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Research Paper

NSQIP 5-factor modified frailty index and complications after ileal anal pouch anastomosis for ulcerative colitis

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HIGHLIGHTS

- mFI-5 is associated with complications following ileal pouch-anal anastomosis (IPAA) for chronic ulcerative colitis (CUC).
- There is a need to develop better predictive tools for complications in CUC patients who undergo IPAA.

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ABSTRACT

Background: Frailty has been associated with worse postoperative outcomes. The 5-factor modified frailty index (mFI-5) is an objective measure although its validity in measuring frailty in patients undergoing ileal pouch-anal anastomosis (IPAA) for chronic ulcerative colitis (CUC) has not been reported.
Methods: This study used the American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) targeted proctectomy database. The mFI-5 was calculated by five preoperative diagnoses: insulin-dependent or noninsulin-dependent diabetes, congestive heart failure, hypertension, chronic obstructive pulmonary disease, and dependent or partially dependent functional status. The impact of mFI-5 on minor and major postoperative morbidity in CUC patients undergoing IPAA was analyzed.
Results: The cohort included 1454 patients (median age 38 years, median body mass index [BMI] 26 kg/m2) of which 87 % had a mFI-5 = 0, 11 % had a mFI-5 = 1, and 2.5 % a mFI-5 $\geq$ 2. In multivariable logistic regression, mFI-5 $\geq$ 2 was significantly associated with minor complications (OR = 2.29, 95 % CI [1.00–5.22], $p = 0.049$), but not with major complications ($p = 0.860$).
Conclusion: IPAA for CUC is associated with high postoperative morbidity, however, the mFI-5 alone has limited utility in determining which patients are at a higher risk of complications due to frailty. These observations suggest there is a need for more relevant instruments to measure frailty in this patient cohort.

Introduction

Frailty is a multidimensional construct associated with a decrease in physiological reserve across multiple organ systems that has been identified as a risk factor for postoperative complications [1,2]. Its association with adverse events is considered to be due to the inability of frail patients to adequately respond to the stress of surgery. Frail patients undergoing colorectal surgery have been shown to have worse postoperative outcomes including increased complications, mortality, and healthcare costs [3–5]. As a result, frailty has been increasingly utilized in surgical decision making and risk stratification for colorectal surgical procedures [6,7].

Frailty lacks a universally accepted definition, and it is challenging to objectively measure as it encompasses physical examination findings

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along with medical conditions and physiological parameters. There have been several instruments developed to assess frailty including the Canadian Study of Health and Aging frailty index (CSHA-FI) [8], which uses 70 patient variables, with worse outcomes associated with an increasing number of risk factors. However, the high number of variables make it cumbersome to use. Furthermore, some of the included variables are not considered to provide additional clinical utility. Hence, frailty indices with fewer variables have been investigated as they may be easier to use in clinical practice while maintaining their predictive value. The modified frailty index (mFI) was developed using the American College of Surgeons National Surgical Quality Improvement Program (NSQIP) database with 16 variables that mapped to 11 factors matching the original CSHA-FI [8]. The mFI-11 was proven to adequately reflect frailty and had been shown to predict mortality and morbidity among surgical patients [9]. As the NSQIP database evolved, certain variables were changed or removed to accommodate the quality improvement goals of the database. Subsequently, the mFI was further modified to be based on only 5 variables still collected in the NSQIP [10]. However, the predictive power and usefulness of the 5-factor modified frailty index (mFI-5) has not been well documented in the surgical literature.

Ileal pouch-anal anastomosis (IPAA) following total proctocolectomy for chronic ulcerative colitis (CUC) is the accepted standard surgical treatment for patients desiring reestablishment of intestinal continuity. It is associated with significant perioperative morbidity that is in the range of 20–30 % regardless of operative approach. This morbidity includes postoperative infectious complications, delay in return of bowel function and readmissions, all of which can impact length of stay, functional outcomes, and healthcare costs. Therefore, identifying patients at risk for postoperative complications can lead to development of mitigation strategies and potentially improve outcomes. We hypothesized that the mFI-5 would be associated with early postoperative morbidity and could supplement preoperative clinical decision making. The aim of this study was to therefore assess the relationship of the mFI-5 on postoperative complications in patients with CUC undergoing IPAA.

