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DETERMINANTS OF 30-DAY READMISSION FOLLOWING COLECTOMY: A STATEWIDE COHORT ANALYSIS

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ABSTRACT

Background. Readmission following colectomy has become an important metric for measuring quality of care. Our aim was to investigate the impact of patient and hospital characteristics on 30-day readmission rates among patients undergoing colectomies in Pennsylvania.

Methods. Data were obtained from the Pennsylvania Health Care Cost Containment Council (PHC4), which included all patients undergoing colectomy during 2011 (n=10,155). Characteristics of non-readmitted and readmitted patients were compared with univariate tests. The primary outcome was 30-day readmission, which was modeled using multivariable logistic regression.

Results. Of the 10,155 patients who underwent colectomy, 1,492 (14.7%) were readmitted within 30 days of discharge. Readmission was influenced by the underlying diagnosis ($P<0.001$). Additionally, readmission was more likely with a Charlson Comorbidity Index ≥2 (OR=1.57, $P<0.001$), emergent admission (OR=1.26, $P=0.001$), an in-hospital complication (OR=1.46, $P<0.001$), lowest quartile for surgeon volume (OR=1.24, $P<0.001$), and construction of an ileostomy (OR=2.31, $P<0.001$). Factors associated with decreased likelihood of readmission included laparoscopic surgery (OR=0.73, $P<0.001$). No association with hospital volume was found.

Conclusions. 30-day readmission following colectomy is influenced by numerous patient and surgeon-related factors. Reducing in-hospital complications, and improving patient education following ileostomy construction, provide substantial targets for intervention. Our data also suggests that there may be a critical range of colectomies performed annually by surgeons, greater than which, no additional benefit is conferred in reducing readmissions, but below which, there is increased risk of readmission. Further research is needed to determine the influence of laparoscopic surgery in reducing readmission in equally matched patient populations.

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Chapter 1

Introduction

Growing attention has been directed toward readmissions as a metric for measuring quality health care [1,2]. Costs exceeding 40 billion dollars have been attributed to the financial impact of readmissions annually to the health care system [2]. The Centers for Medicare and Medicaid Services (CMS) and other payers have targeted readmissions as a potential cost-saving measure for some procedures and conditions and many providers are responding by escalating efforts to reduce readmissions [1].

Among surgical patients, colectomies are associated with high complications rates, longer hospitalizations and significant risks for readmission [1,3,4]. Readmissions are difficult to predict and in colorectal surgery alone have been estimated to cost 300 million dollars annually in health care expenditure [5]. Recent literature has aimed to understand the factors associated with readmission [6-8]. Previous studies have focused on disease-type, admission-type, or payer-specific or single-institution databases or have emphasized mortality as the primary outcome 2,3,5,9,10].

The present study utilized a unique statewide, all-payer discharge database containing data for all hospital discharges in Pennsylvania, in order to evaluate factors associated with 30-day readmission following elective and emergent colectomies. Delineating these factors provides an opportunity to identify areas for targeted intervention, to reduce costs from readmissions, and to improve patient outcomes. The present analysis was performed with the hypothesis that patient comorbidities and in-hospital complications would increase the likelihood of 30-day readmission, whereas higher surgeon and hospital volume would decrease readmissions.

Chapter 2

Methods

This was an Institutional Review Board (IRB) exempt, retrospective cohort study performed solely at the authors' institution.

Data

Data on colectomies performed in the Commonwealth of Pennsylvania during the year 2011 were obtained from the Pennsylvania Health Care Cost Containment Council (PHC4). PHC4 is an independent state agency responsible for monitoring the quality and cost of health care, as well as improving access [11]. The PHC4 data set is unique in that it is an all-payer database and contains longitudinal data relating to patient demographics (age, sex, race), admission and discharge diagnoses (up to 18 distinct codes including primary admission diagnoses), surgical procedures (up to six distinct codes including primary procedure), unique physician and hospital identifiers, resource utilization (length of stay, charges), and discharge status for all hospital discharges occurring in all general acute care Pennsylvania hospitals (not including Veterans Affairs Hospitals). The database registers all readmissions within any of these hospitals in the state of Pennsylvania, but does not capture out-of-state readmissions. Complete 30-day follow-up information was available for all patients.

