Original Investigation

Association of Frailty and 1-Year Postoperative Mortality Following Major Elective Noncardiac Surgery
A Population-Based Cohort Study

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IMPORTANCE Single-center studies identify frailty as a risk factor for 30-day postoperative mortality. The long-term and population-level effect of frailty on postoperative mortality is, to our knowledge, poorly described, as are the interactions of frailty with important predictors of mortality.

OBJECTIVE To measure the population-level effect of patient frailty on, and its association with, 1-year postoperative mortality.

DESIGN, SETTING, AND PARTICIPANTS Population-based retrospective cohort study in Ontario, Canada, with data collected between April 1, 2002 and March 31, 2012. Analysis was performed from December 2014 to March 2015. All patients were community-dwelling individuals aged 65 years or older on the day of elective, major noncardiac surgery.

EXPOSURE Frailty, as defined by the Johns Hopkins Adjusted Clinical Groups (ACG) frailty-defining diagnoses indicator. The ACG frailty-defining diagnoses indicator is a binary variable that uses 12 clusters of frailty-defining diagnoses

MAIN OUTCOMES AND MEASURES One-year all-cause postoperative mortality.

RESULTS Of 202 811 patients, 6289 (3.1%) were frail (mean [SD] age, 77 [7] years). Within 1 year, 13.6% (n = 855) of frail and 4.8% (n = 9433) of nonfrail patients died. Adjustment for sociodemographic and surgical confounders resulted in a hazard ratio of 2.23 (95% CI, 2.08-2.40). The interaction between frailty and postoperative time demonstrated an increased relative hazard for death in frail patients (hazard ratio, 35.58; 95% CI, 29.78-40.19) on postoperative day 3. The association between frailty and increased risk of death decreased with patient age (HR, 2.66; 95% CI, 2.28-3.10 at age 65; HR, 1.63; 95% CI, 1.36-1.95 at age 90). Significant variations in the increased risk for death in frail patients existed between different surgery types and was strongest after total joint arthroplasty (HR, 3.79; 95% CI, 3.21-4.47 for hip replacement; HR, 2.68; 95% CI, 2.10-3.42 for knee replacement).

CONCLUSIONS AND RELEVANCE At a population level, preoperative frailty-defining diagnoses were associated with a significantly increased risk of 1-year mortality that was particularly notable in the early postoperative period, in younger patients, and after joint arthroplasty.

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Frailty is an aggregate expression of susceptibility to poor outcomes, owing to age- and disease-related deficits that accumulate within multiple domains.[1,2] Frailty-related risk is manifest through vulnerability to stressors,[2] which translates into risk of mortality and adverse health outcomes.[1,3,4]

Elderly patients make up an ever-increasing proportion of the surgical population.[5] The prevalence of frailty increases with age[1,6]; 10% of those aged 65 to 75 years are frail compared with 40% of those 80 years and older.[4] Given the significant stress induced by surgery, it is not surprising that frailty is an independent predictor of mortality, morbidity, extended length of stay, and institutional discharge among elderly surgical patients.[7-13]

Despite this accumulating evidence, knowledge gaps remain regarding the effect of frailty on outcomes after surgery. To our knowledge, the literature consists primarily of single-center studies limited to 30-day or in-hospital outcome windows. Furthermore, the association of frailty and mortality appears to vary by a factor of 40 depending on surgery type.[14] Patient age, sex, and socioeconomic status are important predictors of both frailty and adverse postoperative outcomes.[6,15-17] It is unknown how these risk factors modify the impact of frailty on postoperative mortality. Finally, frail patients experience a 1.7 to 1.9 times increased baseline risk of 1-year mortality.[1,6] Findings that frailty increases the risk of postoperative mortality could largely be a reflection of the underlying frailty–early mortality relationship. Understanding how surgery specifically affects the frailty-related risk of mortality over the postoperative period would provide useful insight to guide clinical care and future research directed at improving the outcomes of the frail elderly.

Population-level studies could address these knowledge gaps; however, the lack of a universal frailty metric is a key barrier to large-scale investigations of our frail surgical population. To our knowledge, population-based studies of perioperative frailty are limited to those using a nonvalidated modified frailty index in the National Surgical Quality Improvement Program database.[18] In Ontario, Canada, population-based health administrative data exist, which allow identification of frail individuals using validated methods. Therefore, we undertook this study with 2 main goals: (1) to describe and clarify the population-level association of frailty and mortality in the year following a number of well-studied, major elective noncardiac operations, and (2) to explore how the association between frailty and postoperative mortality is influenced by important surgical and patient factors.

