Timing to surgery in elderly patients with small bowel obstruction: An insight on frailty

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BACKGROUND: Small bowel obstruction (SBO) frequently necessitates emergency surgical intervention. The impact of frailty and age on operative outcomes is uncertain. This study evaluated postoperative outcomes of SBO surgery based on patient's age and frailty and explore the optimal timing to operation in elderly and/or frail patients.

METHODS: Patients who underwent SBO surgery were identified in American College of Surgeons National Surgical Quality Improvement Program database 2005 to 2021. Patients aged ≥65 years were defined as elderly. Patients with 5-Factor Modified Frailty Index≥2 were defined as frail. Multivariable logistic regression was used to compare 30-day postoperative outcomes between elderly frail versus nonfrail patients, as well as between nonfrail young versus elderly patients.

RESULTS: There were 49,344 patients who had SBO surgery, with 7,089 (14.37%) patients classified as elderly frail, 17,821 (36.12%) as elderly nonfrail, and 21,849 (44.28%) as young nonfrail. Elderly frail patients had higher mortality (adjusted odds ratio, 1.541; $p < 0.01$) and postoperative complications compared with their elderly nonfrail counterparts; these patients also had longer wait until definitive operation ($p < 0.01$). Among nonfrail patients, when compared with young patients, the elderly had higher mortality (adjusted odds ratio, 2.388; $p < 0.01$) and complications, and longer time to operation ($p < 0.01$). In elderly nonfrail patients, a higher mortality was observed when surgery was postponed after 2 days. Mortality risk for frail elderly patients is heightened from their already higher baseline when surgery is delayed after 4 days.

CONCLUSION: When SBO surgery is postponed for more than 2 days, elderly nonfrail patients have an increased mortality risk. Consequently, upon admission, these patients should be placed under a nasogastric tube and undergo an initial gastrograffin challenge. If there is no contrast in colon, they should be operated on within 2 days. Conversely, elderly frail patients with SBO have a higher mortality risk when surgery is delayed beyond 4 days. Thus, following the same scheme, they should be operated on before 4 days if gastrograffin challenge fails. (*J Trauma Acute Care Surg.* 2024;97: 623–630. Copyright © 2024 Wolters Kluwer Health, Inc. All rights reserved.)

LEVEL OF EVIDENCE: Therapeutic/Care Management; Level III.

KEY WORDS: Age; frailty; geriatric; mortality; small bowel obstruction.

Small bowel obstruction (SBO) is characterized by a partial or total blockage of the small intestine. Small bowel obstruction is responsible for 2% to 15% of emergency department visits related to acute abdominal pain.[1] Historically, the saying "never let the sun set on a small bowel obstruction" prevailed in the surgical management of SBO.[2] However, contemporary practices now tend to try for initial nonoperative management, reserving immediate surgical intervention for cases presenting with clear signs of peritonitis or bowel ischemia.[2] For nonoperative management, gastrograffin challenge has been used as a diagnostic and potentially therapeutic tool, particularly in adhesive SBO.[2,3] Nonoperative management is recommended as the initial treatment for patients with no indications for emergency surgery and can be safely extended up to 72 hours, provided the patient shows no signs of peritonitis or clinical deterioration.[4,5] If the gastrograffin was not found in the colon after 3 days, operative intervention to resolve the SBO is most likely needed.[4,5]

Elderly adults inherently have a degree of decreased bowel motility and are more likely to have had prior abdominal surgeries.[6] Thus, these patients are at an increased risk of developing SBO. There exists a notable gap in the literature addressing the outcomes of surgery for SBO and the optimal timing for intervention specific to this population.[7] Frailty can be age-related, and acts as a clinically discernible state characterized by diminished physiological reserve and heightened vulnerability.[8] While frailty has been linked to adverse outcomes across various surgical disciplines,[9–11] the literature presents mixed findings regarding its impact on surgery for SBO outcomes.[1,2]

Both nonoperative management and surgical intervention pose challenges due to their inherent risk/comorbidities in the elderly and/or frail patients. Thus, our study aimed to examine the distinct impacts of age and frailty on the 30-day outcomes after operation for SBO. We further explored the optimal timing between initial nonoperative attempts and surgical interventions in these patients.

MATERIALS AND METHODS

Data Source

This retrospective cohort study used the deidentified American College of Surgeons National Surgical Quality Improvement Program (ACS-NSQIP) database, and the institutional review board (IRB) review was exempted by [anonymized for peer review].

