ORIGINAL CONTRIBUTION

Factors Associated With 30-Day Readmission After Restorative Proctocolectomy With IPAA: A National Study

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BACKGROUND: Hospital readmission has been identified by many payers as a surrogate for surgical quality. The 30-day readmission rate and factors associated with hospital readmission after restorative proctocolectomy with IPAA have not been well studied.

OBJECTIVE: The purpose of this work was to identify the rate of and factors associated with hospital readmission within 30 days of restorative proctocolectomy with IPAA.

DESIGN: A retrospective review of patients undergoing IPAA from 2009 to 2012 in the University HealthSystem Consortium database was performed. Hospitals were stratified into quartiles according to the number of cases performed annually.

SETTING: This study was conducted using a national database of university hospitals.

PATIENTS: A total of 4952 patients within the 4-year study period were included in the analysis.

MAIN OUTCOME MEASURES: The primary outcome measured was readmission within 30 days of discharge.

RESULTS: The 30-day readmission rate was 22.8% overall, although high-volume centers performed significantly better than low-volume centers (high vs low volume: 19.7% vs 28.2%; $p < 0.001$). When controlling for confounding variables, multivariate analysis identified female sex (OR, 1.191; $p = 0.02$), government-based (vs private) insurance (OR, 1.364; $p < 0.001$), and higher preoperative severity of illness (OR, 1.491; $p = 0.001$) to be associated with readmission. In addition, a significant volume-dependent relationship on 30-day readmission was identified, wherein undergoing operation at the higher-volume hospitals was protective for predicting readmission. Hierarchical regression modeling indicated that 31% of the variation in readmission rates among individual hospitals was accounted for by hospital volume.

LIMITATIONS: This study was limited by its retrospective nature and limited postoperative complication data.

CONCLUSIONS: The national 30-day readmission after IPAA creation was 22.8%, at least double that of other colorectal procedures. This high rate of readmission was mitigated by centers performing the highest volume of cases. Avoidance of referral to centers performing very few of these procedures annually may improve perioperative outcomes and reduce associated morbidity.

KEY WORDS: Hospital volume; IPAA; J-pouch; Readmission; Ulcerative colitis.

Unplanned hospital readmission after complex gastrointestinal operations is costly: in addition to its associated morbidity, hospital readmissions incur a substantial burden to the health-care system in terms of increased cost and use of resources. An estimated 20% of the annual $100 billion in Medicare payments are allocated toward hospitals for unplanned readmissions.[1] In an effort toward cost-effectiveness and quality improvement in health care, the Centers for Medicare and Medicaid Services began collecting and reporting 30-day readmission

Financial Disclosure: None reported.

Podium presentation at the meeting of The American Society of Colon and Rectal Surgeons, Hollywood, FL, May 17 to 21, 2014.

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Dis Colon Rectum 2014; 57: 1371–1378
DOI: 10.1097/DCR.0000000000000227

rates for patients treated for various medical disorders.[2] Initially targeting patients treated for medical conditions such as myocardial infarction and pneumonia, policymakers are currently adopting similar efforts toward quality improvement after surgical procedures as well.[3]

Although the debate regarding the efficacy of using readmission rates as a metric of quality is ongoing,[2,4,5] individual institutions and health services researchers have recently focused on identifying and mitigating factors associated with unplanned readmission after various operations.[6–10] Outcomes after some gastrointestinal procedures, such as pancreaticoduodenectomy[6] and colectomy,[7] have been extensively investigated, whereas other procedures have received less attention.

Since its first description in 1978 by Parks and Nicholls,[11] restorative proctocolectomy with IPAA has been the procedure of choice for many patients with refractory ulcerative colitis or familial adenomatous polyposis.[12,13] Despite its relatively favorable mortality profile, it carries an early morbidity rate of >30%.[12] Early reports demonstrated a cumulative 5-year probability for readmission of 68%,[14] whereas more recent reports demonstrate that 30-day readmission rates vary between 12% and 30%,[15–17] nearly double to triple that of other colorectal procedures.[18] Although higher operative volumes of IPAA have been associated with improved clinical outcomes,[19,20] the effect of hospital volume on readmission after this procedure is currently unknown. The aim of this study was to identify factors associated with readmission after IPAA on a national level.

