantly greater proportion of Medicaid patients than non-MSH (21.1% vs 5.2%, respectively, $P < .0001$).

At both MSH and non-MSH, the majority of index operations were nonemergent, open colon resections with no ostomy created. Overall, 66% of cases were elective while 34% were emergent, 88.5% were colectomies, 86% done via open technique, and 17.7% ostomies were created. Interestingly, rectal resections (11.0% vs 9.0%) and laparoscopic operations (13.8% vs 9.1%) were significantly more common at non-MSH than MSH (both $P < .0001$). In contrast, emergent operations (46.4% vs 32.9%) and ostomy creation during index operation (20.1% vs 17.9%) were significantly more common at MSH than non-MSH (both $P < .0001$). The top 3 reasons for index admission based on ICD-9 primary diagnosis codes were colon and/or rectal cancer, diverticular disease, and miscellaneous (ie, rectal prolapse, benign neoplasm, etc; Supplementary Table II).

Multiple differences in hospital-level factors were identified in MSH versus non-MSH (Table III). The presence of intensive care units and physical rehabilitation care was similar between these 2 types of hospitals. Non-MSH institutions were significantly more likely to have high bed size (ie, >400) compared with MSH (9.5% vs 4.3%, respectively; $P = .003$). The following variables were significantly more common in MSH versus non-MSH: 1) low procedure volume (69.1% vs 93.6%, respectively; $P = .002$), 2) teaching hospital (25.5% vs 18.0%, respectively; $P = .039$), and 3) lack of a comprehensive cancer program (70.2% vs 60.2%, respectively; $P = .009$). Wound management services and nurse-to-bed ratios under 2 were significantly less common in MSH ($P = .011$, respectively).

Table IV summarizes estimated odds ratios of readmission between patients of MSH and non-MSH from our logistic models. After controlling for patient's age, sex, comorbidity, as well as year and type of procedure (colon versus rectal) in model 1, MSH patients exhibited 19%, 20%, and 38% greater odds of 30-day, 90-day, and repeated readmission, respectively, compared with non-MSH patients (all $P < .001$). These effects were partially attenuated by additional adjustment of patient-, hospital-, and procedure-level characteristics to various extents. Patient factors including race, primary insurance payer, and income accounted for up to 55–65% of the observed increase in odds for readmission after colorectal resections at MSH (65.2% for 30-day, 55.8% for 90-day, and 57.7% for repeated readmission). In comparison, hospital structure factors contributed 34–42% (41.6% for 30-day and 90-day, 34.9% for repeated readmission) and procedure-related factors 21–29% (26.2% for 30-day, 28.6% for 90-day, and 21.5% for repeated readmission) to the increased odds for MSH readmissions.

Odds ratios of readmission associated with all predictors were reported in Table V as estimated from the full model. Although MSH status was no longer significantly associated with readmission measures after additional risk adjustment, multiple risk factors were associated with significantly increased odds of 30-day, 90-day, and repeated readmissions: 1) Charlson comorbidity score of 1, 2) rectal resection, 3) non-Hispanic black race, 4) Medicaid or Medicare primary insurance, 5) emergent operation, and 6) ostomy created

during index case. Factors significantly likely to decrease 30-day, 90-day, and/or repeated readmissions included the following: 1) age group 65–74 years, 2) Asian/Pacific islander race, 3) laparoscopic resection, 4) low bed size (1–99), and 5) nonteaching hospital.

Overall, inpatient mortality after colon and/or rectal resections was significantly greater at MSH versus non-MSH (4.9% vs 3.8%, respectively; $P < .0001$). Risk factors significantly associated with inpatient mortality were somewhat similar to those associated with increased readmissions and included increasing age, Charlson comorbidity score of ≥ 1 , lower income quartiles (first and second), Medicaid or Medicare primary insurance, emergent operation, ostomy created during index case, and lower procedure volumes. On subsequent regression analysis, patient factors accounted for 44.5% of the observed increase in odds for mortality (odds ratio [OR]: 1.23; 95% confidence interval [CI], 1.06–1.43) after colon or rectal resections at MSH while hospital-level factors contributed 51.8% (OR: 1.20; 95% CI, 1.02–1.42; data not shown).

