

Association of Patient Frailty With Increased Morbidity After Common Ambulatory General Surgery Operations

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 Supplemental content

IMPORTANCE Frailty is a measure of decreased physiological reserve that is associated with morbidity and mortality in major elective and emergency general surgery operations, independent of chronological age. To date, the association of frailty with outcomes in ambulatory general surgery has not been established.

OBJECTIVE To determine the association between frailty and perioperative morbidity in patients undergoing ambulatory general surgery operations.

DESIGN, SETTING, AND PARTICIPANTS A retrospective cohort study was conducted of 140 828 patients older than 40 years of age from the 2007-2010 American College of Surgeons National Surgical Quality Improvement Program Participant Use File who underwent ambulatory and 23-hour-stay hernia, breast, thyroid, or parathyroid surgery. Data analysis was performed from August 18, 2016, to June 21, 2017.

MAIN OUTCOMES AND MEASURES The association between the National Surgical Quality Improvement Program modified frailty index and perioperative morbidity was determined via multivariable logistic regression with random-effects modeling to control for clustering within *Current Procedural Terminology* codes.

RESULTS A total of 140 828 patients (80 147 women and 60 681 men; mean [SD] age, 59.3 [12.0] years) underwent ambulatory hernia (n = 71 455), breast (n = 51 267), thyroid, or parathyroid surgery (n = 18 106). Of these patients, 2457 (1.7%) experienced any type of perioperative complication and 971 (0.7%) experienced serious perioperative complications. An increasing modified frailty index was associated with a stepwise increase in the incidence of complications. In multivariable analysis adjusting for age, sex, race/ethnicity, anesthesia type, tobacco use, renal failure, corticosteroid use, and clustering by *Current Procedural Terminology* codes, an intermediate modified frailty index score (0.18-0.35, corresponding to 2-3 frailty traits) was associated with statistically significant odds ratios of 1.70 (95% CI, 1.54-1.88; $P < .001$) for any complication and 2.00 (95% CI, 1.72-2.34; $P < .001$) for serious complications. A high modified frailty index score (≥ 0.36 , corresponding to ≥ 4 frailty traits) was associated with statistically significant odds ratios of 3.35 (95% CI, 2.52-4.46; $P < .001$) for any complication and 3.95 (95% CI, 2.65-5.87; $P < .001$) for serious complications. Anesthesia with local and monitored anesthesia care was the only modifiable covariate associated with decreased odds of serious 30-day complications, with an adjusted odds ratio of 0.66 (95% CI, 0.53-0.81; $P < .001$).

CONCLUSIONS AND RELEVANCE Frailty is associated with increased perioperative morbidity in common ambulatory general surgery operations, independent of age, type of anesthesia, and other comorbidities. Surgeons should consider frailty rather than chronological age when counseling and selecting patients for elective ambulatory surgery.

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The population of patients older than 65 years of age continues to increase and alter the demographics of those seeking surgical care. In 2006, patients older than 65 years of age made up 32% of patients undergoing ambulatory surgery in the United States, and with this group projected to double in number from 2010 to 2050, this percentage is likely to increase accordingly.^{1,2} As the baby boomer generation ages and life expectancy increases, surgical services will have to focus on providing safe and specialized care for this aging population in the ambulatory setting.

Frailty is a measure of decreased physiological reserve that results from impairments in multiple organ systems and can be distinguished from the aging process and comorbidity. Multiple studies have shown that frailty is associated with increased risk of complications in a wide range of elective and emergency operations.³⁻⁸ These effects appear to be independent of chronological age. However, there is evidence that older patients are less likely than younger patients to receive standard of care operative management for benign and malignant conditions, even after adjusting for health status and preference.⁹⁻¹² In addition, higher-than-anticipated complication rates for younger frail patients¹³ suggest that operative risks should be carefully weighed in this group and that informed consent must take into account more than just chronological age. Preoperative assessment of frailty is critical to ensuring that indicated operations are performed on the right patients and that patients are well informed of their surgical risk. In addition, there is evidence that preoperative targeted interventions to optimize medical comorbidities, nutrition, and physical fitness in at-risk patients can improve outcomes and postoperative functional status and reduce complications and length of stay (LOS).¹⁴⁻¹⁷

There are few studies addressing the association of frailty with outcomes in patients undergoing ambulatory and 23-hour-stay surgery. Although operations performed in this setting are generally considered to be low risk, studies of surgical outcomes that stratify patients based on age may be subject to selection bias and fail to address the association of impaired physiological reserve with complications and quality of life. In addition, results from single-center studies of elderly patients are often superior to those in population-based studies, suggesting that continued investigation is needed to inform decision making in this group.³ The aim of this study is to better understand the association of frailty with perioperative outcomes of patients undergoing common ambulatory general surgery operations. Further information on this association will allow us to appropriately counsel elderly patients on the risks of surgery; improve access to care for older, nonfrail patients; and intervene preoperatively to improve patient fitness and surgical outcomes.