MATERIALS AND METHODS

Patient Selection and Stratification

The University HealthSystem Consortium (UHC) Clinical Database/Resource Manager was queried for all patients undergoing elective proctocolectomy with IPAA between 2009 and 2012. This previously validated data set is composed of national administrative-level data collected from 120 academic medical centers and ≈300 affiliated institutions.[21] Patients ≥18 years of age with an *International Classification of Diseases*, Ninth Revision, procedure code of 45.95 (ie, formation of ileal pouch with anastomosis of small intestine to anus) were selected for further analysis.

Patient and Hospital Variables

Patient-specific variables, including age, sex, race, insurance payer status, and severity of illness, were identified for each patient. The severity of illness ranking (minor, moderate, severe, and extreme) consists of a proprietary construct from the UHC reflecting a complex 18-step algorithm, which incorporates the individual patient's primary diagnosis (eg, colitis), as well as multiple secondary diagnoses and comorbidities. These data are provided as part of the UHC database.

A summary measure of patient socioeconomic status data using US Census American Community Survey 5-year estimates from 2011 for each US ZIP code was constructed to stratify patients by socioeconomic status. Socioeconomic variables included measures of wealth and income (median household income, median value of housing unit, and percentage of households with interest, dividend, or rental income), education (proportion of adult residents completing high school and proportion of adult residents completing college), and employment (percentage of residents with management, business, science, and arts occupations).[22,23] A Z score for each patient was calculated for each variable by subtracting the overall mean (across all of the recipients) and dividing by the SD, and summation of the 6 Z-score variables then yielded the summary socioeconomic status score. Patients were then sorted based on socioeconomic status and were stratified into quintiles for means of analysis.

Hospital-level variables included patient length of stay, discharge disposition (home independently, home with home health care, rehabilitation, or death/other), perioperative mortality, 30-day readmission rate, and annual case volume. Perioperative mortality was defined as death within the index hospitalization, whereas 30-day readmission was defined as readmission to the same hospital within 30 days of discharge from the initial hospitalization. Data from patients who died during their index admission were excluded from readmission analyses. Annual IPAA case volume was used to stratify hospitals into volume-quartiles (lowest, low, medium, and high). We examined the readmission encounter file for all of the patients experiencing 30-day readmission to determine the cause of readmission, procedures performed on readmission, and source of readmission.

Statistical Analysis

Patient- and hospital-level characteristics were examined for their association with readmission status. Median values of continuous variables were analyzed via the Wilcoxon rank-sum test, whereas categorical variables were analyzed via the Pearson χ^2 test. Univariate and stepwise multivariate logistic regression analyses were performed to identify factors associated with 30-day readmission. Hierarchical logistic regression modeling was performed to account for patient clustering within hospitals and to determine the reason for variability in readmission across individual hospitals. We included all of the available patient variables from the multivariate logistic regression models and hospital volume quartiles as fixed effects and included the hospital identification number as the random effect. All of the analyses were performed using SAS version 9.3 (SAS Institute, Cary, NC). This study was approved by the institutional review board at the University of Cincinnati Medical Center.

RESULTS

Case Volume Distribution

Case volume stratification is shown in Table 1. Per year, the lowest-volume institutions performed approximately 1 to 8 procedures, low-volume institutions performed approximately 9 to 20 procedures, medium-volume institutions performed approximately 20 to 40 procedures, and high-volume institutions performed more than 47 procedures per year; slight variations in quartile cutoffs existed across years throughout the study period. Notably, the majority of procedures were performed at institutions performing less than 15 procedures annually (Fig. 1).