Patient Population

Using the NSQIP database from 2005 to 2021, patients who had a primary diagnosis of SBO were identified by International Classification of Diseases, Ninth Revision, Clinical Modification (ICD-9-CM) codes of 560.1, 560.2, 560.31, 560.81, 560.89, 560.9 or International Classification of Diseases, Tenth Revision, Clinical Modification (ICD-10-CM) code of K56. Then, Current Procedural Terminology was used to identify surgery for SBO: open approach: 44005 (adhesiolysis), 44050 (reduce bowel obstruction), 44120 (enterectomy), 44125 (enterectomy with enterostomy), 44130 (bowel to bowel fusion), 44615 (intestinal stricturoplasty), 49000 (exploration of abdomen); laparoscopic approach: 44180 (laparoscopic enterolysis), 44202 (laparoscopic enterectomy). Emergent surgery and cases not done by general surgeons were excluded. Emergency was defined as surgeries that were "performed as soon as possible and no later than 12 hours after the patient has been admitted to the hospital or after the onset of related preoperative symptomatology".[12] Patients 65 years or

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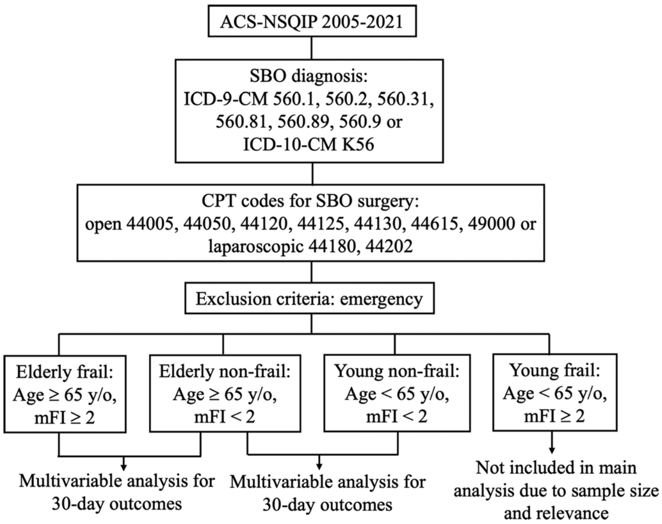

Figure 1. Flow diagram for patient cohort selection. ACS-NSQIP, American College of Surgeons National Surgical Quality Improvement Program; CPT, Current Procedural Terminology; ICD-10-CM, International Classification of Diseases, Tenth Revision, Clinical Modification; ICD-9-CM, International Classification of Diseases, Ninth Revision, Clinical Modification.

older are defined as elderly. The flow diagram for patient cohort selection is shown in Figure 1.

To evaluate for frailty, we utilized the five-item Modified Frailty Index (mFI) which is available in the NSQIP database. There are many instruments that have been used throughout the years to assess frailty in surgical patients. One such thorough evaluation of frailty is possible with the Canadian Study of Health and Aging Frailty Index (CSHA-FI), which utilizes a cumulative deficit model incorporating 70 items.[13] This comprehensive index was later streamlined into an 11-item mFI, which has been validated to predict adverse outcomes specifically in the NSQIP database.[14] For further simplification, the 11-item mFI was distilled into a 5-item mFI, which incorporates five pre-operative variables (the score ranges from 0 to 5): congestive heart failure (CHF), chronic obstructive pulmonary disease (COPD), diabetes mellitus (DM), dependent functional status, and hypertension.[15] The new mFI has been validated and demonstrated efficacy across a range of surgical subspecialties and stands as a reliable predictor for both mortality and postoperative complications.[15,16] Frailty in patients was determined if they had an mFI of 2 or greater.[17] Patients were stratified into four cohorts based on age (elderly/young) and frail/nonfrail.

Preoperative Variables

Sex, race and ethnicity, age, comorbidities, surgical approach, and other baseline characteristics were examined (Table 1 and Table 2). Age was categorized into 10-year ranges using age 65 years as a reference point for multivariable logistic regression analyses.

Perioperative Outcomes

The 30-day perioperative outcomes examined included mortality, major adverse cardiovascular events (MACE), cardiac complications, stroke, pulmonary events, renal dysfunction, sepsis, venous thromboembolism (VTE), bleeding transfusion,

TABLE 1. Demographics of Patients Who Underwent Surgery for SBO

	Age ≥65 y, Frail (n = 7,089)	Age ≥65 y, Nonfrail (n = 17,821)	p*	Age <65 y, nonfrail (n = 21,849)	p**
Sex, n (%)					
Male	2,899 (40.89%)	6,949 (38.99%)	0.01	8,822 (40.38%)	0.01
Female	4,188 (59.08%)	10,859 (60.93%)	0.01	13,013 (59.56%)	0.01
Race and ethnicity, n (%)					
White	4,624 (65.23%)	12,832 (72%)	<0.01	13,876 (63.51%)	<0.01
African American	1,179 (16.63%)	1,774 (9.95%)	<0.01	3,319 (15.19%)	<0.01
Hispanic	356 (5.02%)	687 (3.86%)	<0.01	1,510 (6.91%)	<0.01
Asian American	152 (2.14%)	438 (2.46%)	0.15	558 (2.55%)	0.56
American Indian or Alaska Native	21 (0.3%)	62 (0.35%)	0.63	143 (0.65%)	<0.01
Native Hawaiian or Pacific Islander	15 (0.21%)	38 (0.21%)	1.00	61 (0.28%)	0.22
Other races	991 (13.98%)	2,503 (14.05%)	0.90	3,457 (15.82%)	<0.01
Age, n (%)					
Age <18 y	0 (0.00%)	0 (0.00%)	NA	827 (3.79%)	NA
18 ≤ Age <25 y	0 (0.00%)	0 (0.00%)	NA	2,232 (10.22%)	NA
25 ≤ Age <35 y	0 (0.00%)	0 (0.00%)	NA	3,825 (17.51%)	NA
35 ≤ Age <45 y	0 (0.00%)	0 (0.00%)	NA	6,418 (29.37%)	NA
45 ≤ Age <55 y	0 (0.00%)	0 (0.00%)	NA	8,547 (39.12%)	NA
55 ≤ Age <65 y	0 (0.00%)	0 (0.00%)	NA	827 (3.79%)	NA
65 ≤ Age <75 y	2,803 (39.54%)	8,456 (47.45%)	<0.01	0 (0.00%)	NA
75 ≤ Age <85 y	2,771 (39.09%)	6,327 (35.5%)	<0.01	0 (0.00%)	NA
Age ≥85 y	1515 (21.37%)	3,038 (17.05%)	<0.01	0 (0.00%)	NA