DISCUSSION

In this large retrospective study, we demonstrated that hospital readmission and inpatient mortality rates after colon and/or rectal resections were significantly greater in the MSH versus non-MSH setting. To our knowledge, this is the first study to evaluate patient-, procedure-, and hospital-level factors simultaneously and the relative contribution of these factors to readmissions and mortality among colorectal surgery patients. On multivariate analysis across the entire cohort, 80% of patient factors and 100% of procedure factors compared with only 40% of hospital factors had a significant impact on readmission risk. To assess the variation in readmission and mortality risk at MSH versus non-MSH based on patient-, hospital-, and procedure-level factors, we expanded the HRRP model in 3 separate analyses as previously described; based on these results, patient-related risk factors seemed to be the primary driver of 30-day, 90-day, and repeated readmissions in the MSH setting, although the relative contribution on inpatient mortality was not as strong.

Colorectal surgery patients treated at minority-serving institutions represent a uniquely vulnerable population given the combination of patient-, procedure-, and hospital-level risk factors; there is a robust body of evidence supporting the impact of certain patient- and procedure-related risk factors on readmissions in this surgical cohort. We have recapitulated prior authors by demonstrating that patient factors such as black race^{13,17} and underlying medical illnesses¹⁸ significantly increased readmission risk. While the study by Schneider et al^{17,18} predominantly focused on colorectal cancer patients with Medicare insurance and 30-day readmissions, our results span a broader range of ages, insurance types, and readmission time frames. Furthermore, in agreement with our findings, Hensley et al¹⁹ showed that procedure-related factors including ileostomy formation significantly increase 30-day readmissions after colectomy.

In contrast to patient- and procedure-related factors, the role of hospital-level factors on readmission and mortality risk is not as well-established among colorectal surgery patients. There is a growing body of evidence demonstrating that readmission rates at safety-net hospitals, a subset of MSH, among surgical patients may be largely driven by hospital-level

factors.^{20,21} For example, Tsai et al¹⁵ demonstrated that greatest case volume was associated with significantly lower 30-day readmission rates among Medicare patients undergoing colectomy and that lower hospital mortality rates were significantly associated with decreased readmissions. We also found that low procedure volume was associated with significantly increased odds for readmission among colorectal patients, regardless of MSH status; however, this was only demonstrated for the 90-day time frame. Moreover, low procedure volume also was associated with significantly increased odds for inpatient mortality. In contrast to our results, Hoehn et al²⁰ demonstrated that high safety-net burden versus lower safety-net burden hospitals had significantly increased risk for readmission and inpatient mortality after colectomy after controlling for patient-level factors and hospital volume, suggesting that hospital resources may be the underlying problem. Regardless of the driving factors for readmission and mortality, MSH and safety-net hospitals are at high risk for poor outcomes among colorectal surgery patients and could face serious financial hardship given the associated costs and potential reimbursement implications.

Despite the lower relative contribution of hospital factors to readmission risk in our study, multiple insights were gained from our analysis. First, non-teaching hospital status and low bed size were 2 of the hospital factors significantly associated with decreased odds for readmissions after colorectal resection on multivariate analysis. One explanation for these findings is that lower bed size may be indicative of a less complex operative case mix and hence less complicated postoperative care. Furthermore, for non-teaching hospitals, the lack of resident participation in colorectal cases seemed to be protective for readmission. One could hypothesize that surgery residents may require additional technical and/or knowledge-based skills to participate in colorectal operations and manage postoperative care in order to have better outcomes. Regarding inpatient mortality, low procedure volume was the most significant determinant for increased risk of mortality after colorectal resection. These findings are likely in part due to surgeon expertise and advanced training in colorectal operations given that rectal resections and laparoscopic procedures were, not surprisingly, significantly more common in the non-MSH setting where inpatient mortality rates were significantly lower. Moreover, non-MSH institutions may have the infrastructure to provide superior and more comprehensive care to colorectal surgery patients given the significantly greater bed size, presence of cancer programs, wound management services, and smaller nurse-to-bed ratios.