Patient Demographics

Between 2009 and 2012, 4952 patients who met inclusion criteria were identified within the UHC database (Table 2). The median patient age was 43 years, with a slight male predominance (55.6%). The majority of patients (81.3%) were white, and most patients used private insurance (77.1%) as their primary payer. Approximately 80% of patients were categorized as having a mild-to-moderate severity of illness, whereas the remaining patients demonstrated a severe-to-extreme severity of illness. Approximately 67% of patients underwent IPAA for the treatment of IBD, 26% underwent IPAA for treatment of malignant neoplasm(s), 6% underwent IPAA for treatment of benign neoplasm(s) including familial adenomatous polyposis, and ≈1% of patients underwent IPAA for the treatment of miscellaneous conditions.

TABLE 1. Case volume distribution, 2009–2012

Quartile	*Case range*	*Cases*	*Centers*
2009			
Lowest	1–8	263	80
Low	9–19	298	21
Medium	20–42	309	11
High	65–82	292	4
Totals		1162	116
2010			
Lowest	1–8	278	75
Low	9–20	301	22
Medium	22–39	339	12
High	47–163	338	4
Totals		1256	113
2011			
Lowest	1–9	303	82
Low	10–20	335	25
Medium	21–59	336	10
High	60–185	373	4
Totals		1347	121
2012			
Lowest	1–8	292	79
Low	9–17	265	20
Medium	18–42	294	12
High	49–181	336	4
Totals		1187	115

Stratified by hospital volume, patients undergoing surgery at the lowest-volume centers tended to be older ($p < 0.001$), of a racial minority ($p < 0.001$), and to have government insurance or be uninsured ($p < 0.001$) compared with those patients treated at the high-volume centers (Table 3). There was no difference in sex breakdown across volume quartiles. Preoperative diagnosis did not differ across volume quartiles.

Outcomes

The in-hospital mortality rate was 0.26%. The median length of stay for all of the patients was 6 days (Table 3). Approximately half of all patients were discharged home independently, whereas 46.5% of patients were discharged with home health care arranged for additional assistance. Eighty-seven patients (1.8%) were discharged to rehabilitation. The overall 30-day readmission rate after proctocolectomy with IPAA was 22.8% and demonstrated significant institutional variation (Fig. 2). The most common diagnoses noted on readmission were related to infection (n = 208 [25.0%]), which included diagnoses of abdominal abscess, fistula, skin/soft tissue infection, fever, bacteremia, urinary tract infection, and infections not otherwise specified), obstruction/ileus (n = 193 [23.2%], which included diagnoses of postoperative ileus, gastric outlet obstruction, delayed gastric emptying, nausea, and emesis), fluid/electrolyte abnormalities (n = 179 [21.5%]), and pain management (n = 141 [16.9%]).

Although the overall length of stay was similar across quartiles ($p = 0.64$), patients treated at the lowest-volume centers were discharged to home with home health care or to rehabilitation more often than those patients treated at the high-volume centers ($p < 0.001$). Patients who underwent surgery at a lowest-volume center demonstrated the highest readmission rate, whereas patients who underwent surgery at a high-volume center were readmitted the least often (28.2% vs 19.7%; $p < 0.001$; Fig. 3). The specific diagnoses for readmission did not statistically differ across quartiles. However, a higher proportion of patients treated at the lowest-volume centers may have undergone a laparotomy on readmission (33.3% of all laparotomies performed at the lowest-volume quartile). However, the p value for this finding was 0.45, and our sample size was only 29.7% powered to detect this magnitude of difference in outcome.