Methods

Setting and Data

Following approval by the Research Ethics Board of Sunnybrook Health Sciences, Toronto, Ontario, Canada, we conducted a historical cohort study in Ontario, Canada, where all hospital and physician services are funded through a public health care system. Due to the anonymized nature of our data, the need for oral or written consent was waived. We used population-based health administrative data collected using standardized disease classification, procedural terms,[19] and abstraction formats.[20] All data were linked deterministically using encrypted patient-specific identifiers. Databases included the Discharge Abstract Database, which captures all hospitalizations and in-hospital deaths; the Ontario Health Insurance Plan database, which captures physician service claims; and the Registered Persons Database, which captures all death dates for residents of Ontario. Reporting was in keeping with the Strengthening Reporting in Observational studies in Epidemiology guidelines.[21]

Cohort

We identified all patients who were 65 years or older on the day of elective noncardiac surgery. Operations of interest included carotid endarterectomy, peripheral arterial bypass, total hip replacement, total knee replacement, large bowel surgery, partial liver resection, pancreaticoduodenectomy, gastrectomy, esophagectomy, nephrectomy, or cystectomy. These are all sex-neutral, intermediate- to high-risk operations and have been used together to study outcomes for surgical patients in Ontario.[22-26] All admissions were elective, and the validity and reliability of codes used to identify these elective procedures has been confirmed through reabstraction.[27,28] We included only the first procedure for each patient between April 1st, 2002 (to coincide with the introduction of *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision* [to identify diagnoses] and Canadian Classification of Intervention [to identify procedures]), and March 31st, 2012 (the latest time at which all data sets were complete when we conducted the study). Patients without valid provincial health insurance or residing in a long-term care facility within the 7 days prior to surgery were excluded. This restricted our sample to community-dwelling individuals.

Exposure

Frailty status may be ascertained using scales or phenotypes or through the identification of individuals with frailty-defining diagnoses.[29] We identified frailty using the Johns Hopkins Adjusted Clinical Groups (ACG, Johns Hopkins University) frailty-defining diagnoses indicator, an instrument designed for use in health administrative data.[30-32] The ACG frailty-defining diagnoses indicator is a binary variable that uses 12 clusters of frailty-defining diagnoses (eTable in the Supplement)[32] and has been used to study frailty-related health care resource use[33,34] and surgical outcomes.[13] Because of the proprietary nature of the ACG system, specific diagnostic codes used are not available for dissemination. The presence of frailty was defined based on data available in the 2 years prior to admission.

Because there is no gold-standard frailty instrument,[3] the ACG frailty-defining diagnoses indicator has been externally tested in a comparative analysis with the Vulnerable Elderly Scale (VES).[31] Patients identified as frail using the ACG indicator had higher VES scores than those without frailty-defining diagnoses ($P < .005$). Characteristics of the patients identified as frail using the ACG indicator were consistent with multidimensional frailty, including a higher prevalence of falls, lower cognitive scores, and worse global functional scores than nonfrail patients. Using a VES score of 3 or more as a cutoff, the ACG frailty-defining diagnoses indicator had moderate discrimination between VES-frail and VES-nonfrail (c-statistic, 0.62). This likely reflects the limited agreement typically found between frailty instruments, where more than 90% of comparisons between instruments resulted in only fair to moderate agreement.[3]

Outcomes

In-hospital deaths during the index hospitalization were identified from the Discharge Abstract Database. Deaths occurring after discharge were identified from the Registered Persons Database.

Covariates

Demographics were collected from the Registered Persons Database. Validated algorithms were used to determine whether patients had congestive heart failure,[35] hypertension,[36] a history of acute coronary syndromes,[37] diabetes mellitus,[38] obstructive pulmonary disease, or asthma.[39,40] Standard methods[41] were used to identify Elixhauser comorbidities based on *International Classification of Diseases, Ninth Revision* and *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision* codes from the Discharge Abstract Database in the 2 years preceding surgery, including atrial arrhythmias; dementia; hemiplegia or hemiparesis; cerebrovascular disease; primary (excluding nonmelanomatous skin cancer) malignancy; metastatic tumors; peripheral vascular disease; renal disease; dialysis; liver disease; peptic ulcer disease; rheumatologic disease; and venous thromboembolism.