*Fisher's exact test comparing frail versus nonfrail patients in age ≥65 years.
**Fisher's exact test comparing nonfrail patients with age ≥65 years vs. age <65 years.
NA, not applicable.

TABLE 2. Baseline Characteristics and Surgical Approach of Patients Who Underwent Surgery for SBO

	Age ≥65 y, Frail (n = 7,089)	Age ≥65 y, Nonfrail (n = 17,821)	p*	Age <65 y, Nonfrail (n = 21,849)	p**
Baseline characteristics, n (%)					
BMI >30 kg/m^2	1,987 (28.03%)	3,014 (16.91%)	<0.01	5,578 (25.53%)	<0.01
Smoker	967 (13.64%)	1,820 (10.21%)	<0.01	5,268 (24.11%)	<0.01
DM	3706 (52.28%)	460 (2.58%)	<0.01	646 (2.96%)	0.03
Dyspnea	1023 (14.43%)	844 (4.74%)	<0.01	652 (2.98%)	<0.01
Independent functional status	4,672 (65.9%)	17,137 (96.16%)	<0.01	21,162 (96.86%)	<0.01
Partially dependent functional status	1,987 (28.03%)	466 (2.61%)	<0.01	377 (1.73%)	<0.01
Fully dependent functional status	390 (5.5%)	102 (0.57%)	<0.01	219 (1%)	<0.01
COPD	2,207 (31.13%)	541 (3.04%)	<0.01	350 (1.6%)	<0.01
CHF	830 (11.71%)	55 (0.31%)	<0.01	22 (0.1%)	<0.01
Hypertension	6,792 (95.81%)	9,806 (55.02%)	<0.01	5,285 (24.19%)	<0.01
AKI	137 (1.93%)	130 (0.73%)	<0.01	95 (0.43%)	<0.01
Dialysis	190 (2.68%)	185 (1.04%)	<0.01	209 (0.96%)	0.42
Preoperative sepsis	2,015 (28.42%)	3,230 (18.12%)	<0.01	3,301 (15.11%)	<0.01
Disseminated cancer	387 (5.46%)	1,120 (6.28%)	0.01	1,245 (5.7%)	0.01
Infection	277 (3.91%)	233 (1.31%)	<0.01	351 (1.61%)	0.02
Steroid use	518 (7.31%)	914 (5.13%)	<0.01	1,453 (6.65%)	<0.01
Weight loss	399 (5.63%)	848 (4.76%)	0.01	1,179 (5.4%)	<0.01
Bleeding disorders	1,209 (17.05%)	1,726 (9.69%)	<0.01	934 (4.27%)	<0.01
eGFR<60 mL/min/1.73 m^2	2,899 (40.89%)	4,996 (28.03%)	<0.01	1,544 (7.07%)	<0.01
Serum albumin <3.4 g/L	2,938 (41.44%)	5,220 (29.29%)	<0.01	4,597 (21.04%)	<0.01
White blood cell >11,000 counts/mL	2,017 (28.45%)	4,021 (22.56%)	<0.01	4,192 (19.19%)	<0.01
Hematocrit <37%	3,881 (54.75%)	7,534 (42.28%)	<0.01	8,254 (37.78%)	<0.01
Platelet <150,000 counts/mL	788 (11.12%)	1,850 (10.38%)	0.09	1,318 (6.03%)	<0.01
Blood urea nitrogen>23 mg/dL	2,834 (39.98%)	4,851 (27.22%)	<0.01	2,145 (9.82%)	<0.01
PTT > 60 seconds	99 (1.4%)	126 (0.71%)	<0.01	106 (0.49%)	<0.01
PT > 30 seconds	12 (0.17%)	20 (0.11%)	0.25	14 (0.06%)	0.12
INR > 2	1,273 (17.96%)	2,863 (16.07%)	<0.01	3,557 (16.28%)	0.57
ASA score of 4 or 5	2,098 (29.6%)	2,289 (12.84%)	<0.01	1,155 (5.29%)	<0.01
Surgical approach, n (%)					
Open	5,934 (83.71%)	14,116 (79.21%)	<0.01	16,419 (75.15%)	<0.01
Laparoscopic	1,155 (16.29%)	3,705 (20.79%)	<0.01	5,430 (24.85%)	<0.01