Factors Associated With Readmission

On univariate analysis, patients who were readmitted within 30 days from discharge tended to be younger, female, black, and to have a higher severity of illness at the time of operation (all $p < 0.05$; Table 4). A higher proportion of patients with government-issued health insurance were readmitted ($p < 0.001$). Patients discharged to rehabilitation were readmitted more often than those pa-

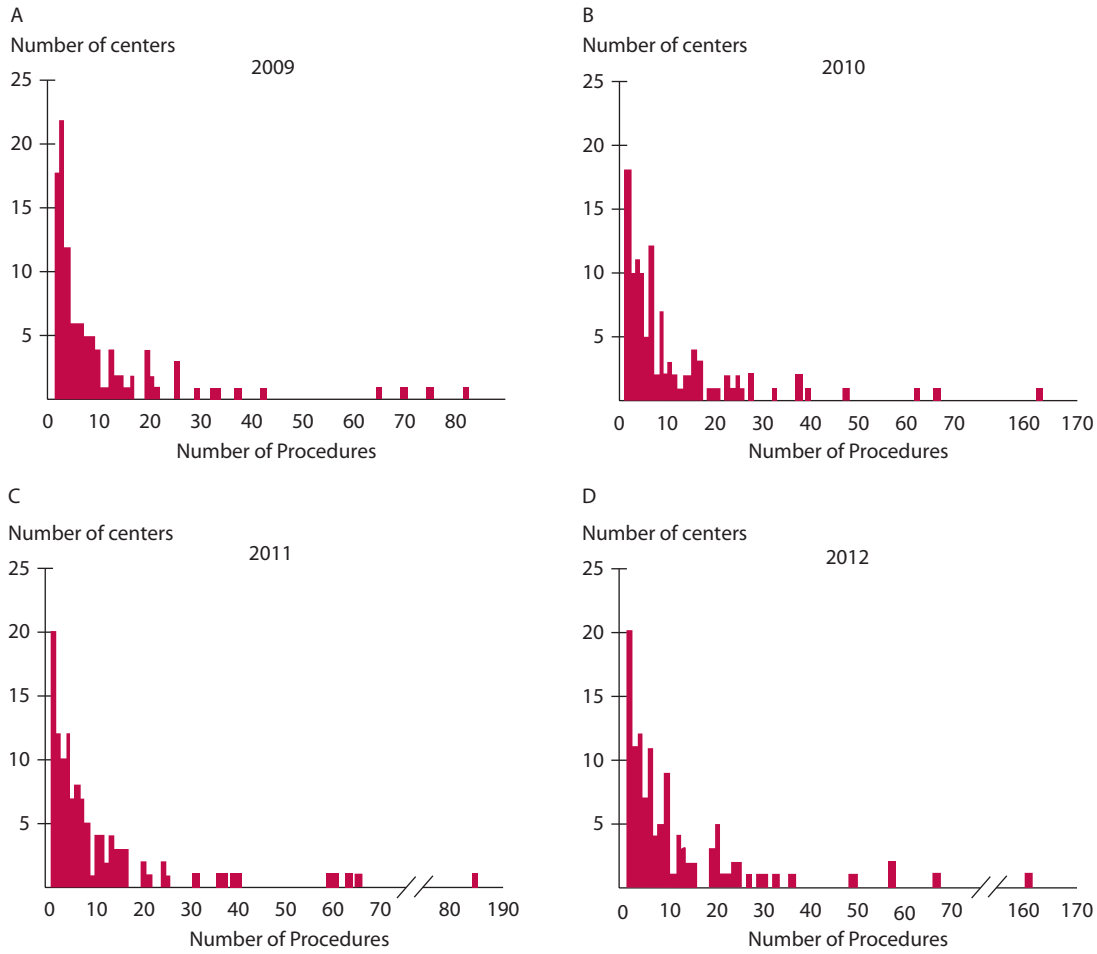

FIGURE 1. Procedural distribution. Note that the majority of cases of IPAA were performed at centers performing less than 15 operations per year in (A) 2009, (B) 2010, (C) 2011, and (D) 2012.

tients discharged to home ($p = 0.002$). An inverse correlation was noted between hospital volume and readmission rate, in which hospitals with lower annual case volumes demonstrated significantly higher rates of readmission ($p < 0.001$). Of note, neither the composite socioeconomic score nor the length of stay was associated with readmission on univariate analysis ($p > 0.05$).