Materials & methods

Data and patient population

The study was deemed exempt by the University of Iowa Institutional Review Board as the Participant Use Files (PUF) contain only de-identified data. This is a retrospective cohort study using data compiled from the NSQIP database proctectomy-targeted PUF between 2016 and 2019. The NSQIP database prospectively collects Health Insurance Portability and Accountability Act (HIPAA)-compliant surgical outcomes data. This nationally validated database tracks baseline preoperative risk factors, intraoperative variables, and 30-day postoperative outcomes. Adult patients ($\geq$18 years) who underwent an IPAA based on their primary procedure current procedural terminology (CPT) codes were included in the study. This included open proctocolectomy with IPAA (CPT 44157, 44158), laparoscopic proctocolectomy with IPAA (CPT code 44211), and completion proctectomy with IPAA (CPT code 45113). Only patients who had a primary ICD10 diagnosis of CUC were included (ICD-10 K51.xx). Patients were categorized as having an open, minimally invasive surgery (MIS), or other approach to surgery. MIS included both laparoscopic and robotics. Other included all other recorded approaches to IPAA. Cases classified as non-elective or emergent were excluded. All included patients had complete data for calculating their mFI-5.

The mFI-5 is based on the mFI-11, but with fewer variables due to the NSQIP database narrowing its number of collected variables starting in 2014 [10]. It is calculated by the following five preoperative diagnoses: insulin-dependent or noninsulin-dependent diabetes, congestive heart failure, hypertension, chronic obstructive pulmonary disease or pneumonia, and dependent or partially dependent functional status at time of surgery. Each variable was given equal weight with a score of 0 if not present and 1 if present. The five factors were summed, and each patient was given a cumulative score from 0 (no comorbidities present) to 5 (all comorbidities present). Patients were stratified based on their mFI-5 as follows: mFI-5 $=$ 0, mFI-5 $=$ 1, and mFI-5 $\geq$ 2.

Patient level variables including baseline demographic, clinical data, and laboratory values were compared between study groups. For analyzing the oldest patients of the cohort, a cutoff of age 50 years was used during comparative analyses as it approximated the upper quartile of the dataset. Obesity was defined as a BMI $\geq$30 kg/m^2. Overall, the primary outcome of interest was all-cause Clavien-Dindo postoperative morbidity within 30 days of surgery [11]. These complications were further categorized into minor and major complications based on the Clavien-Dindo classification. Minor complications (Clavien-Dindo 1–2) included superficial surgical site infections, pneumonia, clostridium difficile infection, sepsis, urinary tract infection, wound disruption, renal failure, and deep vein thrombosis. Major complications (Clavien-Dindo Class 3–5) were organ space infection, deep wound infection, septic shock, progressive renal insufficiency, stroke/cerebrovascular accident (CVA), cardiac arrest, myocardial infarction, ventilator requirement >48 h after surgery, unplanned reintubation, pulmonary embolism, and reoperation. Data on readmission and mortality rates were collected as well. Patients with both a major and minor complication concurrently were only categorized as having a major complication. Ileus and anastomotic leak rates were also analyzed.

Statistical analyses

Frequencies and percentages were used for categorical variables. Continuous variables were expressed as median [IQR]. All statistical analyses were two-sided with significance set at a $p < 0.05$. Pre- and perioperative variables were compared between frailty cohorts by Pearson's chi-squared tests or Fisher exact tests for categorical variables and by Student's *t*-tests or ANOVA for continuous variables. Cramer's V was calculated to assess mFI-5's association with minor and major complications. Strength of association was classified as small if between 0.07 and 0.21, medium if between 0.21 and 0.35, and large if >0.35 due to two degrees of freedom. Multivariable logistic regression models were used to evaluate the relationship between complications and preoperative factors. Covariates included in our multivariable model were chosen based on having a $p < 0.05$ on univariable analyses. Results were shown as odds ratios (OR) with 95 % confidence interval. Statistical analyses were performed using SPSS Version 23.0 (IBM Corp, Armonk, NY).

Results

Patient cohort

After applying the inclusion and exclusion criteria, a total of 1454 patients with CUC who underwent IPAA were identified from the NSQIP database. The median age was 38 years (IQR 29–51; Table 1), more than half the patients were males (58 %), and most patients were Caucasian (83 %). The median BMI was 25.6 (IQR 22.6–29.1), and 305 (21 %) were obese based on having a BMI $\geq$30. When stratified by mFI-5, there were 1262 patients with an mFI-5 of 0 (87 %), 156 with mFI-5 of 1 (11 %), and 36 with mFI-5 of 2 or greater (2.5 %). Higher mFI-5 was associated with age >50 years old, male sex, non-Caucasian race/ethnicity, obesity, and ASA classification $\geq$3 (all $p < 0.05$). The mFI-5 did not differ between the surgical procedure of proctocolectomy vs. completion proctectomy and open vs. MIS approach (both $p > 0.05$; Supplemental Table 1). The most frequently observed comorbidities were hypertension (11 %) and diabetes (4.1 %). COPD, dependent functional status, and CHF were all seen in <10 patients each (<1 %).