Methods

Database and Patient Selection

We used the 2007-2010 American College of Surgeons National Surgical Quality Improvement Program (NSQIP) Participant Use File for our analysis. This database contains prospective, multi-institutional information on patient characteristics and 30-day morbidity and mortality outcomes for a

Key Points

Question Is frailty associated with perioperative morbidity in patients undergoing ambulatory hernia, breast, thyroid, or parathyroid surgery?

Findings In this cohort study, an increasing National Surgical Quality Improvement Program modified frailty index was associated with a stepwise increase in the incidence of 30-day complications; an intermediate modified frailty index (2-3 frailty traits) and a high modified frailty index (≥ 4 frailty traits) were significantly associated with any type of complication and with serious complications, respectively, in multivariable analysis adjusting for other risk factors and clustering by operation. Anesthesia with local and monitored anesthesia care was the only modifiable covariate associated with decreased odds of serious 30-day complications.

Meaning Frailty is independently associated with perioperative morbidity in patients undergoing common ambulatory general surgery and should be considered in patient selection and counseling.

systematic sample of major inpatient and outpatient surgical procedures at participating institutions. Trained surgical clinical reviewers obtain complete 30-day follow-up data on selected patients with regular interrater reliability audits.¹⁸ The collection of NSQIP data has been previously described.¹⁹ This study was exempt from approval by the University of California, San Francisco Institutional Review Board because it involved analysis of deidentified patient data. Informed consent was not required because data were deidentified.

Patients undergoing ambulatory surgery were identified using variables for outpatient procedures and total LOS. Surgical procedures listed as emergencies or that did not use anesthesia were excluded. Ambulatory hernia surgery, breast surgery, thyroid surgery, and parathyroid surgery were identified using *Current Procedural Terminology* codes (eTable 1 in the Supplement). We did not include thyroid or parathyroid surgery requiring sternotomy.

Covariates

Frailty was assessed using the NSQIP modified frailty index (mFI), a measure of frailty based on 11 NSQIP variables that is adapted from the Canadian Study of Health and Aging Frailty Index²⁰ and has been validated to correlate with frailty in all surgical specialties.^{7,13,21,22} The variables included in the mFI are listed in the Box. The mFI scores are obtained by adding the total number of present variables and dividing by 11, the total possible points. The mFI was tested in multivariable models as a continuous predictor and then broken down into the following multilevel categories to facilitate the clinical application of study findings: low mFI (score ≤ 0.18 , corresponding to 0-1 frailty traits), intermediate mFI (score 0.18-0.35, corresponding to 2-3 frailty traits), and high mFI (score ≥ 0.36 , corresponding to ≥ 4 frailty traits). Additional covariates included in multivariable models based on clinical relevance were age, sex, race/ethnicity, type of anesthesia, tobacco use, renal failure, and corticosteroid use.

Outcome Variables

The NSQIP contains comprehensive data on 30-day perioperative complications and mortality. Primary outcomes were any type of 30-day complication and serious 30-day complications.

Box. Variables Corresponding to Frailty Traits That Are Included in the 11-Variable National Surgical Quality Improvement Program Modified Frailty Index

- History of diabetes
- Impaired functional status
- History of chronic obstructive pulmonary disease or pneumonia
- History of congestive heart failure
- History of myocardial infarction within 6 months
- History of percutaneous coronary intervention
- Cardiac surgery or angina
- Receipt of hypertensive medications
- Peripheral vascular disease or rest pain
- Impaired sensorium
- History of transient ischemic attack or cerebrovascular accident with persistent residual deficit

Any type of complication included pneumonia, unplanned intubation, ventilator dependence, cardiac arrest or myocardial infarction, stroke or coma for longer than 24 hours, acute or progressive renal failure, bleeding, sepsis, surgical site infections, wound dehiscence, venous thromboembolism, and urinary tract infections. Serious complications excluded urinary tract infections and superficial surgical site infections, which do not have uniform clinical significance. We chose to include in our primary outcomes complications that are not life threatening but that may significantly affect the quality of life, recovery, and long-term functional outcomes of frail patients undergoing elective surgery. Additional 30-day outcomes included mortality and LOS.