There are several important caveats for interpreting the results of this study. Although we used a large, diverse operative cohort with a wide range of ages, our analysis was limited by being retrospective. Furthermore, we did not include all hospital-level factors such as rural versus urban setting or hospital ownership status which may have an impact on the outcomes evaluated. In addition, we were not able to obtain information on surgeon volume, expertise, and/or advanced training. We were also not able to analyze the impact of postoperative complications germane to colorectal surgery patients such as SSI, bowel obstruction, and dehydration on readmission, and mortality risk. Lastly, we could not assess any details for case complexity or case mix. Ultimately, these findings need to be further validated to shape quality improvement interventions to help decrease readmissions and mortality in colorectal surgery patients.

The complex interplay of patient-, procedure-, and hospital-level factors is important for optimizing postoperative outcomes at MSH, particularly among colorectal surgery patients. This is crucial given the anticipation of HRRP financial penalties for unnecessary readmissions after various operative procedures across 2017, which could include colectomy in the ensuing years.^{22,23} Options to improve MSH operative outcomes that warrant investigation include regionalization of care for specific surgical cohorts like colorectal to determine if clustering index operations at certain hospitals can translate into decreased readmission and mortality rates. Efforts also should be put toward deploying targeted interventions such as prescheduled outpatient follow-up appointments prior to discharge, tablet-based education materials during index admission,²⁴ and post-discharge ostomy care plans to determine the impact on outcomes. MSH require devoted patient safety and quality initiatives to provide optimal care to vulnerable patients. Moreover, HRRP financial penalties should account for pertinent social factors such as race to circumvent further financial hardship in the MSH setting.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Table 1

Proportion of patients readmitted after colorectal resection by minority-serving status of operative hospitals, California Inpatient Database 2004–2011 (*N* = 168,590)

Rate (%)	Non-MSH (<i>N</i> = 151,877) [*]		MSH (<i>N</i> = 10,134) [*]		<i>P</i> value
	<i>N</i>	%	<i>N</i>	%	
30-day readmission	17,544	11.6	1,380	13.6	<.0001
90-day readmission	26,414	17.4	2,035	20.1	<.0001
Repeated readmission [‡]	4,484	3.0	409	4.0	<.0001
Repeated readmission [‡]	—	25.6	—	29.6	<.0001

^{*} Patients who died during the index hospitalization were removed from the denominator.

[‡] Defined as readmitted again within 60 days of discharge from the first 30-day readmission.

[‡] Divided by the total number of 30-day readmissions.

MSH, Minority-serving hospital.

Table II

Distribution of sociodemographic, clinical, and procedure characteristics among colorectal surgery patients by minority-serving status of operative hospitals, California Inpatient Database 2004–2011 ($N = 168,590$)

Column percentage * (%)	Non-MSH	MSH	P value
	N = 157,940	N = 10,650	
Age, y			
18–49	16.5	23.2	<.0001
50–64	29.2	33.0	
65–74	23.5	20.4	
75+	30.8	23.5	
Sex			
Male	46.5	49.7	<.0001
Female	52.1	48.9	
Charlson Comorbidity Score			
0	64.2	61.8	<.0001
1	23.0	23.8	
2	12.8	14.4	
Zip code-level income †			
First quartile	16.2	39.8	<.0001
Second quartile	19.9	24.4	
Third quartile	24.1	15.3	
Fourth quartile	25.5	6.6	
Race			
NH white	71.9	26.6	<.0001
NH black	5.5	19.2	
Hispanic	11.7	43.7	
API	7.6	6.9	
Other	3.3	3.7	
Primary insurance			
Medicare	51.6	41.4	<.0001
Private	39.4	23.5	
Medicaid	5.2	21.1	
Other	3.8	14.1	
Procedure type			
Colon	89.1	91.0	<.0001
Rectum	11.0	9.0	
Emergency status			
Yes	32.9	46.4	<.0001
No	67.1	53.6	
Laparoscopy			
Yes	13.8	9.1	<.0001

Column percentage* (%)	Non-MSH	MSH	P value
	N = 157,940	N = 10,650	
No	86.2	90.9	
Ostomy			
Yes	17.9	20.1	<.0001
No	82.1	9.9	

* Some columns may not add up to 100% due to missing values.