Table 1
Comparison of demographic, co-morbidities and surgical approach for CUC patients undergoing IPAA by mFI-5.

Characteristics		mFI-5 frailty score				*P* value
		Overall n = 1454 (%)	mFI-5 = 0 n = 1262 (%)	mFI-5 = 1 n = 156 (%)	mFI-5 ≥ 2 n = 36 (%)	
Age, years		38 (29, 51)	36 (28, 47)	54.5 (48, 62)	58 (54, 63)	**<0.001**
	Age ≥50	79 (5.4)	43 (3.4)	29 (18.6)	7 (19.4)	**<0.001**
Sex	Male	846 (58.2)	711 (56.3)	109 (69.9)	26 (72.2)	**0.001**
	Female	608 (41.8)	551 (43.7)	47 (30.1)	10 (27.8)	
Race	Caucasian	1212 (83.4)	1047 (83.0)	135 (86.5)	30 (83.3)	**<0.001**
	Black	52 (3.6)	42 (3.3)	6 (3.8)	4 (11.1)	
	Other	45 (3.1)	34 (2.7)	11 (7.1)	0 (0.0)	
	Unknown	145 (10.0)	139 (11.0)	4 (2.6)	2 (5.6)	
BMI (kg/m^2)		25.6 (22.6, 29.1)	25.2 (22.3, 28.6)	28.1 (25.2, 32.1)	28.7 (25.1, 32.2)	**<0.001**
Obesity	BMI < 30	1149 (79.0)	1033 (81.9)	95 (60.9)	21 (58.3)	**<0.001**
	BMI ≥ 30	305 (21.0)	229 (18.1)	61 (39.1)	15 (41.7)	
Current smoker	Yes	80 (5.5)	71 (5.6)	7 (4.5)	2 (5.6)	0.884
Dyspnea	Yes	17 (1.2)	13 (1.0)	3 (1.9)	1 (2.8)	0.200
Steroid use	Yes	409 (28.1)	350 (27.7)	48 (30.8)	11 (30.6)	0.700
Preop. weight loss	≥10 %	53 (3.6)	47 (3.7)	4 (2.6)	2 (5.6)	0.558
Preop. hematocrit	<35 %	230 (17.2)	200 (17.4)	22 (14.9)	8 (21.6)	0.576
Preop. albumin	<3.5 g/dL	133 (15.0)	116 (15.1)	11 (11.3)	6 (24.0)	0.270
ASA Class	1 or 2	996 (66.6)	894 (71.0)	66 (42.3)	6 (16.7)	**<0.001**
	3 or 4	485 (33.4)	365 (29.0)	90 (57.7)	30 (83.3)	
Operative approach	Open	646 (44.4)	564 (44.7)	61 (39.1)	21 (58.3)	0.068
	MIS[a]	776 (53.4)	670 (53.1)	93 (59.6)	13 (36.1)	
	Other	32 (2.2)	28 (2.2)	2 (1.3)	2 (5.6)	

Categorical variables reported as frequencies (percent). Continuous variables reported as median (IQR).
Significance determined at $p < 0.05$ and bold text.
BMI (Body mass index), ASA (American Society of Anesthesiologists), CUC (ulcerative colitis), IPAA (ileal pouch-anal anastomosis), IQR (interquartile range).
[a] Minimally invasive surgery (MIS) includes both laparoscopic and robotic approaches.

Postoperative morbidity

Overall, 36 % of the cohort experienced at least one postoperative complication. The most frequent complications included readmission (23 %), ileus (19.5 %), and organ space infections (8 %). Approximately 11 % of patients had a Clavien-Dindo 1/2 or minor complication and 13 % had a grade 3–5 or major complication (Table 2). Most of the other individual complications occurred at overall rates of <5 % in this IPAA cohort. There was only one mortality.