Statistical Analysis

Statistical analysis was performed from August 18, 2016, to June 21, 2017. χ^2 Statistics and analysis of variance were used to compare differences in perioperative outcomes between mFI categories. Multivariable logistic regression was used to calculate odds ratios (ORs) for the association between mFI category and primary outcomes adjusting for prespecified covariates. Clustering by *Current Procedural Terminology* codes using multilevel modeling with random effects was used to account for intraprocedure variation in the overall model. Adjusted ORs were also calculated within surgery type. Multivariable linear regression was used to compare LOSs in each group. The significance level for all comparisons was $P < .05$, and the tests were 2-tailed. Analysis was performed using STATA statistical software, version 13.0 (StataCorp LP).

Results

Patient Characteristics

We identified 140 828 patients older than 40 years of age who underwent ambulatory hernia ($n = 71\ 455$), breast ($n = 51\ 267$), thyroid, or parathyroid surgery ($n = 18\ 106$). Baseline demographic and comorbidity characteristics are listed in **Table 1**. A total of 118 831 patients had low mFI scores, 21 036 had intermediate mFI scores, and 961 had high mFI scores. As expected in the ambulatory setting, more than 99% of patients ($n = 139\ 732$) had independent functional status on admis-

sion, and most had no or mild systemic disease (102 539 [72.8%] patients with American Society of Anesthesiologists class I or II). However, 192 patients (20.0%) with high mFI scores had dependent functional status prior to admission compared with 255 (0.2%) patients with low mFI scores. The most prevalent comorbidities contributing to frailty in patients with intermediate and high mFI scores were hypertension (20 201 [96.0%] with intermediate mFI scores and 946 [98.4%] with high mFI scores), insulin-dependent and non-insulin-dependent diabetes (11 046 [52.5%] with intermediate mFI scores and 699 [72.7%] with high mFI scores), and coronary artery disease (7286 [34.6%] with intermediate mFI scores and 760 [79.1%] with high mFI scores). A total of 73 033 patients (51.9%) had no frailty traits, 45 798 (32.5%) had 1 frailty trait, 21 036 (14.9%) had 2 to 3 frailty traits, and 959 (0.7%) had 4 or more frailty traits (**Table 2**).

Complications

An increasing mFI score was associated with a stepwise increase in the unadjusted incidence of complications (**Table 2**). Overall complication rates were low, and 30-day mortality was rare. Any type of postoperative complication occurred in 2457 patients (1.7%), and serious postoperative complications occurred in 971 patients (0.7%). An increasing mFI score was associated with a statistically significant increase in the occurrence of any complication (1828 of 118 831 [1.5%] in patients with low mFI scores and 56 of 961 [5.8%] in those with high mFI scores; $P < .001$), serious complications (671 of 118 831 [0.6%] in patients with low mFI scores and 29 of 961 [3.0%] in those with high mFI scores; $P < .001$), and 30-day mortality (52 of 118 831 [0.04%] among patients with low mFI scores and 3 of 961 [0.3%] among those with high mFI scores; $P < .001$). The percentage of patients with an LOS longer than 1 day was greater among patients with intermediate mFI scores (663 of 21 036 [3.2%]) and patients with high mFI scores (52 of 961 [5.4%]) than among those with low mFI scores (2297 of 118 831 [1.9%]; $P < .001$). Data on the unadjusted frequencies of specific complications are provided in **eTable 2** in the **Supplement**. The most common complications were superficial incisional, deep incisional, and organ or space surgical site infections, followed by urinary tract infections, pulmonary complications, and sepsis.

In multivariable logistic regression models, the mFI was strongly associated with the occurrence of complications. In multivariable analysis, intermediate mFI scores were associated with ORs of 1.70 (95% CI, 1.54-1.88; $P < .001$) for any complication and 2.00 (95% CI, 1.72-2.34; $P < .001$) for serious complications (**Table 3**). High mFI scores were associated with ORs of 3.35 (95% CI, 2.52-4.46; $P < .001$) for any complication and 3.95 (95% CI, 2.65-5.87; $P < .001$) for serious complications. In the adjusted model, being 80 to 89 years of age (OR, 1.36; 95% CI, 1.04-1.77; $P = .03$) or 90 years of age or older (OR, 2.27; 95% CI, 1.21-4.24; $P = .01$) was also associated with increased odds of serious complications. The only modifiable covariate associated with decreased odds of serious complications in the multivariable model was anesthesia with local and monitored anesthesia care with an OR of 0.66 (95% CI, 0.53-0.81, $P < .001$). On multivariable linear regression, intermediate and high mFI scores were associated with increases in LOS of 0.099 days (95% CI, 0.054-0.144; $P < .001$)

