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Laparoscopy impacts outcomes favorably following colectomy for ulcerative colitis: a critical analysis of the ACS-NSQIP database

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Abstract
Introduction The surgical management of ulcerative colitis (UC) often involves complex operations. We investigated the outcome of patients who underwent surgery for UC by analyzing a nationwide database.
Methods We queried the American College of Surgeons National Surgical Quality Improvement Program database (ACS-NSQIP, 2005–2008) for all UC patients who underwent colectomy. To analyze by operation, groupings included: partial colectomy (PC; $n = 265$), total abdominal colectomy (TAC; $n = 232$), total proctocolectomy with ileostomy (TPC-I; $n = 134$), and total proctocolectomy with ileal pouch-anal anastomosis (IPAA; $n = 446$) to analyze 30-day outcomes.
Results From 1,077 patients (mean age, 44 years; 45 % female; 7 % emergent), a laparoscopic approach was used in 29.2 %, with rates increasing 8.5 % each year (18.5 % in 2005 to 41.3 % in 2008, $P < 0.001$). Complications occurred in 29 %, and laparoscopy was associated with a lower complication rate (21 vs. 32 % open, $P < 0.001$). On multivariate regression, postoperative complications increased when patients were not functionally independent [odds ratio (OR) = 3.2], had preoperative sepsis (OR = 2.0), or prior percutaneous coronary intervention (OR = 2.8). A laparoscopic approach was associated with a lower complication rate (OR = 0.63). When stratified by specific complications, laparoscopy was associated with lower complications, including superficial surgical site infections (11.4 vs. 6.7 %, $P = 0.0011$), pneumonia (2.9 vs. 0.6 %, $P = 0.023$), prolonged mechanical ventilation (3.9 vs. 1.3 %, $P = 0.023$), need for transfusions postoperatively (1.6 vs. 0 %, $P = 0.016$), and severe sepsis (2.9 vs. 1.0 %, $P = 0.039$). Laparoscopy was also was associated with a lower complication rate in TACs (41.7 vs. 18.8 %, $P < 0.0001$) and IPAA (29.9 vs. 18.2 %, $P = 0.005$) and had an overall lower mortality rate (0.2 vs. 1.7 %, $P = 0.046$).
Conclusions Results from a large nationwide database demonstrate that a laparoscopic approach was utilized in an increasing number of UC patients undergoing colectomy and was associated with lower morbidity and mortality, even in more complex procedures, such as TAC and IPAA.

Keywords NSQIP · Obesity · Laparoscopy · Colectomy · Ulcerative colitis

The investigators have adhered to the policies for protection of human subjects as prescribed in 45 CFR 46. The views expressed are those of the author(s) and do not reflect the official policy of the Department of the Army, the Department of Defense or the U.S. Government. This manuscript was presented as a poster at the 2012 Society for Gastrointestinal and Endoscopic Surgeons Meeting in San Diego, CA.

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Varying outcomes have been reported for the surgical management of ulcerative colitis (UC). Recent literature trends have demonstrated increased utilization of a minimally invasive approach that has corresponded to similar outcomes and even operative times [1–3]. In meta-analysis and comparative studies, patients undergoing laparoscopic operations for UC resume oral intake sooner, have shorter hospitalizations, and report similar quality of life outcomes compared with conventional open operations [1, 4, 5]. Yet, these operations are typically more complex, involve multiple quadrants of the abdomen and pelvis, and generally require a more advanced skill set to accomplish with minimally invasive approaches. Data specifically regarding morbidity and mortality are mostly based on single institutional and smaller combined analyses. Although these smaller series have demonstrated the safety and feasibility of a laparoscopic approach, large-scale data in this subset of patients are lacking. We investigated the impact of surgical approach on the short-term 30-day outcomes of patients who underwent surgery for UC by analyzing a large nationwide database.

Materials and methods

The American College of Surgeons National Quality Improvement Project (ACS-NSQIP) database is a prospective multi-institutional outcomes program that originated from the Veteran Health Administration to assess the quality of healthcare and surgical interventions [6, 7]. The ACS-NSQIP database gathers information on healthcare quality through a compilation of preoperative risk factors, intraoperative factors, and postoperative 30-day morbidity and mortality in patients who undergo major surgical procedures [6]. The data are collected by a dedicated surgical clinical nurse reviewer (SCNR) at each site following both inpatients and outpatients for 30 days postoperatively on 21 defined complications [8]. Data in the ACS-NSQIP database are de-identified to ensure that no patient-identifiable factors are present. The Madigan Healthcare System Institutional Review Board approved this study. Specific details of the data collection, inclusion and exclusion criteria, training of the actuaries, and the method of random sampling are described by the ACS-NSQIP [8].