There was an increase in overall complications in patients with a mFI-5 of 1 (44.9 %) and mFI-5 ≥ 2 (44.4 %) compared to those with mFI-5 = 0 (34.8 %). On multivariable logistic regression, there was an association between an mFI-5 of ≥2 and minor complications (OR = 2.29, 95 % CI [1.00–5.22], $p = 0.049$). Female sex, obesity, and steroid use were also significantly associated with minor complications (Table 3). However, there was no association between mFI-5 and major complications (OR = 1.09, 95 % CI [0.42–2.89], $p = 0.860$) (Table 4). Preoperative steroid use was found to be the only factor significantly associated with increased risk of developing a major complication in the adjusted analysis.

Cramer's V was performed to assess the strength of association between mFI-5 score and minor complications and major complications. The strength of mFI-5's association with minor complications was statistically significant, but weak (0.076, $p = 0.015$). However, it was not significant between major complications and mFI-5 score (0.062, $p = 0.063$).

Discussion

In our analysis, IPAA was associated with significant postoperative morbidity including minor and major complications, postoperative ileus, and readmissions, regardless of operative approach. mFI-5 was able to discriminate between a high and low risk group; however, it did not provide clinically relevant prognostication based on frailty among CUC patients undergoing IPAA. These observations suggest that frailty in this patient population cannot be reliably assessed based on the factors measured in the mFI-5. Furthermore, female sex, obesity and steroid use were independently associated with minor complications, while preoperative steroid use was the only other risk factor associated with major postoperative morbidity in the cohort.

There have been two models of frailty described in the literature (1) frailty phenotype and (2) frailty index or deficit accumulation model [6]. The frailty phenotype model was derived from data taken from the Cardiovascular Health Study [1]. It suggests that there is a relationship between a set criterion that defines frailty (i.e. unintentional weight loss, low physical activity) and the effect on various outcome measures (disability and postoperative morbidity). However, the frailty index or deficit accumulation model which was based on the Canadian Study of Health and Aging, reflects the number of deficits that an individual accrues across several domains [8]. This framework was subsequently used to develop the mFI-5 and allows for the calculation of a "frailty index" which can be considered to be a "count of an individual accumulated deficits" [10]. The variables measured in the mFI-5 are insulin-dependent or noninsulin-dependent diabetes, congestive heart failure, hypertension, chronic obstructive pulmonary disease or pneumonia, and dependent or partially dependent functional status at time of surgery. Four out of the five factors represent age-related medical comorbidities that are unlikely to be present in younger patients. Thus, mFI-5 may not be the ideal tool to predict complications in this patient population who underwent an IPAA. Using the generic NSQIP database, Cohan et al. (2015) also reported that age and frailty were not associated with differences in the mean number of major 30-day complications and hospital length of stay in patients undergoing IPAA for CUC. However, frailty was calculated using a different set of traits than the mFI-5 in their study [12].

The increased incidence of morbidity after IPAA has been well documented but there have been limited advances in decreasing them over the last several decades even with the use of minimally invasive approaches [13]. Therefore, any measure that can identify a high-risk group could lead to risk mitigating interventions that may improve patient outcomes. Frailty among surgical patients has been consistently associated with worse postoperative outcomes. Most of the current literature has focused on elderly patients as they have been considered at being at risk for frailty. Although frailty is considered a decrease in

Table 2
Univariate analysis of 30-day postoperative complications in CUC patients after IPAA by mFI-5.