Analysis

Characteristics were compared between frail and nonfrail groups using standardized differences, which are less sensitive to large sample sizes than tests of significance.[42] Although no cutoff has been universally accepted, standardized differences of less than 10% are thought to represent negligible correlations.[42]

Absolute mortality rates and surgery-specific mortality rates were calculated. Adjusted and unadjusted hazard ratios (HRs) associating the risk of frailty with mortality were computed using Cox regression. Because frailty is an aggregate representation of risk, for which medical comorbidities are on the causal pathway, we did not control for specific medical comorbidities in our primary model.[2,43] We controlled for important confounders in the frailty-mortality relationship[1,6] including age, sex, socioeconomic status, and year of surgery. Age and year of surgery were treated as continuous variables represented by restricted cubic splines (5 knots for age, 3 for year of surgery). Socioeconomic status was modeled as a 5-level categorical variable using neighborhood income quintiles (based on the smallest unit of the national census, representing 400-700 individuals). Surgery type was modeled as a 10-level categorical variable. A post hoc sensitivity analysis was performed to evaluate the association of frailty and mortality in a model controlling for all comorbidities except for delirium, which is a frailty-defining diagnosis.

To investigate the importance of the interaction between frailty and confounders (age, sex, surgery type, neighborhood income quintile, and year of surgery), we tested the statistical significance of the regression coefficient for interaction terms. If the interaction term was significant, we calculated the HRs describing the association of frailty with 1-year mortality for all values of the interacting covariate. We investigated whether the relative hazard of mortality by frailty status differed over postoperative days by including an interaction term between frailty and postoperative day. To identify an appropriate continuous representation for postoperative day, fractional polynomials (with exponent values of −0.5, −1, 1, 2, and 3 and log-transformed) were iteratively tested.[44] The inverse function (ie, postoperative day^{-1}) was found to provide the best model fit using the Akaike Information Criterion. The adjusted HRs for mortality in frail vs nonfrail patients were then calculated for each day in the first postoperative year. The frailty-stratified hazard function for mortality was generated to further explore the frailty-time interaction with regards to mortality (**Figure 1**B).

Finally, because major abdominal surgery (nephrectomy, cystectomy, large bowel, liver, pancreaticoduodenectomy, gastrectomy or esophagectomy, and liver resection) may be performed for benign or malignant reasons, a post hoc sensitivity analysis was conducted. We tested an interaction term between the presence of cancer (a binary variable based on Elixhauser codes for malignant solid tumors, with or without metastases) and frailty.

We used SAS version 9.3 for UNIX (SAS Institute) for analysis. An α of .05 was used as the level of significance for all outcome analyses.

Missing Data

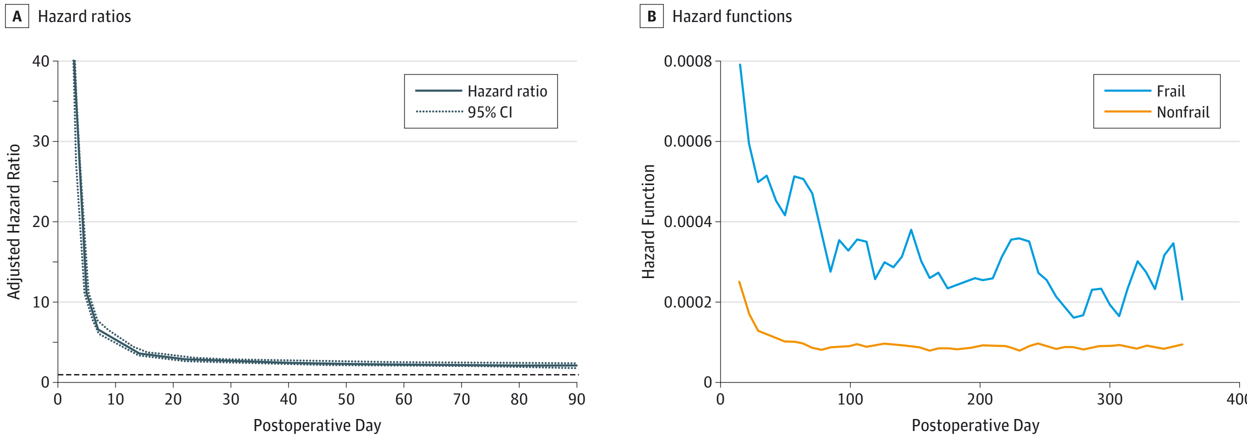
Main outcome and exposure variables were complete for all participants. Neighborhood income quintile was imputed with the group median for 0.3% of patients. No other data were missing.