We identified patients within the ACS-NSQIP dataset from 2005 through 2008 by using the International Classification of Disease, Ninth Revision, Clinical Modification (ICD-9-CM) procedure and diagnostic codes. Inclusion criteria included patients who had the diagnosis of UC based on the ICD-9-CM coding (556.x), with exclusion criteria encompassing those patients younger than age 16 years and those not undergoing colectomy. All CPT codes of colectomy were included in the analysis—specifically partial colectomy (PC), total abdominal colectomy (TAC), total proctocolectomy with ileostomy (TPC-I), and total proctocolectomy with ileal pouch-anal anastomosis (IPAA) to determine the overall complication profile. For stratification purposes, obesity was used as an independent variable and dichotomized as greater than 30 based on WHO criteria, with analysis compared against nonobese patients (BMI < 30). Complications were identified from the database and were analyzed based on the risk-adjusted 30-day outcomes, accounting for patient characteristics, preoperative comorbidities, and surgical procedures (both the type of surgery as well as approach). Overall complications were identified as patients with one or more of the specific NSQIP-defined complications. Demographic variables examined included age (years), gender, race, calendar year (2005–2008), preexisting comorbidities, and type of surgical procedure, which was divided into laparoscopic or open categories. Laparoscopic cases that were converted to open were analyzed based on the surgical approach recorded in ACS-NSQIP. For the IPAA cohort, we stratified by the basis of having a concomitant diversion or not.

The primary postoperative measures were 30-day outcomes as measured using standard NSQIP definitions [8]. Patients with invalid or missing data for demographic variables of interest were analyzed for any significant variance from the study population and then excluded for evaluation of that data element only. Statistical tests were used for both categorical variables (χ^2 analysis or Fisher's exact test) and continuous variables (Mann–Whitney U test or Student's t test) in the univariate analysis comparing demographic and outcomes variables. Variables that reached statistical significance in the univariate model ($P < 0.1$) were then analyzed with a logistic regression model to identify independent factors associated with an increased risk of complications. All data analysis was performed using PASW 18.0 (SPSS Inc., Chicago, IL, USA) with the results presented as adjusted odds ratios (OR) with 95 % confidence intervals (95 % CI). Statistical significance for this study was set at an alpha of 0.05.

Results

A total of 1,077 patients met the inclusion criteria. The mean age of the population was 44 years, 45 % were female, and 7 % of operations were performed emergently. Within the patient cohort, 83 % were white, 5 % black, 2 % Hispanic, 1 % Asian or Pacific Islander, <1 % American Indian or Alaska native, and 8 % unknown or unrecorded. The predominant comorbidities were 6.5 % with diabetes, 7.3 % were current smokers, 18.7 % with hypertension, 1.9 % with previous cardiac surgery, 44.8 %

Table 1 Preoperative demographics and comorbidities in the study population in total and stratified by operative procedure