On multivariate analysis, female sex (OR 1.191; 95% CI 1.034–1.372; $p = 0.02$), having government-issued health insurance (OR 1.364; 95% CI 1.147–1.622; $p < 0.001$), and severe classification severity of illness (OR 1.491; 95% CI 1.169–1.902; $p = 0.001$) were identified as independent predictors of 30-day readmission after proctocolectomy with IPAA (Table 5). Socioeconomic status, length of stay, and discharge disposition were not identified as independent factors associated with readmission on multivariate analysis (p value not significant). In addition, undergoing proctocolectomy with IPAA at high-volume (OR 0.606; 95% CI, 0.492–0.747; $p < 0.001$), medium-volume (OR 0.700; 95% CI 0.577–0.849; $p < 0.001$), and low-volume centers (OR 0.745; 95% CI, 0.613–0.906; $p = 0.003$) was protective for readmission versus undergoing surgery at the lowest-volume centers.

Hierarchical regression modeling indicated that 31% of the variation in readmission rates among individual hospitals is accounted for by hospital volume, whereas only 3.5% of the variation in hospital readmission rates is explained by differences in measurable patient factors ($p < 0.001$).

DISCUSSION

This study identified important patient and hospital factors associated with readmission after restorative proctocolectomy at academic medical centers in the United States. Overall, 22.8% of patients were readmitted to the hospital within 30 days of discharge, confirming previous publications of smaller patient samples.[15,16] This readmission rate increased to 28.2%, an almost 25.0% increase from the national average, for patients undergoing surgery at the lowest-volume hospitals. Hierarchical regression modeling indicated that 31.0% of the variation in read-

TABLE 2. Overall patient demographics

Variable	*Total (N = 4952)*
Age, y, median (interquartile range)	43 (30–54)
Sex, n (%)	
Male	2753 (55.6)
Female	2199 (44.4)
Race, n (%)	
White	4028 (81.3)
Black	298 (6.0)
Other	626 (12.6)
Payer, n (%)	
Private	3817 (77.1)
Medicare/Medicaid	978 (19.8)
Other/uninsured	157 (3.2)
Severity of illness, n (%)	
Mild	1080 (21.8)
Moderate	2992 (60.4)
Severe	718 (14.5)
Extreme	162 (3.3)
Socioeconomic status, n (%)[a]	
Q1	952 (19.7)
Q2	963 (19.9)
Q3	977 (20.2)
Q4	980 (20.2)
Q5	971 (20.1)

[a]Patients were stratified into socioeconomic quartiles as described above, ranging from the lowest (Q1) to highest (Q5) quartiles.

mission rates among individual hospitals is accounted for by hospital volume, whereas only 3.5% of the variation in hospital readmission rates is explained by differences in measurable patient factors.

Although the volume-outcome effect has been demonstrated previously with regard to mortality,[24,25] the volume association with hospital readmission has received less attention. One recent report from Tsai et al[26] investigated the relationship between hospital volume and readmission after 6 major operations, including colectomy, and noted that hospitals within the highest operative quartile demonstrated a significantly lower composite readmission rate when compared with hospitals performing the lowest numbers of operations annually. Two additional investigations of patients undergoing IPAA identified a volume-outcomes association, in which patients undergoing surgery at higher-volume institutions demonstrated lower pouch failure and reoperation rates compared with patients at lower-volume centers, although neither study specifically addressed 30-day readmission rates.[19,20] Similar to our current study, 1 previous report noted that 30.5% of surgical teams performed less than 2 procedures annually and that >90% of surgical teams performed 20 or less operations over an 8-year span.[19]