Table 1. Baseline Characteristics of Patients Undergoing Ambulatory and 23-Hour-Stay Hernia, Breast, Thyroid, or Parathyroid Surgery in 2007-2010 ACS NSQIP PUF

Characteristic	Patients, No. (%)			
	All Patients (N = 140 828)	NSQIP mFI Score Low (<0.18) (n = 118 831)	Intermediate (0.18-0.35) (n = 21 036)	High (≥0.36) (n = 961)
Demographics				
Age, mean (SD), y	59.3 (12.0)	57.8 (11.6)	66.7 (11.3)	70.8 (10.5)
Female sex	80 147 (56.9)	68 822 (57.9)	10 865 (51.7)	460 (47.9)
Race/ethnicity				
American Indian or Alaskan Native	806 (0.6)	700 (0.6)	103 (0.5)	3 (0.3)
Asian or Pacific Islander	3173 (2.3)	2793 (2.4)	371 (1.8)	9 (0.9)
Black	12 675 (9.0)	9863 (8.3)	2697 (12.8)	115 (12.0)
White	109 395 (77.7)	92 472 (77.8)	16 146 (76.8)	777 (80.9)
Other or unknown	14 779 (10.5)	13 003 (10.9)	1719 (8.2)	57 (5.9)
Preoperative health and comorbidities				
BMI, mean (SD)	28.6 (7.3)	28.2 (7.1)	30.8 (8.1)	30.1 (7.9)
Weight loss (>10% in 6 mo)	500 (0.4)	370 (0.3)	117 (0.6)	13 (1.4)
Current smoker	23 157 (16.4)	19 614 (16.5)	3309 (15.7)	234 (24.4)
Insulin-dependent and non-insulin-dependent diabetes	14 287 (10.1)	2542 (2.1)	11 046 (52.5)	699 (72.7)
Chronic obstructive pulmonary disease	3867 (2.8)	1028 (0.9)	2433 (11.6)	406 (42.3)
Hypertension requiring medication	60 740 (43.1)	39 593 (33.3)	20 201 (96.0)	946 (98.4)
Coronary artery disease	9436 (6.7)	1390 (1.2)	7286 (34.6)	760 (79.1)
Congestive heart failure	145 (0.1)	5 (<0.01)	93 (0.5)	47 (4.9)
History of myocardial infarction	131 (0.1)	9 (0.01)	80 (0.4)	42 (4.4)
Peripheral vascular disease	868 (0.6)	98 (0.1)	538 (2.6)	232 (24.1)
History of stroke or transient ischemic attack	5137 (3.7)	880 (0.7)	3645 (17.3)	612 (63.7)
Currently undergoing dialysis	626 (0.5)	318 (0.3)	266 (1.3)	42 (4.4)
Corticosteroid use	2089 (1.5)	1419 (1.2)	620 (3.0)	50 (5.2)
Disseminated cancer	596 (0.4)	478 (0.4)	109 (0.5)	9 (0.9)
Impaired sensorium	26 (0.02)	1 (<0.01)	18 (0.09)	7 (0.7)
Functional status prior to surgery				
Independent	139 732 (99.2)	118 574 (99.8)	20 390 (96.9)	768 (79.9)
Partially or totally dependent	1093 (0.8)	255 (0.2)	646 (3.1)	192 (20.0)
ASA class				
No disease or mild systemic disease	102 539 (72.8)	95 914 (80.7)	6552 (31.2)	73 (7.6)
Severe systemic disease	35 668 (25.3)	21 524 (18.1)	13 428 (63.8)	716 (74.5)
Life-threatening systemic disease or moribund	1647 (1.2)	563 (0.5)	917 (4.4)	167 (17.4)
Type of surgery				
Hernia repair	71 455 (50.7)	59 330 (49.9)	11 583 (55.1)	542 (56.4)
Breast surgery	51 267 (36.4)	44 342 (37.3)	6617 (31.5)	308 (32.1)
Cervical endocrine surgery	18 106 (12.9)	15 159 (12.8)	2836 (13.5)	111 (11.6)
Type of anesthesia				
General	109 207 (77.6)	92 404 (77.8)	16 107 (76.6)	696 (72.4)
Local and monitored anesthesia care	28 318 (20.1)	23 825 (20.1)	4265 (20.3)	228 (23.7)
Epidural or spinal	1881 (1.3)	1394 (1.2)	463 (2.2)	24 (2.5)
Regional	766 (0.5)	645 (0.5)	113 (0.5)	8 (0.8)

Abbreviations: ACS, American College of Surgeons; ASA, American Society of Anesthesiologists; BMI, body mass index (calculated as weight in kilograms divided by height in meters squared); NSQIP mFI, National Surgical Quality Improvement Program modified Frailty Index; PUF, Participant Use File.

and 0.261 days (95% CI, 0.072-0.450; $P = .007$), respectively. In prespecified subgroup multivariable analysis of hernia, breast, thyroid, or parathyroid surgery, the mFI was still associated with any type of 30-day complications and serious 30-day complications in most analyses (Table 4). However, for cervical endocrine surgery, the mFI was not associated with increased odds of serious complications in the adjusted analysis.