Patient population

This study included all patients with a principal International Classification of Diseases, 9th Revision, Clinical Modification (ICD-9) procedure code of open (multiple segmental- [45.71]; cecum- [45.72]; right- [45.73]; transverse- [45.74]; left- [45.75]; sigmoid- [45.76]; other and

unspecified partial excision of large intestine- [45.79]; total intra-abdominal- [45.81]; other and unspecified total intra-abdominal- [45.83]) colectomy, as well as laparoscopic (multiple segmental resection of large intestine- [17.31]; cecum- [17.32]; right- [17.33]; transverse- [17.34]; left- [17.35]; sigmoid- [17.36]; other partial excision of large intestine- [17.39]; total intrabdominal- [45.81]) colectomy.

Covariates and outcomes

Primary diagnoses for undergoing colectomy were categorized into the following underlying etiologies based on ICD-9 codes: malignant (153, 153.0, 153.1, 153.2, 153.3, 153.4, 153.4, 153.5, 153.6, 153.7, 153.8, 153.9), diverticular (562.10, 562.11, 562.12, 562.13), obstructive (560, 552.8, 552.1, 552.21, 552.9, 560.2, 560.81, 560.89, 560.9), ischemic (557.0, 557.1, 557.9), inflammatory bowel disease (IBD) (555.0, 555.1, 555.2, 555.9, 556, 556.5, 556.6, 556.8, 556.9), functional (560.1, 564, 564.09, 564.4, 564.7, 564.89) and other.

The previously described ICD-9 procedure codes were used categorize operations into proximal colectomy (cecum, or right hemicolectomy), distal colectomy (left hemicolectomy or sigmoid), total abdominal colectomy, or other colectomy (transverse, multiple segmental, or other partial). Construction of an ileostomy during the index hospitalization was derived from the ICD-9 codes: 46.20, 46.21, 46.22, 46.23.

By PHC4 definitions, urgent admissions include those admissions where a patient requires immediate attention for the care and treatment of a physical disorder. Emergent admissions refer to patients requiring immediate medical intervention as a result of a severe, life threatening, or potentially disabling condition; these patients are generally admitted through the emergency room.

Surgeons were categorized into quartiles based on the total number of colectomies (including both open and laparoscopic) performed by surgeons in Pennsylvania during 2011

based on PHC4 data. In similar fashion, hospital volumes were categorized as quartiles based on the total number of colectomies (including both open and laparoscopic) performed during 2011 at Pennsylvania hospitals. Length of stay was based on duration of hospital stay associated with the index operative admission.

Comorbidities were defined using the Deyo adaptation of the Charlson Comorbidity Index (CCI), which uses ICD-9 diagnosis codes [12,13]. The impact of comorbidities was assessed using the CCI, which assigns weights to various patient comorbidities and has been validated in numerous studies for a wide variety of diseases for various clinical outcomes [13,14]. In-hospital complications during index hospitalizations were established utilizing previously described methods with the following classification system, which includes: wound (mechanical), infection, urinary, pulmonary, gastrointestinal, cardiovascular, systemic, and procedural [15,16].

The primary outcome of interest was 30-day readmission. Readmission was based on the date of discharge.