Although the volume-outcomes relationship may make intuitive sense, pinpointing the specific mechanism(s) underlying such success has proven difficult. In the current study, we noted that significantly more patients of a minority race were treated at the lowest-volume hospitals compared with the highest-volume hospitals (24.2% vs 11.8%). In addition, the proportion of patients with government-issued insurance or those patients uninsured at the time of operation were twice as likely to be treated at the lowest-volume institutions. Despite our lack of identifying socioeconomic status per se as an independent factor associated with increased readmission, our univariate findings are consistent with additional reports identifying government insurance, minority race, and minority-serving hospitals as predictors of increased readmission.[27,28] In addition, our findings confirm previous reports that preoperative health status and comorbid conditions are additional predictors of readmission, with increasingly morbid patients being discharged to rehabilitation and subsequently readmitted more often than healthier patients.[18]

The most common reasons for readmission noted in this study were similar to those cited for readmission after restorative proctocolectomy and IPAA in other studies, including ileus/obstruction, electrolyte abnormalities, surgical site infection, and anastomotic leak/pelvic sepsis, often requiring reoperation for surgical management.[17] In addition, of particular significance after IPAA is readmission for dehydration and associated electrolyte abnormalities,[29] likely because of difficulty in balancing fluid intake with increased intestinal fluid losses, which can often precipitate acute renal failure.[30,31] In the current study, approximately 1 in 5 patients was readmitted for dehydration and/or electrolyte abnormalities. This finding provides an opportunity for quality improvement through more aggressive perioperative patient education on fluid status management.

This study has several important limitations. First, it is possible that some patients were readmitted at hospitals other than where the index operation was performed. Although this is a possible scenario, we observed that the highest proportion of readmissions to the high-volume centers came from the surgeon's office or via transfer from another facility. Because of the complexity of this procedure, it is unlikely that a substantial proportion of patients would be readmitted to another hospital for a surgical problem without subsequent transfer to the hospital where surgery was performed. Second, our study did not account for those patients who were readmitted multiple times postoperatively; for example, one study noted that approximately one third of readmitted patients were readmitted at least twice after IPAA.[16] Although data regarding reoperative surgery and percutaneous abscess drainage on readmission are available, the readmission data set is not powered to detect meaningful differences in these outcomes. In addition, by limiting our investigation to 30 days from discharge, we may miss the capture of long-term morbidity associated with IPAA. One study noted that more than half of IPAA-related small bowel obstructions requiring hospitalization occurred more than 30 days postdischarge.[32] Lastly, *International Classification*

TABLE 3. Patient demographics and outcomes by hospital volume quartile

Variable	Volume quartile				p
	Lowest	Low	Medium	High	
Age, y, median (IQR)	44 (31–55)	44 (31–56)	44 (31–54)	41 (29–53)	<0.001
Sex, n (%)					0.09
Male	656 (58.0)	664 (55.4)	677 (53.0)	751 (56.1)	
Female	474 (42.0)	535 (44.6)	601 (47.0)	588 (43.9)	
Race, n (%)					<0.001
White	857 (75.8)	1035 (86.3)	952 (74.5)	1181 (88.2)	
Black	100 (8.9)	58 (4.8)	85 (6.7)	53 (4.0)	
Other	173 (15.3)	106 (8.9)	241 (18.9)	105 (7.8)	
Payer, n (%)					<0.001
Private	772 (68.3)	894 (74.6)	1020 (79.8)	1128 (84.2)	
Medicare/Medicaid	296 (26.2)	265 (22.1)	236 (18.5)	178 (13.3)	
Other/uninsured	62 (5.5)	40 (3.3)	22 (1.7)	33 (2.5)	
Severity of illness, n (%)					<0.001
Mild	289 (25.6)	284 (23.7)	272 (21.3)	233 (17.4)	
Moderate	650 (57.5)	711 (59.3)	773 (60.5)	857 (64.0)	
Severe	150 (13.3)	165 (13.8)	194 (15.2)	208 (15.5)	
Extreme	41 (3.6)	39 (3.3)	39 (3.1)	41 (3.1)	
Socioeconomic status, n (%)[a]					<0.001
Q1	262 (23.7)	233 (20.0)	206 (16.4)	251 (19.2)	
Q2	192 (17.4)	246 (21.1)	222 (17.6)	300 (22.9)	
Q3	215 (19.4)	247 (21.2)	245 (19.5)	268 (20.5)	
Q4	204 (18.4)	244 (21.0)	271 (21.5)	261 (20.0)	
Q5	233 (21.1)	194 (16.7)	315 (25.0)	228 (17.4)	
Length of stay, median (IQR), d	6 (5–9)	6 (5–9)	6 (5–8)	6 (5–9)	0.64
Discharge disposition, n (%)					<0.001
Home independently	573 (50.7)	594 (49.5)	602 (47.1)	777 (58.0)	
Home with HHC	525 (46.5)	586 (48.9)	647 (50.6)	545 (40.7)	
Rehabilitation	29 (2.6)	18 (1.5)	25 (2.0)	14 (1.1)	
Other	3 (0.3)	1 (0.1)	4 (0.3)	3 (0.2)	
30-d readmission, n (%)					<0.001
Yes	319 (28.2)	270 (22.5)	274 (21.4)	264 (19.7)	
No	811 (71.8)	929 (77.5)	1004 (78.6)	1075 (80.3)	