Results

We identified 202 980 elderly people who had major elective noncardiac surgery during our study; 169 were excluded because they resided in a long-term care facility (eFigure in the Supplement). Adjusted Clinical Groups frailty-defining diagnoses were present in 6289 patients (3.1%). Frail patients were older and had a higher prevalence of all comorbidities (**Table 1**). The distribution of surgical procedures also differed; joint replacements were the most common procedures in frail and nonfrail groups, but knee replacements were more prevalent in the nonfrail cohort. Vascular and large bowel surgery were more common in frail patients.

In the year after surgery, 855 frail patients (13.6%) compared with 9433 nonfrail patients (4.8%) died (unadjusted

Figure 1. Time-Dependent Adjusted Relative Hazard of Mortality in Frail vs Nonfrail Patients



A, This plot shows the hazard ratio (adjusted for patient age, sex, neighborhood income, and surgical type) and 95% CIs for the association between frailty and 1-year mortality following surgery. The hazard ratio was determined for each postoperative day. Hazard ratios above 1 indicate an increased risk of death in frail compared with nonfrail patients. Hazard ratios beyond 90 days did not change significantly and are not displayed. The x-axis is also truncated for display purposes. The horizontal dotted line indicates the null value of the hazard ratio (1.0). B, This plot shows the hazard function for frail and nonfrail patients over the first postoperative year. The hazard function represents the instantaneous risk of death at any time. The line for frail patients is expected to be less smooth owing to the smaller sample size.

HR, 2.98; 95% CI, 2.78-3.20; eFigure 2 in the Supplement). Adjusting for age, sex, neighborhood income quintile, and procedure, 1-year mortality risk remained significantly higher in the frail group (adjusted HR, 2.23; 95% CI, 2.08-2.40). One-year risk of death was significantly higher in frail patients in all operations, except pancreaticoduodenectomy and liver resection, with absolute risk differences being highest after esosphagectomy and gastrectomy (**Table 2**).

The association between frailty and mortality varied significantly by time (*P* < .001), patient age (*P* < .001), and surgery type (*P* < .001), but not by sex (*P* = .53), neighborhood income quintile (*P* = .29), or year of surgery (*P* = .28). Figure 1A shows that the relative hazard of mortality in frail vs nonfrail patients was extremely high in the early postoperative period (HR, 35.58; 95% CI, 29.78-40.1 at postoperative day 3) before stabilizing between 2 and 3 by postoperative day 90. This association was consistent with the stratified hazard function, which demonstrates that the risk of death is higher in both groups immediately after surgery but much more so in the frail strata (Figure 1B). The HR associating frailty with mortality decreased linearly as patients aged but remained statistically significant for all ages (**Figure 2**). Finally, the adjusted HR for mortality in frail vs nonfrail patients following the different operations studied varied between 0.82 (95% CI, 0.44-1.54) for pancreaticoduodenectomy to 3.79 (95% CI, 3.21-4.47) following hip replacement (**Figure 3**).

In a model controlling for all comorbidities in post hoc sensitivity analyses, frail patients were at significantly higher risk of 1-year mortality (adjusted HR, 1.36; 95% CI, 1.26-1.46) than nonfrail patients. In the sample limited to major abdominal operations, the interaction between frailty and malignancy was not significant (*P* = .07).

Discussion

In this study of 1-year postoperative mortality, frailty was consistently associated with an increased risk of death. The association between frailty and postoperative mortality is not surprising; by definition, frail patients are "sicker," and frailty is associated with early mortality in the general population. However, the interaction between frailty and postoperative time suggests that the early postoperative period is a window of markedly increased risk of mortality for frail elderly patients. Furthermore, significant interactions between frailty, patient age, and surgery type provide important insights into the frailty-postoperative mortality association. Finally, the absolute risk of 1-year mortality for frail patients having abdominal or arterial bypass surgery exceeded a rate of 1 in 5.