Demographic	Partial colectomy ($n = 265$)	Total abdominal colectomy ($n = 232$)	End ileostomy ($n = 134$)	Pouch ($n = 446$)	Total ($n = 1,077$)	Sig
Laparoscopic	47 (17.7 %)	112 (48.2 %)	35 (26.1 %)	148 (33.1 %)	342 (31.7 %)	<0.001
Age	42.9 ± 14.6	45.3 ± 17	53.7 ± 16.5	40.2 ± 13.8	43.6 ± 15.7	<0.001
Creatinine	0.95 ± 0.55	0.95 ± 0.69	0.87 ± 0.37	0.86 ± 0.18	0.9 ± 0.46	0.046
Albumin	3.77 ± 0.97	2.95 ± 0.89	3.33 ± 0.89	3.97 ± 0.6	3.57 ± 0.92	<0.001
Hematocrit	37 ± 5.93	34.7 ± 6.23	36 ± 5.94	39.1 ± 5.46	37.2 ± 6.05	<0.001
INR	1.12 ± 0.3	1.2 ± 0.44	1.09 ± 0.3	1.03 ± 0.17	1.11 ± 0.32	<0.001
White blood cell count	8.28 ± 4.11	10.3 ± 6.18	8.63 ± 3.73	8.26 ± 3.65	8.77 ± 4.51	<0.001
Diabetes	9 (3.39 %)	21 (9.05 %)	20 (14.9 %)	20 (4.48 %)	70 (6.49 %)	<0.001
Current smoker within 1 year	27 (10.1 %)	15 (6.46 %)	7 (5.22 %)	30 (6.72 %)	79 (7.33 %)	0.207
ETOH >2 drinks per day in the 2 weeks before admission	4 (1.5 %)	1 (0.43 %)	1 (0.74 %)	7 (1.56 %)	13 (1.20 %)	0.551
Prior percutaneous coronary intervention	8 (3.01 %)	5 (2.15 %)	5 (3.73 %)	9 (2.01 %)	27 (2.5 %)	0.646
Hypertension requiring medication	37 (13.9 %)	57 (24.5 %)	44 (32.8 %)	63 (14.1 %)	201 (18.6 %)	<0.001
History of revascularization/amputation for PVD	1 (0.37 %)	2 (0.86 %)	2 (1.49 %)	2 (0.44 %)	7 (0.64 %)	0.528
Oral or parenteral steroid use for a chronic condition	71 (26.7 %)	149 (64.2 %)	76 (56.7 %)	186 (41.7 %)	482 (44.7 %)	<0.001
>10 % loss of body weight in the 6 months before surgery	22 (8.30 %)	47 (20.2 %)	16 (11.9 %)	28 (6.27 %)	113 (10.4 %)	<0.001
Transfusions >4 U of PRBCs/whole blood within 72 h before surgery	1 (0.37 %)	6 (2.58 %)	1 (0.74 %)	0 (0 %)	8 (0.74 %)	0.002

taking oral or parenteral steroids, and 10.5 % with >10 % body weight loss within the 6 months before surgery (Table 1). Operations performed were partial colectomies in 24.6 %, total abdominal colectomy in 21.5 %, total proctocolectomy with end ileostomy in 12.4 %, and IPAA in 41.4 %. In regards to operative approach, laparoscopy was used in 29.2 % with rates increasing 8.5 % each year (18.5 % in 2005 to 41.3 % in 2008, $P < 0.001$; Fig. 1). Additionally, an open approach was used more frequently in all surgical groupings, but was highest with TAC

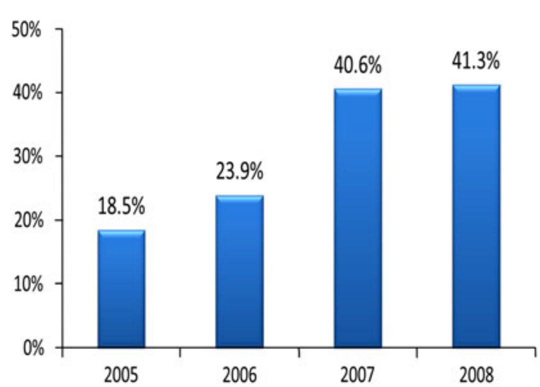

Fig. 1 28.6 % of operations had a laparoscopic approach with rates increasing 8.5 % annually ($P < 0.001$)

($P < 0.001$; Table 1). The overall complication rate was 28.6 %, and this rate was noted to be the lowest with laparoscopy compared with an open approach (21 vs. 32 %, $P < 0.001$; Table 2). Overall mortality rate for the entire cohort was relatively low at 1.3 %, although this was found to be higher in the open (1.7 %, $n = 13$) compared with the laparoscopic group (0.2 %, $n = 1$; $P = 0.046$).

On multivariate regression, postoperative complications increased when patients were not functionally independent, had preoperative sepsis, or had a prior percutaneous coronary intervention, whereas decreasing body mass index and a laparoscopic approach were associated with a lower complication rate (Table 3). When stratified by specific complications, laparoscopy was associated with lower complications, including superficial surgical-site infections (11.4 vs. 6.7 %, $P = 0.0011$), pneumonia (2.9 vs. 0.6 %, $P = 0.023$), prolonged mechanical ventilation (3.9 vs. 1.3 %, $P = 0.023$), need for transfusions postoperatively (1.6 vs. 0 %, $P = 0.016$), and severe sepsis (2.9 vs. 1.0 %, $P = 0.039$). Laparoscopy also was associated with a lower complication rate in TACs (41.7 vs. 18.8 %, $P < 0.0001$) and IPAA (29.9 vs. 18.2 %, $P = 0.005$; Table 2) and decreased mortality with total abdominal colectomy (6.6 vs. 0.89 %, $P = 0.023$).