IQR = interquartile range; HHC = home health care.
[a]Patients were stratified into socioeconomic quartiles as described above, ranging from the lowest (Q1) to highest (Q5) quartiles.

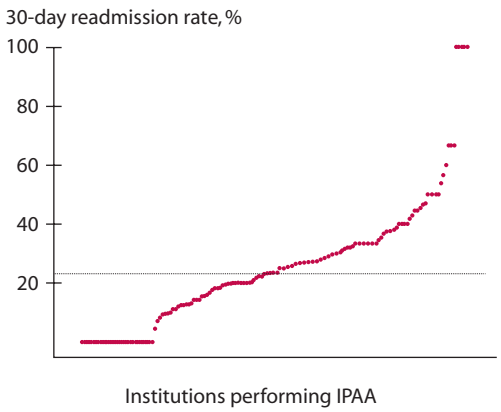

FIGURE 2. National 30-day readmission rates at institutions performing IPAA. The median readmission rate across all of the institutions was 22.8%, represented by the dotted line. Note the significant variability in readmission rates throughout the study period.

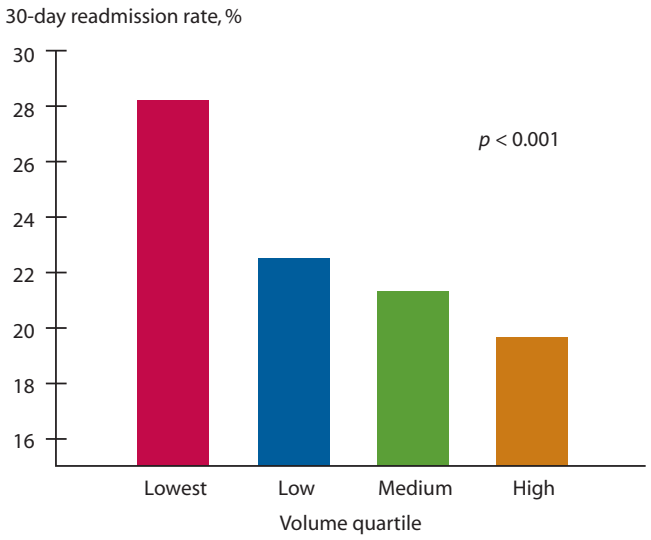

FIGURE 3. Thirty-day readmission rates after restorative proctocolectomy with IPAA. A significant volume-outcomes relationship was observed across institutional volume quartiles.