*Fisher's exact test comparing frail versus nonfrail patients in age ≥65 years.
**Fisher's exact test comparing nonfrail patients with age ≥65 years versus age <65 years.
BMI, body mass index; INR, international normalized ratio; PT, prothrombin time.

wound complications, unplanned operation, discharge not to home, readmission, operation time, length of stay, and time from admission to operation.

Major morbidities were defined as composites of complications. Cardiac complications included myocardial infarction and cardiac arrest requiring cardio-pulmonary resuscitation. Major adverse cardiovascular event was defined as cardiac complications and stroke. Pulmonary events were defined as pneumonia, unplanned reintubation, and/or prolonged mechanical ventilation over 48 hours. Renal dysfunction included acute renal insufficiency (rise in serum creatinine by over 2 mg/dL as compared with the preoperative value) as well as acute renal failure requiring renal replacement therapy. Wound complications were defined as wound dehiscence, superficial surgical site infection (SSI), deep incisional SSI, and organ space infection (OSI).

Statistical Analysis

The binary preoperative variables were compared by Fisher's exact tests. The binary perioperative variables were compared by multivariable logistic regression, adjusting for any preoperative variable with sufficient difference (Fisher's exact test $p < 0.1$). Adjusted odds ratios (aORs) and 95% confidence intervals (CI) were estimated. Continuous outcome variables, including operation time, hospital length of stay, and time from admission to operation, were examined by a generalized linear model (GLM) adjusting all preoperative variables. Among elderly patients, frail and nonfrail patients were compared. In addition, young nonfrail patients were also evaluated. Due to the limited number of young frail patients and concerns about multiplicity in the analysis between groups, young frail patients were not included in the main analyses. Instead, their preoperative characteristics and 30-day perioperative outcomes are detailed in Supplemental Digital Content, Tables S1–S3, http://links.lww.com/TA/D877.

To assess the impact of deferred surgery on SBO, aORs of 30-day mortality were compared based on the time from admission to surgery. The intervals examined were 1 < defer ≤2 days, 2 < defer ≤3 days, 3 < defer ≤4 days, 4 < defer ≤5 days, 5 < defer ≤6 days, and defer >6 days. These were compared against the baseline of

TABLE 3. Thirty-Day Perioperative Outcomes of Patients Who Underwent Surgery for SBO

30-d Outcome, n (%)	Age ≥65 y, Frail (n = 7,089)	Age ≥65 y, Nonfrail (n = 17,821)	Age <65 y, Nonfrail (n = 21,849)	aOR for Frail/Nonfrail, Age ≥65 y (95% CI)	p*	aOR Age ≥65 /< 65 y, Nonfrail (95% CI)	p**
Mortality	746 (10.52%)	821 (4.61%)	300 (1.37%)	1.541 (1.376–1.726)	<0.01	2.388 (2.066–2.762)	<0.01
MACE	306 (4.32%)	420 (2.36%)	133 (0.61%)	1.294 (1.104–1.516)	<0.01	2.984 (2.426–3.672)	<0.01
Cardiac complications	260 (3.67%)	349 (1.96%)	109 (0.5%)	1.333 (1.123–1.583)	<0.01	3.101 (2.47–3.894)	<0.01
Stroke	55 (0.78%)	78 (0.44%)	27 (0.12%)	1.401 (0.979–2.005)	0.06	2.372 (1.496–3.76)	<0.01
Pulmonary events	1,263 (17.82%)	1,563 (8.77%)	942 (4.31%)	1.425 (1.305–1.556)	<0.01	1.73 (1.575–1.9)	<0.01
Renal dysfunction	192 (2.71%)	232 (1.3%)	156 (0.71%)	1.329 (1.082–1.632)	0.01	1.353 (1.076–1.7)	0.01
Sepsis	972 (13.71%)	1,551 (8.7%)	1,528 (6.99%)	1.147 (1.045–1.258)	<0.01	1.065 (0.98–1.157)	0.14
VTE	287 (4.05%)	480 (2.69%)	326 (1.49%)	1.278 (1.096–1.491)	<0.01	1.537 (1.322–1.787)	<0.01
Bleeding transfusion	675 (9.52%)	1,111 (6.23%)	1,015 (4.65%)	0.97 (0.868–1.084)	0.59	1.017 (0.922–1.123)	0.73
Wound complications	884 (12.47%)	2,118 (11.88%)	2,837 (12.98%)	0.973 (0.891–1.062)	0.54	0.907 (0.851–0.966)	<0.01
Unplanned operation	464 (6.55%)	10,73 (6.02%)	1,299 (5.95%)	0.953 (0.848–1.072)	0.42	0.99 (0.905–1.083)	0.82
Discharge not to home	3039 (55.63%)	5,890 (40.32%)	3,606 (21.58%)	1.417 (1.32–1.52)	<0.01	2.044 (1.934–2.159)	<0.01
Readmission	639 (9.01%)	1,469 (8.24%)	1,966 (9%)	1.046 (0.944–1.16)	0.39	0.905 (0.838–0.978)	0.01
	Mean ± SD	**Mean ± SD**	**Mean ± SD**	**F***	**p***	**F†**	**p†**
Operation time (min)	109.10 ± 77.63	107.50 ± 78.34	119.00 ± 85.67	0.38	0.54	203.67	<0.01
Length of stay (days)	14.20 ± 10.57	11.34 ± 9.49	9.69 ± 0.21	51.86	<0.01	364.45	<0.01
Time from admission to operation (days)	3.79 ± 5.40	2.82 ± 5.64	2.49 ± 6.90	11.84	<0.01	27.92	<0.01