Complication	mFI-5 frailty score				P value
	Overall n = 1454 (%)	mFI-5 = 0 n = 1262 (%)	mFI-5 = 1 n = 156 (%)	mFI-5 ≥ 2 n = 36 (%)	
Clavien-Dindo Class 1–2	166 (11.4)	133 (10.5)	25 (16.0)	8 (22.2)	**0.016**
Superficial Incisional SSI	59 (4.1)	50 (4.0)	5 (3.2)	4 (11.1)	0.104
Pneumonia	6 (0.4)	3 (0.2)	3 (1.9)	0 (0.0)	**0.039**
Clostridium Difficile infection	2 (0.1)	2 (0.2)	0 (0.0)	0 (0.0)	1.000
Sepsis	44 (3.0)	38 (3.0)	6 (3.8)	0 (0.0)	0.619
Urinary tract infection	38 (2.6)	30 (2.4)	5 (3.2)	3 (8.3)	0.074
Wound disruption	5 (0.3)	4 (0.3)	1 (0.6)	0 (0.0)	0.508
Renal failure	4 (0.3)	2 (0.2)	1 (0.6)	1 (2.8)	**0.035**
Deep vein thrombosis	30 (2.1)	23 (1.8)	6 (3.8)	1 (2.8)	0.159
Clavien-Dindo Class 3–5	185 (12.7)	151 (12.0)	29 (18.6)	5 (13.9)	0.064
Organ space infection	118 (8.1)	100 (7.9)	17 (10.9)	1 (2.8)	0.253
Deep wound infection	18 (1.2)	16 (1.3)	2 (1.3)	0 (0.0)	1.000
Septic shock	5 (0.3)	4 (0.3)	1 (0.6)	0 (0.0)	0.508
Progressive renal insufficiency	18 (1.2)	8 (0.6)	9 (5.8)	1 (2.8)	**<0.001**
Stroke/CVA	1 (0.1)	0 (0.0)	1 (0.6)	0 (0.0)	0.132
Cardiac arrest	1 (0.1)	0 (0.0)	1 (0.6)	0 (0.0)	0.132
Myocardial infarction	1 (0.1)	0 (0.0)	1 (0.6)	0 (0.0)	0.132
Ventilator >48 h	3 (0.2)	1 (0.1)	2 (1.3)	0 (0.0)	**0.048**
Unplanned intubation	4 (0.3)	1 (0.1)	3 (1.9)	0 (0.0)	**0.011**
Pulmonary embolism	3 (0.2)	3 (0.2)	0 (0.0)	0 (0.0)	1.000
Reoperation	68 (4.7)	53 (4.2)	11 (7.1)	4 (11.1)	**0.043**
Ileus	283 (19.5)	241 (19.1)	35 (22.4)	7 (19.4)	0.613
Anastomotic leak	47 (3.2)	39 (3.1)	8 (5.1)	0 (0.0)	0.227
Readmission	337 (23.2)	273 (21.6)	54 (34.6)	10 (27.8)	**0.001**
Mortality	1 (0.1)	0 (0.0)	1 (0.6)	0 (0.0)	0.132

Categorical variables reported as frequencies (percent).
Significance determined at $p < 0.05$ and bold text.
IPAA (ileal pouch-anal anastomosis), CUC (chronic ulcerative colitis), mFI-5 (5-factor modified frailty index), SSI (surgical site infection).

Table 3
Multivariate analysis of factors associated with IPAA minor complications.

Variable	Referent	OR	95 % CI	P value
mFI-5 = 1	mFI-5 = 0	1.51	0.94–2.45	0.091
mFI-5 ≥ 2	mFI-5 = 0	2.29	1.00–5.22	**0.049**
Male sex	Female sex	0.68	0.47–0.94	**0.020**
Obesity	No obesity	1.66	1.15–2.40	**0.007**
Steroid use	No steroid use	1.78	1.27–2.50	**0.001**

Significance determined at $p < 0.05$ and bold text.

Table 4
Multivariate analysis of factors associated with IPAA major complications.

Variable	Referent	OR	95 % CI	P value
mFI-5 = 1	mFI-5 = 0	1.56	0.99–2.44	0.052
mFI-5 ≥ 2	mFI-5 = 0	1.09	0.42–2.87	0.860
Obesity	No obesity	1.36	0.95–1.96	0.096
Steroid use	No steroid use	1.42	1.02–1.97	**0.036**

Significance determined at $p < 0.05$ and bold text.

physiological reserve and it occurs more commonly in the elderly, it can develop at any age. Patients undergoing an IPAA for CUC are generally younger but can still have decreased physiological reserves due to their underlying disease and ongoing medical treatment regimen. These patients usually have not responded to medical therapy and have refractory disease resulting in side effects such as weight loss, anemia, and malnutrition. Furthermore, in the case of steroids or biologic therapy, these patients can be immunosuppressed and therefore considered frail in terms of their underlying physiologic state. Despite the utility of the mFI-5 in other patient populations, our hypothesis that mFI-5 could accurately predict complications in this IPAA cohort was not reliably validated which may be due to the mFI-5 not accounting for frailty secondary to malnutrition, steroid usage, and biologic usage.

Previous studies have shown obesity to be associated with an increased risk of complications following IPAA compared to non-obese patients with anastomotic/pouch strictures, inflammatory pouch complications, and pouch fistulas particularly being more frequent [14]. In a propensity matched score analysis using the NSQIP dataset, it was observed that obese patients (BMI ≥30 kg/m^2) also had higher rates of deep space infections [15]. These findings together with our observations confirm the importance of appropriate patient selection when making surgical decisions regarding IPAA. Given the high rates of postoperative morbidity associated with IPAA and the fact that obesity is a modifiable risk factor, preoperative weight loss should be considered a viable risk mitigating strategy to decrease the risk of postoperative complications.