Statistical analysis

The purpose of the statistical analysis was to determine the characteristics that affected 30-day readmission, controlling for other confounding factors. Univariate statistical tests were used to compare baseline characteristics between non-readmitted and readmitted patients, using Chi-square tests for categorical variables and Student's *t*-tests for continuous variables. A Wilcoxon rank-sum test was used for comparing medians of non-normally distributed continuous variables. Multivariable analysis was also performed to analyze outcomes of interest after controlling for potential confounding variables. Thirty-day readmission was modeled using logistic regression, controlling for comorbidities, in-hospital complications, demographics, admission type, primary diagnosis, operative details, surgeon and hospital volume. All analyses

were performed using Stata software (version 10/MP; Stata Corp., College Station, TX). P-values less than 0.05 were considered statistically significant.

Chapter 3

Results

Demographics and patient characteristics

A total of 10,155 patients underwent colectomy in Pennsylvania during 2011, with a readmission rate of 14.7% (n = 1,492). Characteristics of the patients are presented in Table 1, stratified by their readmission status. Compared to non-readmitted patients, readmitted patients were more likely to be slightly older (64.5 vs. 62.9 years, $P < 0.001$), African-American (9.3% vs. 7.3%, $P = 0.02$) and covered by Medicare (56.1% vs. 47.1%, $P < 0.001$) or Medicaid (9.5% vs. 7.4%, $P < 0.001$). In addition, readmitted patients were more likely to have been operated on by a low-volume surgeon (bottom quartile) (30.4% vs. 23.6%, $P < 0.001$), had an ileostomy constructed (10.3% vs. 3.2%, $P < 0.001$), and received a colectomy under emergent conditions (38.6% vs. 28.1%, $P < 0.001$). Patients requiring readmission were less likely to have received a laparoscopic surgery (23.6% vs. 35.1%, $P < 0.001$), while hospital volume was comparable between both cohorts. The median LOS was longer among patients who would later require readmission (8 vs. 6 days, $P < 0.001$). Certain primary diagnoses were observed more frequently in the readmitted group including ischemia (3.2% vs. 1.4%, $P < 0.001$) and IBD (6.4% vs. 4.1%, $P < 0.001$), while colectomies performed for diverticular disease were observed less frequently in the readmitted cohort (17.0% vs. 26.5% $P < 0.001$).

Table 1 Demographics and patient characteristics

	Not Readmitted N = 8,663 (%)	Readmitted N = 1,492 (%)	*P*-value
Age	62.9	64.5	<0.001
Age <45	993 (11.5)	181 (12.1)	
Age 45-65	3548 (41.0)	507 (34.0)	
Age 65-75	2152 (24.8)	358 (24.0)	
Age >75	1970 (22.7)	446 (29.9)	
Sex			0.20
Male	3927 (45.3)	703 (47.1)	
Female	4736 (54.7)	789 (52.9)	
Race			0.02
White	7727 (89.2)	1307 (87.6)	
African-American	629 (7.3)	139 (9.3)	
Other Race	307 (3.5)	46 (3.1)	
Payment			<0.001
Medicare	4080 (47.1)	837 (56.1)	
Commercial	3765 (43.5)	480 (32.2)	
Medicaid	638 (7.4)	142 (9.5)	
Other	180 (2.1)	33 (2.2)	
Admission type			<0.001
Emergent	2431 (28.1)	576 (38.6)	
Urgent	886 (10.2)	158 (10.6)	
Elective	5346 (61.7)	758 (50.8)	
Transfer			0.05
Yes	174 (2.0)	42 (2.8)	
No	8489 (98.0)	1450 (97.2)	
Surgeon volume			<0.001
Bottom quartile (<12)	2046 (23.6)	454 (30.4)	
Second quartile (≥12 & <22)	2096 (24.2)	360 (24.1)	