Frailty is consistently associated with increased risk of in-hospital or 30-day mortality.[14] Because we were able to capture all deaths over the first postoperative year in a population-based sample, our study provides further insight into the association between surgery and mortality in frail patients. The reported increased risk of mortality after surgery could be driven by the underlying effect of frailty on all-cause mortality, independent of surgery. In this case, the relative hazard of mortality associated with frailty would be elevated, but nonvarying, over time. Alternatively, the effect of surgical stress in frail individuals could drive the association. In this case, the relative hazard of mortality would be expected to decrease as time from the surgery increased. Based on our analysis, the latter appears to be the case. This elevated relative hazard of death in frail patients in the immediate postoperative period suggests that clinicians and researchers should focus efforts

Table 1. Baseline Characteristics of Study Population by Frailty Status

Demographic	Frail (n = 6289)	Nonfrail (n = 196 522)	Standardized Difference	*P* Value
Age, mean (SD), y	77 (7)	74 (6)	46.0	<.001
Female	58.5	55.5	6.1	<.001
Rural	17.3	16.6	1.9	.15
Neighborhood income quintile, median (IQR)	3 (4-2)	3 (4-2)	0.0	<.001
Comorbidities				<.001
Asthma	16.3	13.0	9.3	
Atrial arrhythmia	16.6	2.7	48.4	
Cerebrovascular disease	13.6	1.8	45.4	
Chronic obstructive pulmonary disease	33.9	21.5	28.0	
Dementia	11.3	0.1	49.9	
Diabetes mellitus	35.0	24.8	22.4	
Dialysis	2.4	0.4	17.1	
Heart failure	25.4	8.2	47.3	
Hemiplegia	2.8	0.2	21.5	
Hypertension	83.5	75.0	21.1	
Liver disease	1.7	0.2	15.5	
Malignancy	19.8	6.5	40.1	
Metastases	4.4	1.0	21.1	
Peptic ulcer disease	3.0	0.6	18.1	
Peripheral vascular disease	11.1	1.9	38.0	
Prior myocardial infarction	9.9	4.5	21.0	
Renal disease	8.4	1.0	35.5	
Rheumatic disease	2.9	0.4	19.7	
Venous thromboembolism	2.4	0.3	18.3	
Health care resource use				
Hospitalization in last year	76.9	18.8	143.0	<.001
Procedure				<.001
Hip replacement	27.8	24.4	7.7	
Knee replacement	26.2	42.4	34.6	
Carotid endarterectomy	5.7	3.1	12.7	
Arterial bypass	10.0	4.1	23.2	
Nephrectomy	2.9	3.2	1.7	
Cystectomy	1.8	1.4	3.2	
Large bowel	22.5	18.9	8.9	
Liver resection	0.5	0.5	0.0	
Pancreaticoduodenectomy	0.7	0.5	2.6	
Gastrectomy/esophagectomy	1.9	2.0	0.7	

Abbreviation: IQR, interquartile range.

on risk mitigation in frail patients during this time. Additional investigations of the underlying causal mechanisms are needed, including failure-to-rescue analyses.

The association of patient age and frailty-related mortality after surgery is not well defined. The prevalence of frailty is at least 40% in patients aged 80 years and older (compared with 10% at 65 years). Furthermore, patients older than 75 years experience worse outcomes than younger patients.[17,45] Therefore, frailty is sometimes framed as an issue specific to very elderly surgical patients.[11] In our study, the presence of frailty-defining diagnoses was a stronger risk factor for postoperative death in younger patients. While a single study cannot prove causality for the age-frailty interaction and its effect on postoperative mortality, our finding supports the need for future research investigating this association.