† Zip code-level income indicates the median income of the patient's zip code area.

API, Asian-Pacific Islander; MSH, minority-serving hospital; NH, non-hispanic.

Table III

Distribution of structural characteristics among hospitals that performed colorectal operation by minority-serving status, California Inpatient Database 2004–2011 ($N = 374$)

	Non-MSH	MSH	
Column percentage* (%)	$N = 327$	$N = 47$	P value
Procedure volume			
Low	69.1%	93.6%	.002
Medium	19.3%	6.4%	
High	11.6%	0.0%	
Bed size			
1–99	23.5%	4.3%	.003
100–399	59.0%	74.5%	
400+	9.5%	4.3%	
Teaching hospital			
Yes	18.0%	25.5%	.039
No	74.0%	57.4%	
Has cancer program			
Yes	31.8%	12.8%	.009
No	60.2%	70.2%	
Intensive care unit			
Yes	69.7%	59.6%	.058
No	11.0%	6.4%	
Wound management services			
Yes	48.3%	36.2%	.011
No	26.0%	17.0%	
Physical rehabilitation facilities			
Yes	7.3%	4.3%	.11
No	84.7%	78.7%	
Nurse-to-bed ratio			
<2	29.7%	17.0%	.011
2–3.5	26.3%	14.9%	
3.5	16.8%	19.1%	

* Some columns may not add up to 100% due to missing values.

MSH, Minority-serving hospital.

Table V

Adjusted odds ratios associated with of sociodemographic, clinical, and procedure characteristics among colorectal surgery patients by minority-serving status of operative hospitals, California Inpatient Database 2004–2011 ($N = 168,590$)

	30-day readmission	90-day readmission	Repeated readmissions
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Minority serving status (ref = Non-MSH)			
MSH	1.02 (0.92, 1.12)	1.04 (0.95, 1.13)	1.10 (0.96, 1.26)
Age (ref = 75 y)			
50–64	0.94 (0.89, 0.99)*	0.98 (0.94, 1.03)	0.88 (0.79, 0.97)*
65–74	0.82 (0.76, 0.89) [†]	0.89 (0.83, 0.95) [‡]	0.68 (0.60, 0.77) [‡]
75+	0.94 (0.87, 1.01)	1.05 (0.98, 1.13)	0.79 (0.68, 0.91) [‡]
Sex (ref = female)			
Male	1.01 (0.98, 1.04)	0.97 (0.94, 0.99)*	0.88 (0.83, 0.93) [‡]
Charlson Comorbidity Score (ref = 0)			
1	1.25 (1.21, 1.30) [‡]	1.28 (1.24, 1.32) [‡]	1.42 (1.32, 1.53) [‡]
2+	1.73 (1.65, 1.81) [‡]	1.85 (1.77, 1.93) [‡]	2.22 (2.05, 2.40) [‡]
Year	1.02 (1.01, 1.03) [‡]	1.01 (1.00, 1.02) [‡]	1.03 (1.01, 1.05) [‡]
Procedure type (ref = rectal)			
Colon	1.19 (1.12, 1.26) [‡]	1.19 (1.13, 1.25) [‡]	1.26 (1.13, 1.40) [‡]
Zip code-level income [‡] (ref = fourth quartile)			
First quartile	1.00 (0.95, 1.06)	0.99 (0.95, 1.04)	0.99 (0.89, 1.10)
Second quartile	0.99 (0.94, 1.05)	0.99 (0.95, 1.03)	1.04 (0.95, 1.14)
Third quartile	1.01 (0.96, 1.07)	1.00 (0.96, 1.05)	1.07 (0.98, 1.18)
Race (ref = NH white)			
API	0.92 (0.86, 0.98) [§]	0.88 (0.84, 0.93) [‡]	0.91 (0.79, 1.03)
Hispanic	1.03 (0.99, 1.08)	0.99 (0.95, 1.03)	1.02 (0.94, 1.12)
NH black	1.18 (1.10, 1.25) [‡]	1.10 (1.05, 1.17) [‡]	1.24 (1.11, 1.39) [‡]
Other	0.86 (0.79, 0.94) [‡]	0.84 (0.78, 0.91) [‡]	0.82 (0.68, 0.98)*
Primary insurance (ref = private)			
Medicaid	1.39 (1.29, 1.49) [‡]	1.47 (1.38, 1.56) [‡]	1.88 (1.66, 2.12) [‡]
Medicare	1.31 (1.24, 1.39) [‡]	1.36 (1.29, 1.43) [‡]	1.60 (1.43, 1.81) [‡]
Other	1.02 (0.95, 1.11)	1.03 (0.96, 1.10)	1.03 (0.88, 1.20)
Emergency status (ref = no)			
Yes	1.28 (1.23, 1.33) [‡]	1.36 (1.31, 1.41) [‡]	1.46 (1.35, 1.56) [‡]
Laparoscopy (ref = no)			
Yes	0.77 (0.73, 0.82) [‡]	0.76 (0.72, 0.80) [‡]	0.71 (0.63, 0.79) [‡]
Ostomy (ref = no)			
Yes	1.49 (1.42, 1.57) [‡]	1.59 (1.53, 1.67) [‡]	1.76 (1.63, 1.91) [‡]