Discussion

Our understanding of the association of frailty with outcomes of patients undergoing the acute stress of surgery has expanded significantly in recent years. It is well supported that frail geriatric patients experience increased complications, loss of

Table 2. Data on 140 828 Patients Stratified by NSQIP mFI Score and Unadjusted Frequency of 30-Day Complications After Ambulatory Hernia, Breast, Thyroid, or Parathyroid Surgery in 2007-2010 ACS NSQIP PUF

NSQIP mFI Score ^a	Patients, No. (%)		
	Total	Complication	
		Any	Serious ^b
0	73 033 (51.9)	992 (1.4)	349 (0.5)
0.09	45 798 (32.5)	836 (1.8)	322 (0.7)
0.18	17 063 (12.1)	437 (2.6)	201 (1.2)
0.27	3973 (2.8)	136 (3.4)	70 (1.8)
0.36	803 (0.6)	45 (5.6)	23 (2.9)
≥0.45	156 (0.1)	11 (7.1)	6 (3.9)

Abbreviations: ACS, American College of Surgeons; NSQIP mFI, National Surgical Quality Improvement Program modified Frailty Index; PUF, Participant Use File.

^a See the Covariates subsection in the Methods section for definition of these scores.

^b Excludes superficial surgical site infection and urinary tract infection.

functional status, and prolonged recovery after a wide range of elective and emergency surgical procedures.³⁻⁸ However, there has been little focus on how frailty affects patients undergoing common ambulatory general surgery. The assessment of frailty in a geriatric patient can be relevant to both preoperative risk stratification and risk modification to improve outcomes. Therefore, our goal for frailty assessment in the preoperative setting should be to improve patient selection and the informed consent process for frail patients, regardless of chronological age, and to remove barriers to treatment for older nonfrail patients. The results of this study will improve our ability to do this for patients undergoing common general surgery operations.

Our data show that frailty is associated with increased adjusted odds of 30-day morbidity after hernia, breast, thyroid, and parathyroid surgery. Although complication rates were low overall, the relative risk of complications was increased, with patients with 2 to 3 frailty traits (intermediate mFI score) having more than 2 times the odds of serious complications, after adjusting for poor prognostic factors. Hypertension, diabetes, and coronary artery disease were the most common comorbidities contributing to frailty, so the presence of 2 or more of these conditions should be noted in preoperative evaluations. In addition, our findings show that the assessment of preoperative frailty should affect the informed consent process in an elective setting because the risks of operative intervention may outweigh the benefits for certain frail patients.

Inguinal and ventral hernias can have a significant negative effect on quality of life and have the potential to cause life-threatening complications. Although elective inguinal hernia repair is performed routinely on an outpatient basis with low morbidity among young and old patients,²³⁻²⁵ published surgical outcomes are subject to selection bias and do not include patients who are not referred for or are denied hernia repair based on age and comorbidities. Older patients make up a disproportionate number of those who undergo emergency hernia repair owing to strangulation or bowel obstruction, which suggests that access to care or surgeon decision making in the elective setting may leave more elderly patients at risk for these

complications.²⁶ Emergency hernia repair in this group is associated with increased morbidity and mortality²⁶⁻²⁸ and often results in reoperations and hernia recurrence, leading to a cycle of high-risk surgery, complications, and cost.²⁹ Our results should serve as evidence that older patients with few frailty traits have low risks of complications after elective hernia repair and can be safely offered these surgical procedures. Using preoperative assessment tools that support elective hernia repair for nonfrail elderly individuals may minimize morbidity and cost. However, complication rates and adjusted ORs do increase for patients older than 80 years of age; for this group of patients, more emphasis should be placed on patient selection based on surgical indication and risk modification.