*Fisher's exact test comparing frail versus nonfrail patients in age ≥65 years.
**Fisher's exact test comparing nonfrail patients with age ≥65 years vs. age <65 years.
MACE, major adverse cardiovascular events; SD, standard deviation; SSI, surgical site infection; SBO, small bowel obstruction; VTE, venous thromboembolism.

defer ≤1 day. This analysis was conducted separately for the three patient categories: young nonfrail, elderly nonfrail, and elderly frail.

All statistical analyses were conducted by SAS, version 9.4. A p value <0.05 was considered statistically significant. All methods adhere to the STROBE guidelines (Supplemental Digital Content, http://links.lww.com/TA/D876). Missing data in the NSQIP database were addressed through a single iteration of multivariable imputation.[18] The authors have full access to the NSQIP data set and hold full responsibility for the integrity of all statistical analyses.

RESULTS

From 2005 to 2021, 49,344 patients had surgery for SBO. The total number of surgeries being performed for SBO in patients 65 and older was 50.48% of all SBO operations. Among those who were 65 years and older, the average mFI is 1.1 with a standard deviation of 0.88 and a range of 0 to 5, where 7,089 (14.37%) were frail and 17,821 (36.12%) were nonfrail patients. In patients under 65 years old, mFI has a mean of 0.55 with a standard deviation of 0.74 and a range of 0 to 5, where 2,585 (5.24%) of the patients were frail and 21,849 (44.28%) were nonfrail.

Elderly Frail Patients' Comorbidities and Outcomes Compared With Elderly Nonfrail Patients

Table 1 summarizes the demographics of elderly frail and nonfrail patients who underwent surgery for SBO. Among elderly patients, compared with nonfrail patients, frail patients were more likely to be male ($p = 0.01$), African American ($p < 0.01$), Hispanic ($p < 0.01$), and aged 75 years or older ($p < 0.01$).

The baseline characteristics and surgical approach of patients who underwent surgery for SBO are summarized in Table 2. Among elderly patients, frail patients were more likely to have, a history of smoking ($p < 0.01$), DM ($p < 0.01$), dyspnea ($p < 0.01$), partially or fully dependent functional status ($p < 0.01$), COPD ($p < 0.01$), CHF ($p < 0.01$), hypertension ($p < 0.01$), acute kidney injury (AKI) at presentation ($p < 0.01$), dialysis ($p < 0.01$), preoperative sepsis ($p < 0.01$), weight loss ($p = 0.01$), estimated glomerular filtration rate (eGFR) <60 mL/min/1.73 m^2 ($p < 0.01$), serum albumin <3.4 g/L ($p < 0.01$), White Blood Cell >11,000 counts/mL ($p < 0.01$), hematocrit <37% ($p < 0.01$), partial thromboplastin (PTT) > 60 seconds ($p < 0.01$), international normalized ratio > 2 ($p < 0.01$), American Society of Anesthesiology (ASA) score of 4 or 5 ($p < 0.01$), and undergo open surgery ($p < 0.01$). Elderly frail patients were less #likely undergo laparoscopic surgery ($p < 0.01$) than their nonfrail counterparts.

Thirty-day perioperative outcomes of patients who underwent surgery for SBO are summarized in Table 3. Among elderly patients, frail patients had a higher risk of mortality (10.52% vs. 4.61%; aOR, 1.541; $p < 0.01$), MACE (4.32% vs. 2.36%; aOR, 1.294; $p < 0.01$), cardiac complications (3.67% vs. 1.96%; aOR, 1.333; $p < 0.01$), pulmonary events (17.82% vs. 8.77%; aOR, 1.425; $p < 0.01$), renal dysfunction (2.71% vs. 1.30%; aOR, 1.329; $p = 0.01$), sepsis (13.71% vs. 8.70%; aOR, 1.147; $p < 0.01$), VTE (4.05% vs. 2.69%; aOR, 1.278; $p < 0.01$), and discharge not to home (55.63% vs. 40.32%; aOR, 1.417; $p < 0.01$). Also, elderly frail patients had a longer length of stay (14.20 ± 10.57 vs. 11.34 ± 9.49 days; $p < 0.01$) and longer time from admission to operation (3.79 ± 5.40 vs. 2.-82 ± 5.64 days; $p < 0.01$).