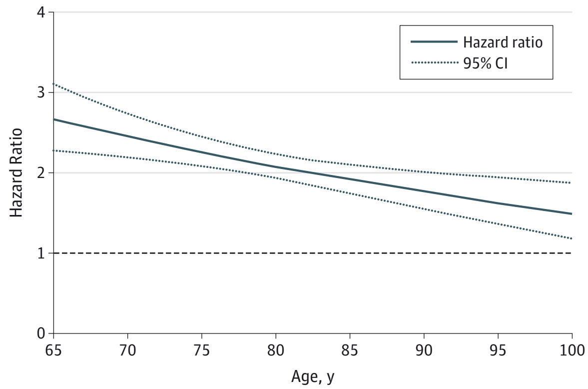
A 2014 review[14] described how the increase in the odds of mortality following coronary artery bypass surgery appears to be 1.1 to 1.4 times higher in frail people; following esophagectomy or thoracotomy, the relative odds of mortality were 30 to 40 times higher for frail patients. Such variation could be caused by differences in measurement, control for confounding, or true effect modification by surgery type. Using a single validated frailty instrument and a consistent set of covariates, we found an approximately 4-fold variation in the association between frailty and mortality. The HRs for major intraperitoneal and vascular surgical procedures mostly clustered between 1 and 2; for hip and knee replacement, HRs were noticeably higher (3.79 and 2.68, respectively). Total joint arthroplasties were by far the most common major elective operations among our frail patients. Because joint arthroplasty

Table 2. Absolute Rates and Difference in 365-Day Mortality

Procedure	% Frail	% Nonfrail	Risk Difference (95%CI)
Overall (n = 202 811)	13.6	4.8	8.8 (8.0 to 9.7)
Total knee replacement (n = 85 005)	4.2	1.4	2.8 (1.8 to 3.7)
Carotid endarterectomy (n = 6401)	7	3.6	3.3 (0.8 to 6.0)
Total hip replacement (n = 49 777)	9.4	2.1	7.3 (5.9 to 8.6)
Nephrectomy (n = 6368)	17.1	9.2	7.9 (2.4 to 13.5)
Large bowel (n = 37 682)	20.9	9.6	11.3 (9.2 to 13.4)
Pancreaticoduodenectomy (n = 1115)	22.2	24.6	−2.4 (−14.8 to 10.1)[a]
Peripheral arterial bypass (n = 8745)	24.2	11.9	12.4 (8.9 to 15.8)
Liver resection (n = 980)	33.3	22.5	10.8 (−5.5 to 27.1)
Cystectomy (n = 2760)	41.4	26.5	14.9 (5.8 to 24.0)
Esophagectomy or gastrectomy (n = 3978)	42.9	21.2	21.7 (12.7 to 30.7)

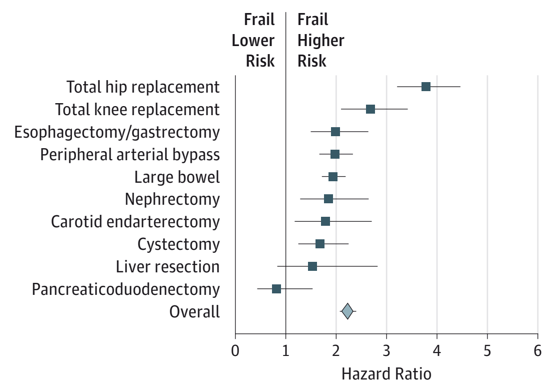
[a] Risk lower in frail group.

Figure 2. Impact of Frailty on Postoperative Mortality by Patient Age



This plot presents the hazard ratio (adjusted for patient sex, neighborhood income, and surgical type) and 95% CIs for the association between frailty and 1-year mortality following surgery. The hazard ratio was determined for all patient ages. Hazard ratios above 1 indicate an increased risk of death in frail patients. The horizontal dotted line indicates the null value of the hazard ratio (1.0).

Figure 3. Hazard Ratio for Effect of Interaction Between Frailty and Surgery Type on 1-Year Mortality Risk



The hazard ratio (adjusted for patient age, sex, and neighborhood income) measuring the association between frailty and 1-year mortality is presented for each surgical type. Hazard ratios whose lower 95% CI excludes 1 indicate a significantly increased risk of 1-year death in frail patients.

is a truly elective surgery (unlike cancer surgery, which may be done urgently, but on an elective basis) and given the stronger relative association of frailty and mortality after joint arthroplasty, these data suggest that frail patients having joint arthroplasty are a high-priority population for clinicians, administrators, and researchers.