Table 2 Specific complication rates of ulcerative colitis patients undergoing colectomy

Complication	Surgery[a]	Lap	Open	Total	*P* value
Superficial incisional SSI	Partial colectomy	18 (8.25 %)	5 (10.6 %)	23 (8.67 %)	0.599
	Total abdominal colectomy	14 (11.6 %)	7 (6.25 %)	21 (9.05 %)	0.151
	End ileostomy	14 (14.1 %)	2 (5.71 %)	16 (11.9 %)	0.186
	Pouch	37 (12.4 %)	11 (7.43 %)	48 (10.7 %)	0.11
Deep incisional SSI	Partial colectomy	4 (1.83 %)	2 (4.25 %)	6 (2.26 %)	0.312
	Total abdominal colectomy	0 (0 %)	1 (0.89 %)	1 (0.43 %)	0.3
	End ileostomy	2 (2.02 %)	1 (2.85 %)	3 (2.23 %)	0.774
	Pouch	7 (2.34 %)	0 (0 %)	7 (1.56 %)	0.06
Organ/space SSI	Partial colectomy	20 (9.17 %)	3 (6.38 %)	23 (8.67 %)	0.538
	Total abdominal colectomy	10 (8.33 %)	3 (2.67 %)	13 (5.60 %)	0.061
	End ileostomy	2 (2.02 %)	5 (14.2 %)	7 (5.22 %)	0.005
	Pouch	15 (5.03 %)	8 (5.4 %)	23 (5.15 %)	0.867
Wound disruption	Partial colectomy	3 (1.37 %)	2 (4.25 %)	5 (1.88 %)	0.188
	Total abdominal colectomy	3 (2.5 %)	1 (0.89 %)	4 (1.72 %)	0.347
	End ileostomy	6 (6.06 %)	0 (0 %)	6 (4.47 %)	0.136
	Pouch	4 (1.34 %)	2 (1.35 %)	6 (1.34 %)	0.994
Pneumonia	Partial colectomy	5 (2.29 %)	1 (2.12 %)	6 (2.26 %)	0.945
	Total abdominal colectomy	10 (8.33 %)	0 (0 %)	10 (4.31 %)	0.002
	End ileostomy	4 (4.04 %)	0 (0 %)	4 (2.98 %)	0.227
	Pouch	3 (1.00 %)	1 (0.67 %)	4 (0.89 %)	0.727
On ventilator >48 h	Partial colectomy	6 (2.75 %)	1 (2.12 %)	7 (2.64 %)	0.809
	Total abdominal colectomy	15 (12.5 %)	1 (0.89 %)	16 (6.89 %)	<0.001
	End ileostomy	6 (6.06 %)	1 (2.85 %)	7 (5.22 %)	0.464
	Pouch	2 (0.67 %)	2 (1.35 %)	4 (0.89 %)	0.473
Progressive renal insufficiency (no dialysis)	Partial colectomy	2 (0.91 %)	0 (0 %)	2 (0.75 %)	0.510
	Total abdominal colectomy	1 (0.83 %)	0 (0 %)	1 (0.43 %)	0.333
	End ileostomy	1 (1.01 %)	0 (0 %)	1 (0.74 %)	0.551
	Pouch	2 (0.67 %)	0 (0 %)	2 (0.44 %)	0.318
Urinary tract infection	Partial colectomy	8 (3.66 %)	1 (2.12 %)	9 (3.39 %)	0.597
	Total abdominal colectomy	7 (5.83 %)	8 (7.14 %)	15 (6.46 %)	0.685
	End ileostomy	7 (7.07 %)	4 (11.4 %)	11 (8.2 %)	0.42
	Pouch	19 (6.37 %)	4 (2.70 %)	23 (5.15 %)	0.099
Bleeding requiring >4 U PRBCs or whole blood transfusions within the first 72 h after surgery	Partial colectomy	3 (1.37 %)	0 (0 %)	3 (1.13 %)	0.419
	Total abdominal colectomy	2 (1.66 %)	0 (0 %)	2 (0.86 %)	0.17
	End ileostomy	5 (5.05 %)	0 (0 %)	5 (3.73 %)	0.175
	Pouch	2 (0.67 %)	0 (0 %)	2 (0.44 %)	0.318
Deep vein thrombosis (DVT)/ requiring therapy	Partial colectomy	6 (2.75 %)	0 (0 %)	6 (2.26 %)	0.25
	Total abdominal colectomy	5 (4.16%)	2 (1.78%)	7 (3.01%)	0.289
	End ileostomy	4 (4.04 %)	1 (2.85 %)	5 (3.73 %)	0.751
	Pouch	11 (3.69 %)	2 (1.35 %)	13 (2.91 %)	0.167
Systemic sepsis	Partial colectomy	16 (7.33 %)	2 (4.25 %)	18 (6.79 %)	0.446
	Total abdominal colectomy	8 (6.66 %)	6 (5.35 %)	14 (6.03 %)	0.676
	End ileostomy	7 (7.07 %)	3 (8.57 %)	10 (7.46 %)	0.772
	Pouch	26 (8.72 %)	9 (6.08 %)	35 (7.84 %)	0.328
Severe sepsis/septic shock	Partial colectomy	5 (2.29 %)	1 (2.12 %)	6 (2.26 %)	0.945
	Total abdominal colectomy	7 (5.83 %)	2 (1.78 %)	9 (3.87 %)	0.111
	End ileostomy	5 (5.05 %)	1 (2.85 %)	6 (4.47 %)	0.59
	Pouch	4 (1.34 %)	0 (0 %)	4 (0.89 %)	0.157