Age appears to be a barrier to appropriate oncologic management of women with breast cancer. A large proportion of surgical procedures for breast cancer are now performed in the ambulatory setting,³⁰ and morbidity for breast-conserving therapy, mastectomy, and aesthetic breast surgery is uncommon.^{31,32} However, there is evidence that, as a whole, older women with breast cancer are less likely to receive standard oncologic surgical management of their disease.³³ Studies have shown that patients 85 years of age or older still have lower odds of undergoing surgery for breast cancer after controlling for patient preference and comorbidities.⁹ Although the diagnosis of early-stage breast cancers (stage I) may not significantly affect the life expectancy of older patients, overall survival is decreased among those who receive less-aggressive surgical and medical therapy, regardless of the stage of the cancer.¹⁰ Our findings should help minimize the role of chronological age in patient selection for ambulatory treatment of breast cancer and should encourage frailty assessment to identify patients at risk for complications or functional decline so that appropriate discussion of medical therapy can be had with patients in this group.

Many single-center studies show that thyroid surgery and parathyroid surgery are safe for older patients, with overall and endocrine-specific complication rates similar to those in their younger counterparts.³⁴⁻³⁷ In population-based studies, however, older age is independently associated with a longer LOS and morbidity,^{38,39} possibly associated with the effect of low-volume surgeons.^{38,40-42} There is evidence that a patient's age also negatively affects decisions about the management of differentiated thyroid cancer. The prevalence of thyroid nodules and the risk of associated malignant neoplasms increases with age.^{43,44} Differentiated thyroid cancer in older patients has also been associated with more aggressive disease, such as extrathyroidal extension and distant metastases, in addition to increased recurrence and disease-specific mortality.^{11,45,46} However, large database studies have shown that patients older than 65 years of age with differentiated thyroid cancers larger than 1 cm are less likely to be treated according to guidelines with thyroidectomy, lymph node dissection, and/or radioactive iodine ablation, despite their more advanced disease and the survival benefit of these therapies.¹¹ Therefore, preoperative assessment of elderly patients requiring thyroidectomy is critical to make appropriate management decisions, and high-volume surgeons may be better equipped to select and operate on appropriate patients.

Table 3. Association of NSQIP mFI and 30-Day Morbidity After Ambulatory and 23-Hour-Stay Hernia, Breast, Thyroid, or Parathyroid Surgery in 2007-2010 ACS NSQIP PUF

Characteristic	Unadjusted Frequency of Complications, No./Total No. (%)	Adjusted OR (95% CI)	P Value
Any Complication			
NSQIP mFI			
Low (<0.18)	1828/118 831 (1.5)	1.0 [Reference]	NA
Intermediate (0.18-0.35)	573/21 036 (2.7)	1.70 (1.54-1.88)	<.001
High (≥0.36)	56/961 (5.8)	3.35 (2.52-4.46)	<.001
Sex			
Male	850/60 480 (1.4)	1.0 [Reference]	NA
Female	1606/80 147 (2.0)	1.33 (1.18-1.50)	<.001
Age, y			
40-49	583/34 383 (1.7)	1.0 [Reference]	NA
50-59	657/40 627 (1.6)	0.95 (0.85-1.06)	.35
60-69	588/33 895 (1.7)	0.96 (0.86-1.09)	.55
70-79	379/20 243 (1.9)	1.01 (0.88-1.16)	.92
80-89	192/8549 (2.3)	1.21 (1.02-1.45)	.03
≥90	24/692 (3.5)	1.99 (1.30-3.05)	.002
Race/ethnicity			
American Indian or Alaskan Native	16/806 (2.0)	1.0 [Reference]	NA
Asian or Pacific Islander	29/3173 (0.9)	0.50 (0.27-0.94)	.03
Black	227/12 675 (1.8)	0.87 (0.52-1.46)	.60
White	1960/109 395 (1.8)	0.95 (0.58-1.57)	.85
Other or unknown	225/14 779 (1.5)	0.86 (0.52-1.45)	.58
Anesthesia type			
General	2096/109 207 (1.9)	1.0 [Reference]	NA
Local and monitored anesthesia care	315/28 318 (1.1)	0.63 (0.56-0.72)	<.001
Epidural or spinal	27/1881 (1.4)	0.88 (0.60-1.30)	.53
Regional	16/766 (2.1)	1.09 (0.66-1.80)	.74
Tobacco use	481/23 157 (2.1)	1.20 (1.08-1.34)	.001
Currently undergoing dialysis	30/655 (4.6)	2.10 (1.43-3.05)	<.001
Corticosteroid use	67/2089 (3.2)	1.52 (1.18-1.96)	.001
Serious Complications			
NSQIP mFI score			
Low (<0.18)	671/118 831 (0.6)	1.0 [Reference]	NA
Intermediate (0.18-0.35)	271/21 036 (1.3)	2.00 (1.72-2.34)	<.001
High (≥0.36)	29/961 (3.0)	3.95 (2.65-5.87)	<.001
Sex			
Male	383/60 480 (0.6)	1.0 [Reference]	NA
Female	587/80 147 (0.7)	1.12 (0.94-1.34)	.21
Age, y			
40-49	218/34 383 (0.6)	1.0 [Reference]	NA
50-59	233/40 627 (0.6)	0.86 (0.72-1.04)	.13
60-69	239/33 895 (0.7)	0.98 (0.81-1.19)	.85
70-79	164/20 243 (0.8)	1.06 (0.85-1.31)	.62
80-89	90/8549 (1.1)	1.36 (1.04-1.77)	.03
≥90	11/692 (1.6)	2.27 (1.21-4.24)	.01
Race/ethnicity			
American Indian or Alaskan Native	8/806 (1.0)	1.0 [Reference]	NA
Asian or Pacific Islander	10/3173 (0.3)	0.33 (0.13-0.87)	.02
Black	107/12 675 (0.8)	0.80 (0.39-1.66)	.55
White	764/109 395 (0.7)	0.70 (0.35-1.42)	.33
Other or unknown	82/14 779 (0.6)	0.62 (0.30-1.28)	.20
Anesthesia type			
General	832/109 207 (0.8)	1.0 [Reference]	NA
Local and monitored anesthesia care	114/28 318 (0.4)	0.66 (0.53-0.81)	<.001
Epidural or spinal	17/1881 (0.9)	1.22 (0.74-2.00)	.43
Regional	6/766 (0.8)	1.02 (0.45-2.29)	.97
Tobacco use	208/23 157 (0.9)	1.31 (1.11-1.54)	.001
Currently undergoing dialysis	15/655 (2.3)	2.12 (1.25-3.60)	.005
Corticosteroid use	42/2089 (2.0)	2.28 (1.65-3.14)	<.001