Elderly Nonfrail Patients' Comorbidities and Outcomes Compared With Younger Nonfrail Patients

Table 1 summarizes the demographics of young and elderly nonfrail patients who underwent surgery for SBO. Among nonfrail

TABLE 4. Assessment of the Impact of Deferred Surgery on SBO, Where the Risks of 30-Day Mortality Were Compared Across Various Time Intervals From Admission to Surgery

	Age <65 y, Nonfrail (n = 21,849)	aOR (95% CI)	*p*	Age ≥65 y, Nonfrail (n = 17,821)	aOR (95% CI)	*p*	Age ≥65 y, Frail (n = 7,089)	aOR (95% CI)	*p*
Defer ≤1 d	83/12338 (0.67%)	Ref.	NA	281/8207 (3.42%)	Ref.	NA	200/2590 (7.72%)	Ref.	NA
1 < defer ≤2 d	28/2452 (1.14%)	0.839 (0.524–1.343)	0.46	95/2502 (3.80%)	0.905 (0.706–1.162)	0.43	93/960 (9.69%)	1.082 (0.822–1.425)	0.57
2 < defer ≤3 d	27/1925 (1.40%)	1.359 (0.844–2.187)	0.21	102/1990 (5.13%)	1.306 (1.017–1.677)	0.04	73/834 (8.75%)	0.932 (0.689–1.26)	0.65
3 < defer ≤4 d	30/1420 (2.11%)	1.51 (0.919–2.483)	0.10	83/1464 (5.67%)	1.43 (1.086–1.882)	0.01	66/660 (10.00%)	1.195 (0.86–1.66)	0.29
4 < defer ≤5 d	18/952 (1.89%)	1.275 (0.708–2.295)	0.42	54/1054 (5.12%)	1.251 (0.897–1.744)	0.19	69/494 (13.97%)	1.405 (1.013–1.948)	0.04
5 < defer ≤6 d	16/722 (2.22%)	1.197 (0.632–2.27)	0.58	40/710 (5.63%)	1.283 (0.883–1.864)	0.19	50/340 (14.71%)	1.455 (0.996–2.125)	0.05
defer >6 d	98/2,040 (4.80%)	1.431 (0.981–2.086)	0.06	166/1,894 (8.76%)	1.498 (1.167–1.923)	<0.01	195/1,211 (16.10%)	1.544 (1.181–2.02)	<0.01
Total	300/21,849 (1.37%)	NA	NA	821/17,821 (4.61%)	NA	NA	746/7,089 (10.52%)	NA	NA

Ref, reference.

patients, elderly patients were more likely to be female ($p = 0.01$) and Caucasian ($p < 0.01$) but less likely to be African American ($p < 0.01$), Hispanic ($p < 0.01$), American Indian or Alaska Native ($p < 0.01$), or other races ($p < 0.01$) than young patients.

Among the nonfrail patients, when compared with their younger cohort, elderly patients were more likely to have partially dependent functional status ($p < 0.01$), COPD ($p < 0.01$), CHF ($p < 0.01$), hypertension ($p < 0.01$), AKI ($p < 0.01$), preoperative sepsis ($p < 0.01$), eGFR<60 mL/min/1.73m^2 ($p < 0.01$), serum albumin <3.4 g/L ($p < 0.01$), White Blood Cell >11,000 counts/mL ($p < 0.01$), hematocrit <37% ($p < 0.01$), 0 PTT > 60 seconds ($p < 0.01$), ASA score of 4 or 5 ($p < 0.01$) (Table 2). We also found that elderly patients were less likely to undergo laparoscopic surgery for their SBO ($p < 0.01$) (Table 2).

As for 30-day outcomes, when compared with young patients, the elderly patients had a higher risk of mortality (4.61% vs. 1.37%; aOR, 2.388; 95 CI, 2.066–2.762; $p < 0.01$), MACE (2.36% vs. 0.61%; aOR, 2.984; $p < 0.01$), cardiac complications (1.96% vs. 0.50%; aOR, 3.101; $p < 0.01$), stroke (0.44% vs. 0.12%; aOR, 2.372; $p < 0.01$), pulmonary events (8.77% vs. 4.31%; aOR, 1.73; $p < 0.01$), renal dysfunction (1.30% vs. 0.71%; aOR, 1.353; $p = 0.01$), VTE (2.69% vs. 1.49%; aOR, 1.537; $p < 0.01$), wound complications (11.88% vs. 12.98%; aOR, 0.907; $p < 0.01$), discharge not to home (40.32% vs. 21.58%; aOR, 2.044; $p < 0.01$) (Table 3). However, elderly nonfrail patients had a lower readmission rate (8.24% vs. 9.00%; aOR, 0.905; $p = 0.01$) (Table 3). Also, elderly nonfrail patients had a longer length of stay (11.34 ± 9.49 vs. 9.69 ± 0.21 days; $p < 0.01$), longer time from admission to operation (2.82 ± 5.64 vs. 2.49 ± 6.90 days; $p < 0.01$), but shorter operation time (107.50 ± 78.34 vs. 119.00 ± 85.67 minutes; $p < 0.01$) (Table 3).