The data regarding the association between steroid use and complications after IPAA have been conflicting [16–18]. While initial reports from the beginning of the biologic era reported a higher incidence of postoperative complications, subsequent reports did not confirm these findings [19,20]. In our study, we identified steroid use as being associated with postoperative morbidity. Although one third of IPAAs were performed in patients who had previously undergone a colectomy and likely were not on any medications (i.e., they were physiologically optimized with a lower risk of complications) a subset of patients undergoing a 2-stage IPAA may still have been on medical treatment for their disease including steroids contributing to postoperative morbidity. This observation should also be considered in the context of the fact that the NSQIP database does not have the ability to determine steroid dose or duration.

Recently, other prognostic variables have been investigated that further quantify patient frailty which are not currently part of the mFI-5 or NSQIP database. In particular preoperative imaging to diagnose sarcopenia has been found to be an important indicator of frailty [21]. It specifically refers to the loss of muscle mass which is associated with the presence of underlying disease and patient biological age. The current gold standard for sarcopenia diagnosis is imaging with CT or MRI which allows for the objective quantification of muscle mass by measuring skeletal muscle index at the L3 vertebral body, the total volume of psoas muscle, Hounsfield average of the psoas muscle, intramuscular adiposity, or dorsal muscle group area [22]. If present, sarcopenia is able to identify patients at higher risk of overall postoperative complications, longer length of hospitalization, and mortality in both emergent and elective general surgery procedures [23–25]. Additionally, sarcopenia has been shown to be predictive of surgical site infection after pouch surgery for ulcerative colitis [26]. Thus, imaging to evaluate for sarcopenia can be considered in conjunction with frailty metrics such as the mFI-5.

Overall, patient frailty has become an increasingly relevant factor in identifying patients who may be at higher risk of perioperative complications. In line with this increased awareness, the American Society of Colon and Rectal Surgeons (ASCRS) have released guidelines for assessing and managing frailty in surgical patients [27]. If a patient is deemed to be frail, patient-specific perioperative modifications have been proven to improve surgical outcomes such as mortality [28]. For example, patients undergoing prehabilitation may undergo psychological intervention, exercise programs, and tobacco cessation. Of particular interest to the results of this study, undergoing prehabilitation that includes weight loss and minimizing steroid use are potential modifiable risk factors that can decrease postoperative complication risk in patients undergoing IPAA for UC.

There were several limitations to this study including the fact that the NSQIP database does not measure outcomes after 30 days which precludes it ability to assess long-term patient outcomes such as functional outcomes, hernias, bowel obstruction, pouch failure, strictures, and fistula formation, which are of particular importance for young IPAA patients. In addition, there were only 38 patients with an mFI-5 of ≥2 who underwent IPAA, which made it challenging to make strong conclusions for patients with a higher frailty score. Furthermore, there was likely selection bias in operative approach choice (open vs. MIS) that may have also influenced risk of complications. Finally, the NSQIP database only collects data from participating NSQIP sites, which are primarily tertiary care centers therefore limiting the generalizability of these observations.

Conclusions

IPAA for CUC is associated with high postoperative morbidity, however, the mFI-5 alone has limited utility in determining which patients are at a higher risk of complications due to frailty. Further investigation is necessary to identify disease and procedure specific instruments that can measure frailty in this patient population. Nevertheless, obesity and preoperative steroid use are two potential modifiable preoperative risk factors associated with an increased risk of complications prior to IPAA surgery.

Ethics approval

The ACS-NSQIP database contains deidentified patient information. This study was exempt from ethics approval.

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CRediT authorship contribution statement

Dakota T. Thompson: Writing – review & editing, Writing – original draft, Formal analysis, Data curation, Conceptualization. **Ethan G. Breyfogle:** Writing – original draft, Data curation, Conceptualization. **Catherine G. Tran:** Writing – review & editing, Writing – original draft, Formal analysis, Conceptualization. **Mohammed O. Suraju:** Writing – review & editing. **Aditi Mishra:** Writing – review & editing. **Hussain A. Lanewalla:** Writing – review & editing. **Paolo Goffredo:** Writing – review & editing, Supervision, Conceptualization. **Imran Hassan:** Writing – review & editing, Writing – original draft, Formal analysis, Conceptualization.

Declaration of competing interest

The authors have no conflicts of interest to declare.

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Appendix A. Supplementary data

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