Abbreviations: ACS, American College of Surgeons; NA, not applicable; NSQIP mFI, National Surgical Quality Improvement Program modified Frailty Index; OR, odds ratio; PUF, Participant Use File.

Table 4. Operation-Specific Association of NSQIP mFI and 30-Day Morbidity After Ambulatory and 23-Hour-Stay Hernia, Breast, Thyroid, or Parathyroid Surgery in 2007-2010 ACS NSQIP PUF

Characteristic	Unadjusted Frequency of Complications, No./Total No. (%)	Adjusted OR (95% CI)	P Value
Hernia			
Any complication			
Low mFI score (<0.18)	879/59 330 (1.5)	1.0 [Reference]	NA
Intermediate mFI score (0.18-0.35)	324/11 583 (2.8)	1.89 (1.65-2.17)	<.001
High mFI score (≥0.36)	33/542 (6.1)	4.11 (2.83-5.97)	<.001
Serious complication			
Low mFI score	365/59 330 (0.6)	1.0 [Reference]	NA
Intermediate mFI score	161/11 583 (1.4)	2.06 (1.69-2.51)	<.001
High mFI score	16/542 (2.9)	3.90 (2.28-6.67)	<.001
Breast			
Any complication			
Low mFI score	843/44 342 (1.9)	1.0 [Reference]	NA
Intermediate NSQIP mFI score	217/6617 (3.3)	1.75 (1.49-2.06)	<.001
High mFI score	18/308 (5.8)	2.98 (1.82-4.88)	<.001
Serious complication			
Low mFI score	265/44 342 (0.6)	1.0 [Reference]	NA
Intermediate mFI score	92/6617 (1.4)	2.42 (1.87-3.13)	<.001
High mFI score	12/308 (3.9)	6.39 (3.45-11.84)	<.001
Cervical Endocrine			
Any complication			
Low mFI score	106/15 159 (0.7)	1.0 [Reference]	NA
Intermediate NSQIP mFI score	32/2836 (1.1)	1.42 (0.93-2.16)	.10
High mFI score	5/111 (4.5)	4.53 (1.73-11.86)	.002
Serious complication			
Low mFI score	41/15 159 (0.3)	1.0 [Reference]	NA
Intermediate NSQIP mFI score	18/2836 (0.6)	1.59 (0.88-2.87)	.12
High mFI score	1/111 (0.9)	1.49 (0.19-11.44)	.70

Abbreviations: ACS, American College of Surgeons; NA, not applicable; NSQIP mFI, National Surgical Quality Improvement Program modified Frailty Index; OR, odds ratio; PUF, Participant Use File.