Third quartile (≥22 & <38)	2180 (25.2)	316 (21.2)	
Top quartile (≥38)	2341 (27.0)	362 (24.3)	
Hospital volume			0.94
Bottom quartile (<67)	2039 (23.5)	348 (23.3)	
Second quartile (≥67 & <112)	2240 (25.9)	394 (26.4)	
Third quartile (≥67 & <211)	2163 (25.0)	369 (24.7)	
Top quartile (≥211)	2221 (25.6)	381 (25.5)	
Length of stay (days), median	6.0	8.0	<0.001
Operative details			
Surgical approach			<0.001
Open	5620 (64.9)	1140 (76.4)	
Laparoscopic	3043 (35.1)	352 (23.6)	
Type of resection			<0.001
Proximal colectomy	3585 (41.4)	640 (42.9)	
Distal colectomy	4169 (48.1)	604 (40.5)	
Total abdominal colectomy	214 (2.5)	94 (6.3)	
Other colectomy	695 (8.0)	154 (10.3)	
Construction of ileostomy			<0.001
Yes	277 (3.2)	154 (10.3)	
No	8386 (96.8)	1338 (89.7)	
Diagnosis			
Malignancy	3018 (34.8)	535 (35.9)	0.45
Diverticular	2296 (26.5)	254 (17.0)	<0.001
Obstructive	683 (7.9)	131 (8.8)	0.24
Ischemic	117 (1.4)	48 (3.2)	<0.001
IBD	357 (4.1)	95 (6.4)	<0.001
Functional	50 (0.6)	13 (0.9)	0.18
Other	2142 (24.7)	416 (27.9)	0.01

HMO - Health Maintenance Organization

IBD - Inflammatory Bowel Disease

Patient comorbidities and in-hospital complications

Patient comorbidities and in-hospital complications are presented in Table 2. Greater numbers of comorbidities were observed in the readmitted group, and the median Charlson Comorbidity Index in the readmission cohort was 2.0 compared to 1.0 for those not readmitted ($P < 0.001$). Furthermore, more in-hospital complications were observed in the readmitted group (27.2% vs. 17.5%, $P < 0.001$).

Table 2 Patient comorbidities and in-hospital complications

	Not Readmitted N = 8,663 (%)	Readmitted N = 1,492 (%)	*P*-value
Comorbidities			
Acute myocardial infarction	358 (4.1)	97 (6.5)	<0.001
Congestive heart failure	483 (5.6)	142 (9.5)	<0.001
Peripheral vascular disease	226 (2.6)	61 (4.1)	0.001
Cerebrovascular disease	151 (1.7)	49 (3.3)	<0.001
Dementia	17 (0.2)	1 (0.1)	0.27
COPD	1294 (14.9)	291 (19.5)	<0.001
Rheumatoid arthritis	190 (2.2)	44 (2.9)	0.07
Peptic Ulcer disease	72 (0.8)	22 (1.5)	0.02
Mild liver disease	57 (0.7)	10 (0.7)	0.96
Diabetes	1386 (16.0)	256 (17.2)	0.26
Diabetes with complications	129 (1.5)	28 (1.9)	0.26
Hemi/Para-plegia	14 (0.2)	5 (0.3)	0.15
Renal disease	498 (5.7)	131 (8.8)	<0.001
Cancer	2177 (25.1)	323 (21.6)	0.004
Moderate/severe liver disease	18 (0.2)	8 (0.5)	0.02
Metastatic cancer	1028 (11.9)	263 (17.6)	<0.001

AIDS	5 (0.1)	0 (0.0)	0.35
Charlson Index, median	1	2	<0.001
0	3451 (39.8)	486 (32.6)	-
1	1323 (15.3)	204 (13.7)	-
2+	3889 (44.9)	802 (53.8)	-
Complications	1516 (17.5)	406 (27.2)	<0.001
Mechanical wound complications	99 (1.1)	32 (2.1)	0.002
Infections	260 (3.0)	97 (6.5)	<0.001
Urinary complications	117 (1.4)	27 (1.8)	0.17
Pulmonary complications	276 (3.2)	101 (6.8)	<0.001
GI complications	494 (5.7)	117 (7.8)	0.001
CV complications	200 (2.3)	62 (4.2)	<0.001
Systemic complications	28 (0.3)	14 (0.9)	0.001
Procedural complications	353 (4.1)	96 (6.4)	<0.001