TABLE 4. Univariate analysis, readmission status

Variable	Readmitted within 30 d		p
	Yes (n = 1131 [22.8%])	No (n = 3821 [77.2%])	
Age, median (IQR), y	41 (29–54)	44 (31–54)	0.049
Sex, n (%)			0.01
Male	591 (52.3)	2162 (56.6)	
Female	540 (47.8)	1659 (43.4)	
Race, n (%)			0.01
White	906 (80.1)	3122 (81.7)	
Black	80 (7.1)	218 (5.7)	
Other	145 (12.8)	481 (12.6)	
Payer, n (%)			<0.001
Private	826 (73.0)	2991 (78.3)	
Medicare/Medicaid	266 (23.5)	712 (18.6)	
Other/uninsured	39 (3.5)	118 (3.1)	
Severity of illness, n (%)			0.007
Mild	220 (19.5)	860 (22.5)	
Moderate	675 (59.7)	2317 (60.6)	
Severe	190 (16.8)	528 (13.8)	
Extreme	46 (4.1)	116 (3.0)	
Socioeconomic status, n (%)[a]			0.60
Q1	231 (20.8)	721 (19.3)	
Q2	212 (19.1)	751 (20.1)	
Q3	221 (19.9)	756 (20.3)	
Q4	234 (21.1)	746 (20.0)	
Q5	211 (19.0)	760 (20.4)	
Length of stay, median (IQR), d	6 (5–9)	6 (5–8)	0.07
Discharge disposition, n (%)			0.002
Home independently	550 (48.6)	2000 (52.3)	
Home with HHC	550 (48.6)	1754 (45.9)	
Rehabilitation	31 (2.7)	56 (1.5)	
Other	0 (0.0)	11 (0.3)	
Hospital volume, n (%)			<0.001
Lowest	319 (28.3)	811 (21.2)	
Low	270 (24.0)	929 (24.3)	
Medium	274 (24.3)	1004 (26.3)	
High	264 (23.4)	1075 (28.2)	

HHC = home health care; IQR = interquartile range.
[a]Patients were stratified into socioeconomic quartiles as described above, ranging from the lowest (Q1) to highest (Q5) quartiles.

TABLE 5. Multivariate analysis, factors associated with readmission

Variable	OR (95% CI)	p
Age	0.992 (0.987–0.997)	0.002
Sex		
Male	1.00 (reference)	-
Female	1.191 (1.034–1.372)	0.02
Payer		
Private	1.00 (reference)	-
Medicare/Medicaid	1.364 (1.147–1.622)	<0.001
Other/uninsured	1.156 (0.779–1.715)	0.47
Severity of illness		
Mild	1.00 (reference)	-
Moderate	1.174 (0.980–1.407)	0.08
Severe	1.491 (1.169–1.902)	0.001
Extreme	1.339 (0.856–2.093)	0.20
Hospital case volume		
Lowest	1.00 (reference)	
Low	0.745 (0.613–0.906)	0.003
Medium	0.700 (0.577–0.849)	<0.001
High	0.606 (0.492–0.747)	<0.001

of Diseases, Ninth Revision, codes lack the precision to indicate whether these patients received laparoscopic surgery or a 2- or 3-stage operation, a phenomenon demonstrated previously to influence readmission rates.[33] Lastly, the UHC only includes a single diagnosis code. It is likely that most of the patients who were coded as having a malignant neoplasm were patients with ulcerative colitis and either high-grade dysplasia or rectal cancer. In addition, some of these patients may have had familial adenomatous polyposis or Lynch syndrome. Because of the coding scheme available, we are unable to determine admission diagnosis with any further details.

CONCLUSION

Even in the most experienced centers, restorative proctocolectomy is associated with a readmission rate of ≈20%, increasing to ≈30% at the lowest-volume centers nationally.

This volume-outcome relationship deserves further attention, because currently the majority of IPAA procedures are performed in low-volume centers. In the current healthcare climate, avoidance of referral to centers performing very few of these procedures annually may improve perioperative outcomes and reduce associated morbidity.

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