A patient’s age affects the likelihood of managing primary hyperparathyroidism with surgical therapy. The prevalence of primary hyperparathyroidism increases with age and is estimated to be 1.5% among patients 65 years of age or older and 3.4% among postmenopausal women.⁴⁷ Surgery is the only definitive treatment for primary hyperparathyroidism, and long-term observational studies demonstrate improvement in bone mineral density and decreased overall mortality owing to cardiovascular events after successful parathyroidectomy.⁴⁸⁻⁵³ Because many elderly patients with primary hyperparathyroidism are asymptomatic with mild hypercalcemia, surveillance is often advocated. The older a patient is, the less likely he or she is to undergo a parathyroidectomy, even when the patient meets consensus criteria for operative management and after adjusting for comorbidity and biochemical parameters.¹² In addition, older patients experience significantly longer delays to surgical referral, exposing them to additional negative effects on the skeletal, renal, and cardiovascular systems.^{12,37} Our data show that a preoperative frailty assessment will improve our ability to identify patients with primary hyperparathyroidism who are at higher risk of complications and those who will benefit from a parathyroidectomy.

The only factor associated with decreased odds of complications in our analysis was anesthesia with local and monitored anesthesia care. These results are consistent with those of single-center studies of elderly patients undergoing inguinal hernia repair that have shown low complication rates, comparable to those

of younger, healthier patients, with the use of local anesthesia.^{54,55} For frail patients who choose to undergo hernia repair, local and monitored anesthesia care should be used whenever possible. Reports have documented the successful use of local anesthesia in breast-conserving therapy and mastectomy, although most studies are small, have focused on feasibility without conversion to general anesthesia, and have not shown significant differences in complications or oncologic outcomes.⁵⁶⁻⁶⁰ The use of local with monitored anesthesia care may be challenging in complex surgical procedures for breast cancer, such as modified radical mastectomy or axillary dissection, but it should be considered for patients with increased anesthesia risk who are undergoing ambulatory breast surgery. Most studies of local anesthesia in thyroidectomy and parathyroidectomy report using it in combination with regional superficial and deep cervical plexus blocks. Most large studies are from high-volume, tertiary referral centers, with many being single-surgeon series.⁶¹⁻⁶³ Although their results suggest this technique is feasible, it is not likely that outcomes are generalizable, especially given the inability to use nerve monitoring, which has become routine at many centers, and the difficulty converting a cervical operation to general endotracheal anesthesia, which is required in 3% to 10% of operations.⁶¹⁻⁶³

Limitations

Many limitations of our study are inherent to those that use large administrative databases and are due to the nature of data col-

lection and reporting. Outcomes reported in the NSQIP are limited to 30 days, which is a short period to assess the physiological and functional effects of surgery on older patients, given evidence of the increased risk of progressive functional decline and death at 1 year and longer after major general surgery.⁶⁴ In addition, the NSQIP prior to 2011 does not include data on readmissions, which are associated with persistent functional deficits in elderly patients and are a critical perioperative outcome in frail populations.⁶⁵ Owing to the data available in the NSQIP, our ability to assess frailty was limited, and we chose to use the mFI because of its validation and use in prior studies.^{13,21,66} Many variables included in the mFI are comorbidities, and although they map to variables from the Canadian Study of Health and Aging Frailty Index and contribute to frailty as accumulated deficits that make patients vulnerable to acute stressors, they provide an incomplete picture of patient frailty. An evaluation of functional status, cognition, and mobility would have allowed a more comprehensive assessment. The NSQIP does not include several adverse outcomes documented in elderly patients after surgery, such as postoperative depression, anxiety, loss of independence, and accelerated cognitive decline, so we may not be capturing the magnitude of the negative effect these operations have on this vulnerable patient population.⁶⁴ In addition, large academic teaching institutions are overrepresented in the NSQIP, which may affect the generalizability of our results to community hospitals that perform a large proportion of common ambulatory

general surgery procedures. Finally, the NSQIP stopped collecting data on many variables in the validated mFI after 2010,⁶⁷ so we were unable to include recent years in our analysis.

Conclusions

Frailty is associated with worse perioperative outcomes in patients undergoing ambulatory hernia, breast, thyroid, or parathyroid surgery, and its preoperative assessment is still necessary in these seemingly low-risk operations. Our findings contribute to the expanding literature highlighting the relevance of frailty rather than chronological age in preoperative decision making and preparation. Informed consent should be adjusted based on frailty to ensure that patients have an accurate assessment of their risk when making decisions about whether to undergo surgery. A patient's age should not be used as a barrier to appropriate surgical management of conditions that affect quality of life and long-term risk of associated complications, such as in hernia repair or parathyroidectomy, or treatment of malignant neoplasms, such as in breast surgery and thyroid surgery. Best practices guidelines⁶⁸ should be followed to ensure an adequate preoperative assessment of frailty in geriatric patients planned for any inpatient or outpatient operation to appropriately care for and minimize morbidity in this unique patient population.

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