COPD - Chronic Obstructive Pulmonary Disease

AIDS - Acquired Immunodeficiency Syndrome

GI - Gastrointestinal

CV - Cardiovascular

Logistic regression analysis of variables associated with 30-day readmission

The factors associated with readmission in multivariable analysis are presented in Table 3. Numerous factors were found to increase the odds of readmission following colectomy. Patients with two or more CCI comorbidities (OR = 1.57, *P* <0.001*)*, emergent admissions (OR = 1.26, *P* < 0.001), who were operated upon by a lower volume (bottom quartile) surgeon (OR = 1.24, *P* = 0.01), or experienced a postoperative complication (OR = 1.46, *P* < 0.001) were more likely to be readmitted within 30 days. The primary diagnosis and the indication for colectomy also influenced readmission, with readmission more likely following surgery for an ischemic etiology (OR = 1.89, *P* < 0.001), and IBD (OR = 1.85, *P* < 0.001). Finally, the construction of an ileostomy during surgery was strongly associated with higher odds of readmission (OR = 2.31, *P* < 0.001). No significant effect on readmission was observed based on hospital volume. Those undergoing a colectomy via a laparoscopic approach had a lower likelihood of readmission (OR = 0.73, *P* < 0.001). Compared to proximal colectomies, those patients requiring total abdominal colectomies also had increased odds of readmission (OR = 1.49, P =0.02)

Table 3 Logistic regression analysis of variables associated with 30-day readmission.

	Multivariate			
		95% Confidence		
Variable	Odds Ratio	Lower	Upper	*P*-value
Age				
Age <45	REFERENCE			
Age 45-65	0.85	0.69	1.03	0.10
Age 65-75	0.90	0.72	1.12	0.35
Age >75	1.13	0.90	1.40	0.29
Sex (male)	1.09	0.97	1.22	0.13

Race				
White	REFERENCE			
Black	1.20	0.98	1.46	0.08
Other race	0.87	0.63	1.20	0.40
Admission type				
Elective	REFERENCE			
Urgent	1.05	0.86	1.27	0.66
Emergent	1.26	1.11	1.44	0.001
Transfer (yes)	0.90	0.63	1.29	0.55
Surgeon volume				
Bottom quartile (<12)	1.24	1.05	1.48	0.01
Second quartile (≥12 & <22)	1.03	0.86	1.23	0.75
Third quartile (≥22 & <38)	0.91	0.77	1.08	0.30
Top quartile (≥38)	REFERENCE			
Hospital volume				
Bottom quartile (<67)	0.88	0.74	1.05	0.16
Second quartile (≥67 & <112)	1.03	0.88	1.22	0.69
Third quartile (≥67 & <211)	0.98	0.83	1.15	0.77
Top quartile (≥211)	REFERENCE			
Charlson index				
0	REFERENCE			
1	1.03	0.86	1.24	0.73
2+	1.57	1.31	1.88	<0.001
In-hospital complications	1.46	1.28	1.67	<0.001
Operative details				
Surgical approach				
Open	REFERENCE			
Laparoscopic	0.73	0.64	0.85	<0.001
Type of resection				
Proximal colectomy	REFERENCE			

Distal colectomy	1.04	0.89	1.21	0.62
Total abdominal colectomy	1.49	1.06	2.11	0.02
Other colectomy	1.16	0.93	1.44	0.18
Construction of ileostomy				
No	REFERENCE			
Yes	2.31	1.76	3.03	<0.001
Diagnosis				
Malignancy	REFERENCE			
Diverticular	1.02	0.81	1.28	0.87
Obstructive	1.27	0.99	1.62	0.06
Ischemic	1.89	1.29	2.76	0.001
IBD	1.85	1.35	2.53	<0.001
Functional	1.88	0.98	3.62	0.06
Other	1.42	1.19	1.71	<0.001