Finally, patients, families, and clinicians must be aware of the absolute increase in frailty-related mortality risk. The 1-year mortality rate for patients having elective nephrectomy, cystectomy, large-bowel surgery, liver resection, peripheral arterial bypass, esophagectomy or gastrectomy, or pancreaticoduodentectomy was at least 1 death per 5 frail patients. While the choice to proceed with an elective surgery must be weighed on a case-by-case basis, our findings support the need for thorough considerations of risk vs benefit and the overall goals of care in frail patients considering major surgery. Frailty may already be influencing patient selection, given the lower prevalence of frailty defined by ACG frailty-defining diagnoses in our sample compared with the general elderly population of Ontario (3.1% vs 9.2%).[34] Furthermore, the lower relative effect of frailty in major abdominal operations (such as cystectomy, liver resection, and the decreased hazard in pancreaticoduodenectomy) may reflect more subtle considerations in patient selection that we could not capture in our data. Finally, while some evidence does support the role of preoperative optimization of frail patients,[46] further efforts are needed to clearly delineate the role of "prehabilitation" in improving the outcomes of frail surgical patients.

This study had several strengths. We used high-quality, population-based data and defined our cohort using reliable codes for elective operations. Mortality was captured using the gold standard from vital statistics that captured deaths that occur for any cause in any jurisdiction of Ontario residents. Follow-up was complete for all patients. Our exposure was defined using an externally validated method that has been shown to identify patients with characteristics consistent with multidimensional frailty and that has been used previously in our health administrative data environment[34] and in the study of frailty-related surgical outcomes.[13]

Because there is no universal definition of frailty, the results of our study are difficult to generalize across populations using other frailty instruments and to the clinical realm. The ACG frailty-defining diagnoses indicator is a binary definition; therefore we were unable to account for the impact of increasing levels of frailty. While we reliably identified surgical procedures using accurate methods, we were unable to account for the surgical indication. It is possible that frail patients are sent for "urgent" elective surgery more often than nonfrail patients; this could bias our findings away from the null. Because complications were not reliably coded in our data, we were unable to assess whether failure to rescue underlies our findings of early postoperative mortality risk. Finally, we approached frailty as an aggregate risk, with comorbidities considered to be on the causal pathway. While controlling for individual comorbidities in our models attenuated the association of frailty and mortality, the effect was still significant, and we feel that the aggregate-risk approach to frailty clearly frames the population-level epidemiology of this high-risk strata of the surgical population.

Conclusions

The presence of frailty-defining diagnoses before surgery is strongly associated with increased risk of postoperative mortality; this risk appears to be very high early in the postoperative period. The presence of frailty is more strongly associated with mortality in younger patients and after total joint arthroplasty. Our findings suggest specific areas of focus for clinical and research efforts aimed at improving the care and outcomes of frail elderly surgical patients.

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Study concept and design: McIsaac, Bryson.
Acquisition, analysis, or interpretation of data: McIsaac, van Walraven.
Drafting of the manuscript: McIsaac, Bryson.
Critical revision of the manuscript for important intellectual content: McIsaac, Bryson, van Walraven.
Statistical analysis: McIsaac, van Walraven.
Obtained funding: McIsaac.
Administrative, technical, or material support: McIsaac, Bryson.
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Invited Commentary

Frailty and Mortality After Noncardiac Surgery in Elderly Individuals
Metrics, Systems, and the Elephant

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Frailty is increasingly recognized as a key determinant of poor surgical outcomes. The impact of frailty assessment at the patient and system level has significant implications.

Metrics

With this rigorous population-based, retrospective cohort study of surgical patients in Ontario, Canada, McIsaac and colleagues[1] add to the growing literature demonstrating markedly increased risks frailty imposes on surgical populations. Using sophisticated and measured statistical analyses, the Johns Hopkins Adjusted Clinical Groups frailty score was used to model risk of death from day of surgery to 1 year, in contrast to many databases limited to 30-day outcomes. This extended timeframe demonstrates in Canada the frailty-associated mortality risk after surgery is greatest in the first 3 days (hazard ratio = 35.6) declining rapidly over 10 days and stabilizing by 90 days. In a similar, but contrasting, study, surgical patients in the Veterans Affairs highest-risk group (bottom decile) demonstrated a stable mortality rate over time during the first 30 days that continued over 1 year.[2]

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We also commend the detailed analysis of demographic variables and surgical procedures. Not surprisingly, frail patients were older, but the risk of mortality among frail patients was highest in the young, again alluding to the prognostic power of frailty in contrast to classic medical comorbidities. Not surprisingly, the study also confirms that physiologically stressful procedures of the thorax, peritoneal cavity, and vascular procedures result in a high 1-year mortality rate in frail patients (20%) compared with elective extremity orthopedic operations.