Table 2 continued

Complication	Surgery[a]	Lap	Open	Total	*P* value
Complication	Partial colectomy	62 (28.4 %)	13 (27.6 %)	75 (28.3 %)	0.914
	Total abdominal colectomy	50 (41.6 %)	21 (18.7 %)	71 (30.6 %)	<0.001
	End ileostomy	34 (34.3 %)	12 (34.2 %)	46 (34.3 %)	0.995
	Pouch	89 (29.8 %)	27 (18.2 %)	116 (26.0 %)	0.008
Death	Partial colectomy	3 (1.37 %)	0 (0 %)	3 (1.13 %)	0.419
	Total abdominal colectomy	8 (6.66 %)	1 (0.89 %)	9 (3.87 %)	0.023
	End ileostomy	2 (2.02 %)	0 (0 %)	2 (1.49 %)	0.397

SSI surgical site infection

[a] If surgery group not listed, there were no patients who had that complication

Table 3 Multivariate analysis of variables reaching statistical significance

Factor	Odds ratio (95 % CI)	*P* value
Preoperative sepsis	2.0 (1.21–3.42)	0.007
Functionally dependent	3.2 (1.6–6.75)	0.001
Prior percutaneous coronary intervention	2.8 (1.3–6.2)	0.009
Body mass index	0.9 (0.96–0.97)	0
Laparoscopic approach	0.5 (0.42–0.79)	0.001

Preoperative variables entered into the multivariate analysis: diabetes mellitus, dyspnea, functional independence, prior operation, septic preoperatively, DNR status, ventilator dependence, chronic obstructive pulmonary disease, pregnant, smoker, alcohol use, preoperative pneumonia, ascites, esophageal varices, congestive heart failure, history of MI, prior percutaneous coronary intervention, angina pectoris, hypertension, peripheral arterial disease, rest pain, preoperative acute renal failure, dialysis dependent, impaired neurologic sensorium, preoperative coma, hemiplegia, prior transient ischemic attack, prior cerebrovascular accident, cerebrovascular accident with neurologic deficit, central nervous system tumor, paraplegia, quadriplegia, metastatic cancer, open wound, transfusion, bleeding disorder, steroid use, preoperative weight loss, prior chemotherapy, prior radiation therapy, body mass index

Discussion

Laparoscopy has almost universally become the standard approach for appendectomy and cholecystectomy, even in complex patients [9, 10]. Yet, its use in colectomy, and specifically in ulcerative colitis patients, remains relatively low. Despite the fact that minimally invasive approaches to the surgical treatment of UC have been described during the past two decades, the present study demonstrated that only 29 % of UC cases were performed laparoscopically. This is consistent with the current literature, whether single-center studies or comparative analyses [11–14]. On the positive side, we found that a laparoscopic approach was slowly increasing throughout the study period, even when stratified by the type of operation (Fig. 2). Reasons for this increasing trend may include overall skill by laparoscopic surgeons, improved equipment, or a generational shift toward graduating residents. Even single-incision and robot-assisted approaches are being reported increasingly, which may herald a new era of colonic surgery for UC [15, 16]. Although seemingly counterintuitive, these newer laparoscopic approaches may facilitate shorter operative times as surgeons become more familiar with these advanced laparoscopic techniques [17].