HMO - Health Maintenance Organization

IBD - Inflammatory Bowel Disease

C-index = 0.65

Chapter 4

Discussion

Hospital readmission as a quality metric

Hospital readmission has been targeted as an important quality measure in the effort to reduce health care costs and as a marker of superior patient care [5]. The magnitude of this health care issue is highlighted in the troubling statistic that nearly one in seven hospitalized patients following major surgery is readmitted within 30 days [17]. The Medicare payment advisory commission estimates that up to 75% of readmissions are avoidable, with subsequent expenses of over 40 billion dollars annually associated with 30-day readmissions [2]. To incentivize reducing readmissions, both public and private payers are adjusting reimbursements for expected versus observed 30-day readmission rates [1]. Within general surgery, colectomies have been associated with among the highest readmission rates [1]. As such, delineating the factors contributing to readmission following colectomy and identifying areas for targeted intervention may have important implications for improving the cost of quality health care.

Using a single state, all-payer database of all hospital discharges for all colectomies performed in Pennsylvania in one year, we found an overall 30-day readmission rate of 14.7%. As we hypothesized, comorbidities, in particular two or more (per the CCI), and in-hospital postoperative complications were associated with 57% and 46% increased risk of readmission, respectively. Contrary to our hypotheses, higher surgeon volume (as reflected by higher quartiles) was not associated with a reduced odds of readmission; however, we discovered that patients operated on by surgeons performing less than 12 colectomies per year (lowest quartile) had a 24% increased odds of readmission. Also contrary to our hypotheses, we did not find any effect of hospital volume on readmission rates. However, we did find additional factors that had a

strong influence on readmission, namely the construction of an ileostomy, and laparoscopic approach to colectomy.

Comorbidities and readmission

The role of comorbidities in increasing the risk of readmission has been reported in several studies [2,3,9]. Direct comparisons between studies is challenging due to different comorbidity classification schemes, and varying categorizations of the number of comorbidities used for analysis. Schnieder et al. also utilized the CCI and for 3 or more weighted comorbidities found a 27% increase in readmission among patients undergoing colon cancer resections, while the current study found a 56% increase in readmission for 2 or more weighted comorbidities, in an all-payer, and inclusive colorectal pathology patient population [2]. Using a Medicare beneficiary database, Jencks et al. estimated that among patients readmitted within 30 days after a surgical discharge, 70.5% were rehospitalized for a medical condition; in half of these patients no documentation of a follow-up visit existed prior to the readmission [4]. These findings emphasize the importance of recognizing pre-existing conditions, optimizing patient comorbidities prior to surgery, and closer postoperative follow-up after discharge as strategies which may help reduce readmissions among this group.

Complications and readmission

The impact of complications on readmission rates has received significant attention, and has been a focus of the American College of Surgeon's National Surgical Quality Improvement Program (NSQIP). Among general surgery patients, the occurrence of any postoperative complication was the most significant independent risk factor in a NSQIP-based study using single-institutional data [1]. A recent study by Kerwel et al. also concluded that postoperative complications accounted for the majority of the risk of readmission [8]. Our findings of a 46%

increased risk of readmission following the occurrence of any in-hospital complication is similar to that in other colorectal surgery studies, which collectively have demonstrated a 17%-42% increased risk of readmission following the diagnosis of any postoperative complication [2,9]. Notably, we found that the increased risk of readmission was generalizable to colectomies performed for a number of indications, as well as to a diverse payer mix.