The Impact of Timing on Surgical Outcomes

Table 4 and Figure 2 demonstrate the impact of deferred surgery on SBO. The risks of 30-day mortality were compared across various time intervals from admission to surgery against the baseline of defer ≤1 day. Among young nonfrail patients, no significant difference in mortality risk was observed regardless of the surgery's deferral time. However, in elderly nonfrail patients, compared with those who were deferred less than 1 day (mortality rate, 3.42%), a heightened mortality risk was evident when surgery was postponed for 2 days to 3 days (5.13%; aOR, 1.306; $p = 0.04$), 3 days to 4 days (5.67%; aOR, 1.43; $p = 0.01$), and beyond 6 days (8.76%; aOR, 1.498; $p < 0.01$). For elderly frail patients, compared with those who were deferred less than 1 day (mortality rate 7.72%), an increased mortality risk, on an already higher mortality rate compared with elderly nonfrail, was observed when surgery was delayed beyond 4 days (4–5 days; 13.97%; aOR, 1.405; $p = 0.04$; 5–6 days; 14.71%; aOR, 1.455; $p = 0.05$; over 6 days; 16.10%; aOR, 1.544; $p < 0.01$).

DISCUSSION

This study examined the influence of age and frailty on the outcomes following surgery for SBO. Both age and frailty are independently associated with 30-day mortality, several surgical complications, extended length of hospital stays, and prolonged durations from admission to operation. The results of this study are consistent with the research by Quero et al. who

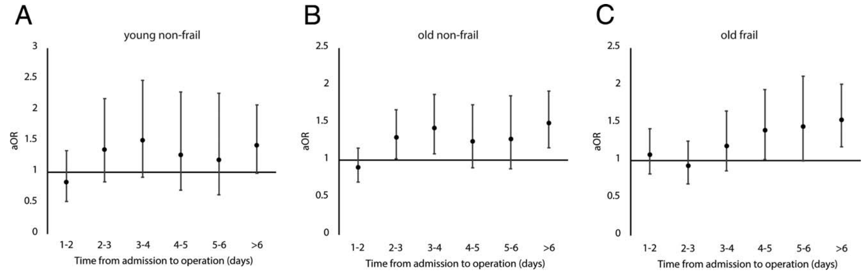

Figure 2. Assessment of the impact of deferred surgery on SBO, where the risks of 30-day mortality were compared across various time intervals from admission to surgery against the baseline of defer ≤1 day in a) young (age <65 years) nonfrail, (*B*) old (age ≥65 years) nonfrail, and (*C*) old (age ≥65 years) frail patients. The aOR and their 95 CIs are shown.

demonstrated increased rates of mortality and complications in elderly patients with SBO regardless of the type of intervention and timing to intervention, despite they included patients who underwent both surgical and nonsurgical management for SBO.[19] In comparison, Krause and Webb reported comparable outcomes between elderly and younger patients after an operative intervention.[20] The literature on the influence of age on surgical outcomes for SBO has been inconsistent and is likely related to the insufficient statistical power of these single-institution studies and differences in practice at each institution. Utilizing NSQIP, a nationally validated surgical database tailored for quality control, this study corroborates that age stands as a prominent risk factor for 30-day mortality and various morbidities following surgery for SBO.

Prior studies presented mixed conclusions regarding the impact of frailty on outcomes following surgery for SBO. A single-institution study involving 104 patients found no discernible difference in outcomes between frail and nonfrail patients, while their conclusions may be significantly limited by the small sample size.[1] In contrast, a more recent, comprehensive study utilizing the National Inpatient Sample database found frailty was associated with 1.82 times higher odds for in-hospital mortality in patients with SBO over age 65 years.[2] While Hwang et al. focused solely on in-hospital mortality, our findings indicate not only an elevated 30-day mortality rate but also an increase in postoperative complications spanning various organ systems, encompassing cardiac, pulmonary, and renal issues, in addition to other complications such as sepsis and VTE. Collectively, these findings underscore frailty as a significant risk factor for adverse outcomes following operation for SBO.