Corresponding to other studies performed in other pathologic conditions, a laparoscopic approach was associated with significantly fewer postoperative complications

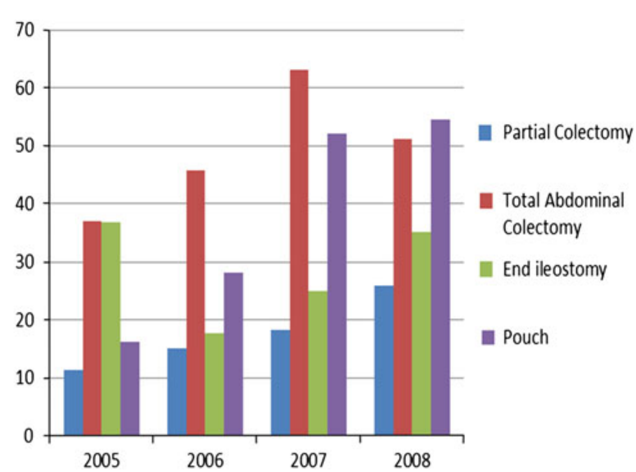

Fig. 2 Rates of laparoscopic surgery stratified by operation over the study period of time

as well as shorter inpatient hospital stay [18, 19]. This was noted to be different as a whole, but also when the patient cohort was stratified by the type of surgical procedure (Fig. 2). Specifically, this study found decreased rates of superficial incisional SSI, pneumonia, ventilator independence (off ventilator within 48 h postoperatively), decreased transfusion requirements (>4 U 72 h postoperatively), and severe sepsis/septic shock. These findings are important, because they demonstrate that not only are complications decreased, but they are decreased in specific, modifiable ways. For example, the improved pulmonary hygiene is likely directly attributable to quicker extubation, and decreased septic complications may be a result of decreased immunosuppression through decreased postoperative blood transfusion requirements.

Finally, on multivariate analysis, the current study found several preoperative areas that were found to increase the rate of postoperative morbidity. Patients lacking functional independence, having preoperative sepsis, and with a prior percutaneous intervention were at a higher risk of complications. Interestingly, the only factor associated with a decreased risk of postoperative morbidity was a laparoscopic approach, which was associated with a 1.6-fold decreased risk of postoperative morbidity when looking at all procedures combined. This finding is important, because it coincides with increased rates of minimally invasive approaches, even with the complex operations associated with UC. More importantly, this demonstrates that a laparoscopic approach is not only safe, but may be beneficial—even in obese patients.

Although this study does not demonstrate definitive advantages in all types of laparoscopic surgery, there were several specific complications that were decreased with laparoscopic approach, such as decreased organ space infections (end ileostomy), pneumonia rates (total abdominal colectomy), postoperative ventilator dependence (total abdominal colectomy), and mortality (total abdominal colectomy). This type of study is highly important, because only a database of this size would be able to stratify out specific operations based on operative approach to analyze outcomes.

Some limitations of our study are inherent to this type of outcomes analysis. The database is prospectively maintained in a highly specific, systematic, and uniform manner. Whereas the use of a large database allows a broad view of national trends, it also introduces the potential for bias as a result of coding and tracking errors. Furthermore, although ACS-NSQIP provides a large sample size, it lacks some details specific to patients' hospital course, details of specific immunosuppression, which is important in a group of patient with IBD, and indications for surgery (i.e., bleeding, refractory medical management, or toxic megacolon). Additionally, there may be some bias against open operations as those patients who undergo an initial laparoscopic approach with conversion to open may then be recorded as having an open operation. It is important to analyze the anatomy, physiology, or prior operative procedures in this group of patients, although it is likely very small. However, this study does allow the analysis of surgical approaches and population size that would be impossible with single- and even multicenter studies.

Conclusions

These results from a large, nationwide database (NSQIP) demonstrate that a laparoscopic approach was utilized in one third of UC patients undergoing colectomy, with rates increasing each year. Moreover, a minimally invasive approach was associated with lower morbidity and mortality, even in more complex procedures, such as TAC and IPAA. Although population databases provide important information, further prospective randomized trials are needed to confirm these findings and provide additional insight about specifics that are unable to be ascertained from this valuable resource.

Ethical standards This paper has been approved by the Madigan Army Medical Center Human Use Institutional Review Board.

Disclosures Authors Marlin W. Causey, Doug stoddard, Eric K. Johnson, Justin A. Maykel, Mathew J. Martin, David Rivadeneira and Scott R. Steele have no conflict of interest or financial ties to disclose.

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