	30-day readmission	90-day readmission	Repeated readmissions
	OR (95% CI)	OR (95% CI)	OR (95% CI)
Procedure volume (ref = high)			
Low	1.02 (0.95, 1.08)	1.07 (1.01, 1.13) [*]	1.00 (0.89, 1.11)
Med	1.00 (0.94, 1.06)	1.01 (0.95, 1.07)	1.00 (0.90, 1.11)
Bed size (ref = 400)			
1–99	0.85 (0.75, 0.96) [§]	0.78 (0.69, 0.89) [‡]	0.82 (0.67, 1.00)
100–399	0.93 (0.86, 1.01)	0.90 (0.84, 0.97) [§]	0.93 (0.82, 1.06)
Teaching hospital (ref = yes)			
No	0.91 (0.85, 0.96) [§]	0.92 (0.86, 0.98) [§]	0.84 (0.77, 0.92) [‡]
Has cancer program (ref = yes)			
No	1.05 (0.99, 1.11)	1.00 (0.95, 1.06)	1.05 (0.96, 1.15)
Intensive care unit (ref = yes)			
No	1.05 (0.93, 1.19)	1.06 (0.96, 1.18)	0.96 (0.74, 1.24)
Wound management services (ref = res)			
No	0.98 (0.91, 1.04)	0.95 (0.90, 1.01)	1.05 (0.95, 1.16)
Physical rehabilitation facilities (ref = yes)			
No	1.06 (0.99, 1.14)	1.05 (0.98, 1.12)	1.08 (0.97, 1.21)
Nurse-to-bed ratio (ref = 0–2)			
2–3.5	1.02 (0.96, 1.09)	1.02 (0.96, 1.08)	1.02 (0.93, 1.13)
3.5+	1.06 (0.98, 1.14)	1.03 (0.96, 1.10)	1.10 (0.98, 1.23)

^{*} $P < .05$.

[‡] $P < .001$.

[‡] Zip code-level income indicates the median income of the patient's zip code area.

[§] $P < .01$.

API, Asian-Pacific Islander; *CI*, confidence interval; *MSH*, minority-serving hospital; *NH*, non-hispanic; *OR*, odds ratio; *Ref*, reference.