Surgeon volume and readmission

Prior studies have evaluated the relationship between hospital and surgeon volume and surgical outcomes [18-25]. While numerous studies have established that increasing surgeon operative volume is associated with decreased mortality, this relationship has not been well-studied with regard to readmission rates [18-25]. In a 10-year study on colectomies for colorectal cancer utilizing a Medicare database, Greenblatt et al. did not find any relationship between surgeon volume and the rate of readmission [9]. Additionally, a study by Faiz et al. focusing on major elective colorectal surgeries, which itself was based on a 10-year experience of the English National Health Services (NHS), found that high provider volume status was an independent predictor of 28-day readmissions [10]. In contrast to both the Greenblatt and Faiz studies, the findings of the present work suggest that there may be a critical range of colectomies performed by surgeons annually, greater than which no additional benefit is conferred in reducing readmissions, but below which there is increased risk of readmission. Our study reports a contemporary colectomy experience in a single state, which may account for the differences in our findings compared to previous publications.

Ileostomy and readmission

Two surgical characteristics that influenced the rate of readmission in this study were the construction of an ileostomy and the use of laparoscopic surgery. In multivariable analysis,

increased readmission rates of 13-20% were observed in previous studies studying patient with stoma construction [5,9]. We found that patients with an ileostomy were nearly 2.5 times greater odds of being readmitted compared to those without an ileostomy. Notably, the previously cited studies included both colostomies and ileostomies in evaluating the influence of stoma construction on readmission, while we focused specifically on the impact of ileostomies. As dehydration is the most common indication for readmissions for ileostomies, the findings of the present analysis suggest that more targeted educational interventions in this population may be necessary to help reduce readmissions [26].

Laparoscopic colectomy and readmission

Literature regarding the impact of laparoscopic colectomies on readmission rates is limited. Greenblatt found an increased risk of readmission with laparoscopic colectomies for cancer patients, but this finding did not meet the criterion for statistical significance. Hendren et al. estimated an 8% decrease in readmission rates following laparoscopic surgery [3,9]. Both of these studies involved a less contemporary cohort of patients compared to this study, as well as there being a large difference in the proportion of colectomies performed laparoscopically during the study interval. The present work demonstrates that in 2011, in Pennsylvania, one third of all colectomies were performed laparoscopically; the readmission rate was 16.9% and 10.4% for open and laparoscopic colectomies, respectively. When adjusting for confounders, laparoscopy was associated with 27% lower odds of readmission.

Limitations

Our study has several limitations to consider. By using an administrative database, we did not have more detailed information beyond what was presented. Due to the reliance on ICD-9 codes to identify procedures, comorbidities and complications, there may have been

misclassifications or errors present during administrative data entry. Additionally, we could not distinguish between the specialties of the surgeons performing the operations, or the causes of readmission. While we codified indications for colectomy and type of resection, we were unable to assess the difficulty of the operation, and therefore, the influence of ileostomy construction on readmission, may be confounded by the complexity of an operation for which we could not account. Due to collinearity between length of stay, and both emergent admission status and laparoscopic surgery, we could not further evaluate the impact of length of stay in multivariable analysis, nor did we have a method to measure whether fast track programs were implemented. As the PHC4 only captures readmissions in Pennsylvania, there is a possibility that patients treated in proximity to other centers in neighboring states were not captured. Finally, while laparoscopic colectomy was associated with decreased odds of readmission, there is also likely a selection bias, and other operative considerations, which may have influenced the choice of surgical approach, and are unable to be measured with our administrative data set. Furthermore, our data only accounts for one year and is limited to the Commonwealth of Pennsylvania. However, our study does account for a contemporary and longitudinal experience with colectomies in Pennsylvania and includes a diverse age and payer mix, a variety of colorectal pathologies, and both open and laparoscopic techniques, which results in data which should be generalizable beyond one state.

Conclusions

As increasing emphasis is placed on readmissions as a quality metric, it will be important to establish acceptable baseline readmission rates for colectomies. While defining preventable versus non-preventable readmissions may be a challenge, the authors' experience in Pennsylvania provides an analysis of the current state-of-affairs related to colorectal readmissions, identifying

several potential areas for targeted intervention to help minimize readmissions, to reduce costs and improve patient outcomes and the delivery of high-quality health care.

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