Currently, there are no established guidelines or consensus statements regarding the management of SBO in elderly and/or frail patients. A prior review suggested that elderly nonfrail patients older than 70 years could be managed similarly to other adult patients with SBO.[7] In the current study, we found that delaying surgery in young nonfrail patients does not affect 30-day mortality compared with immediate surgery. However, a significantly higher mortality rate was evident in elderly nonfrail patients when surgery was postponed beyond 2 days; and 4 days in elderly frail patients. These results were consistent with prior studies demonstrating increased mortality when elderly patients had longer intervals of time between admission to surgery.[2] Moreover, this study also demonstrated increased mortality when time to surgery exceeded 2–3 days and when associated with elderly age regardless of frailty. Older patients may have better survival rates if they undergo an early operation,[2] and this suggests that older patients may wait unnecessarily for surgery.[1]

It is also intriguing to point out that elderly frail patients were more likely to undergo open than laparoscopic surgery. Laparoscopic surgery in elderly frail patients could be technically difficult due to factors such as multiple previous abdominal surgeries leading to increased adhesions or concerns the surgeons may have in relation to the patient's comorbidities and increased intraperitoneal pressure affecting patients' physiology. These considerations might lead to decisions for open surgery, which offers more direct access and control over the operative field, potentially reducing the risk of iatrogenic injury. Surgery may be delayed in this group as a result of cautious initial management approaches, including attempts at nonoperative management given the higher risks associated with surgery in frail patients.

When we examined the effects of deferred surgery on mortality in young nonfrail, elderly nonfrail and elderly frail patients with SBO, we found different effects of delays in surgery among the population. In nonfrail young patients, delaying surgery does not influence the 30-day mortality rate when compared with immediate surgical intervention. This suggests that young nonfrail patients may not be as sensitive to physiologic insults while waiting for eventual surgery. Conversely, in elderly nonfrail patients, a significant rise in mortality was observed when surgery was delayed beyond 2 days. This implies that while nonoperative management might be a viable option in the beginning, surgical intervention may be promptly considered within the first 2 days. Our study is not designed to assess the reason underlying this finding; however, we hypothesized that this may be due to the inability of the elderly population to compensate for the ongoing physiologic insults from the inflammatory process of the disease. Further studies are needed to test for this or other possible mechanisms to explain our findings.

For elderly frail patients, the risk of mortality increases if surgery is postponed beyond 4 days. This population has a higher mortality rate compared with the elderly nonfrail population in our studies. However, their odds of mortality did not significantly increase until 4 days. This may be due to this population's better outcome when they receive nonoperative management prior to their surgical intervention. The effect of optimization may be more highly pronounced in this population compared with the elderly nonfrail patient, thus the effect that we observed in our analyses. These findings could be used to enhance the evaluation of risk-adjusted outcomes in elderly patients who may require surgery for SBO, with considerations based on frailty.

Our findings suggest that tailored surgical interventions, taking into account both age and frailty, may be effective when considering the timing to operate for SBO. Furthermore, this study emphasized the critical role of frailty screening in elderly patients. The mFI-5 score can be a concise and effective tool for assessing frailty in clinical settings.

Limitations

This study recognizes several limitations. First, the NSQIP database does not detail the specific etiology of SBO, such as adhesion, hernia, or cancer, where specific causes, such as different cancer stages, can influence mortality. Second, given that NSQIP is a surgical database, it does not account for patients who were definitively managed without surgery. This omission restricts our ability to compare outcomes of nonoperative versus surgical interventions in SBO patients, which could impact the generalizability of our findings. However, this was outside of the scope of our study, which sought to determine complications related to the timing to the operation. Third, the NSQIP's 30-day postprocedure follow-up limits our capacity to assess long-term outcomes. Moreover, in this study, frail patients were retrospectively defined using the mFI score calculated from five comorbidities recorded in the NSQIP database. Although the mFI score has been validated and proven effective across various surgical subspecialties as a reliable predictor of postoperative mortality and morbidities,[15,16] the usage of only these five specific comorbidities meant that patients without these comorbidities but exhibited other measures of frailty such as mild dementia, ambulatory difficulty, balance issues, or sarcopenia, might not be included as frail patients. Conversely, some elderly patients with well-controlled hypertension and DM may not be considered frail. This could lead to potential cohort selection bias in this study. Finally, the NSQIP database only records discharge destinations and does not provide information on patients' home status prior to surgery, which can limit our interpretation of the "discharge not to home" outcome.

CONCLUSION

Both age and frailty are independently associated with 30-day mortality, various surgical complications, extended hospital stay, and delays from admission to surgical intervention in patients undergoing operation for SBO. When SBO surgery is postponed for more than 2 days, elderly nonfrail patients have an increased mortality risk. Consequently, upon admission, these patients should be placed under a nasogastric tube and undergo an initial gastrograffin challenge. If there is no contrast in the colon, they should be operated on within 2 days. Conversely, elderly frail patients with SBO have a higher mortality risk when surgery is delayed beyond 4 days. Thus, following the same scheme, they should be operated on before 4 days if gastrograffin challenge fails.

AUTHORSHIP

R.L. and S.K. made the conceptualization. R.L. contributed to methodology. R.L. performed formal analysis. R.L., S.K., and B.S. contributed to the investigation. R.L. and S.K. contributed to the resources. R.L. performed data curation. R.L. contributed in writing (original draft). R.L., S.K., B.S., M.T. Q., and J.L. performed writing (review and editing). S.K. and B.S. contributed to the supervision.

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DISCLOSURE

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