Can Routine Preoperative Data Predict Adverse Outcomes in the Elderly? Development and Validation of a Simple Risk Model Incorporating a Chart-Derived Frailty Score

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BACKGROUND: Frailty has emerged as an important predictor of operative risk among elderly surgical patients. However, the complexity of prospective frailty scores has limited their widespread use. Our goal was to develop two frailty-based surgical risk models using only routine preoperative data. Our hypothesis was that these models could easily integrate into an electronic medical record to predict 30-day morbidity and mortality.

STUDY DESIGN: American College of Surgeons NSQIP Participant Use Data Files from 2005 to 2010 were reviewed, and patients 65 years and older who underwent elective lower gastrointestinal surgery were identified. Two multivariate logistic regression models were constructed and internally cross-validated. The first included simple functional data, a comorbidity index based on the Charlson Comorbidity Index, demographics, BMI, and laboratory data (ie, albumin <3.4 g/dL, hematocrit <35%, and creatinine >2 mg/dL). The second model contained only parameters that can directly autopopulate from an electronic medical record (ie, demographics, laboratory data, BMI, and American Society of Anesthesiologists score). To assess diagnostic accuracy, receiver operating characteristic curves were constructed.

RESULTS: There were 76,106 patients who met criteria for inclusion. Thirty-day mortality was seen in 2,853 patients or 3.7% of the study population and 18,436 patients (24.2%) experienced a major complication. The c-statistic of the first expanded model was 0.813 for mortality and 0.629 for morbidity. The second simplified model had a c-statistic of 0.795 for mortality and 0.621 for morbidity. Both models were well calibrated per the Hosmer-Lemeshow test.

CONCLUSIONS: Our work demonstrates that routine preoperative data can approximate frailty and predict geriatric-specific surgical risk. The models' predicative powers were comparable with that of established prospective frailty scores. Our calculator could be used as a low-cost simple screen for high-risk individuals who might require additional evaluation or specialized services. (J Am Coll Surg 2014;219:684–694. © 2014 by the American College of Surgeons)

Individuals older than the age of 65 years represent the fastest-growing segment of the population,[1,2] and account for >40% of all surgical procedures.[3] Although age alone cannot adequately predict operative outcomes,[4-6] seniors are at high risk of operative morbidity and mortality.[7,8] This is particularly true for elderly patients undergoing

Abbreviations and Acronyms	
ACS	= American College of Surgeons
ASA PS	= American Society of Anesthesiologists Physical Status
EMR	= electronic medical record
mFI	= Modified Frailty Index
SSI	= superficial surgical site infection

nonemergent colorectal surgery. Colorectal patients account for the largest number of geriatric postoperative deaths and a substantial proportion of all postoperative complications.[9] As such, the ability to efficiently and proactively identify these patients is critical for patient counseling, shared decision making, and resource allocation.

Geriatric medicine has long recognized frailty, a state of decreased physiologic reserve, as essential to the assessment and treatment of community-dwelling seniors.[10,11] Although frailty is not a condition limited to the elderly, it is a useful way of describing a population that is characterized by multimorbidity. Recently, the surgical literature has adopted this concept, and frailty markers, such as weakness, impaired gait or balance, and decreased function have been shown to positively correlate with the risk of postoperative death and complication.[12,13] However, the complexity and intensity of formal prospective frailty assessments has prohibited their widespread preoperative use.[14] One practical barrier is the need for specialized testing or evaluation, which is time consuming, and is not readily available in many community-based settings.[14]

We hypothesized that we could use routinely collected clinical data to approximate frailty and predict the risk of 30-day postoperative morbidity and mortality among elderly colorectal surgery patients. In this study, we use the American College of Surgeons (ACS) NSQIP, a high-fidelity database of perioperative information, to develop and evaluate two geriatric-specific surgical risk scores. The first is a model that closely approximates the modified Frailty Index (mFI),[15-17] and therefore includes fields that must be manually entered by NSQIP participant institutions (eg, transfer status and functional level). Although these are simple parameters and do not require a geriatrics consult, they still require input from a trained individual, are subject to input error, and cost $10,000 to $29,000 per institution.[18] The second model uses only routine parameters that can be directly autopopulated from an electronic medical record (EMR). The latter would be a valuable resource for clinicians facing the time and economic constraints of the busy preoperative period. Finally, we compare prognostic ability of both the expanded and simple model with that of an established prospective frailty model.[19,20]

METHODS

Study population

ACS NSQIP Participant Use Data Files from 2005 to 2010 were obtained with permission from our institutional NSQIP official. Patients 65 years of age and older who underwent elective lower gastrointestinal surgery were identified by Clinical Classifications Software codes.[21] The most common lower gastrointestinal procedures were selected for inclusion (Clinical Classifications Software codes: 72, 73, 75, 78, 87, 89, 90, 96, and 99; Table 1). Emergency cases and individuals with an American Society of Anesthesiologists Physical Status (ASA PS) score of 5 were excluded.

The NSQIP is a large national database designed to measure and improve hospital-based surgical care.[22] Its methodology has been described previously.[22-24] In brief, the NSQIP dataset includes standardized data on patient demographics, preoperative comorbidities, laboratory tests, intraoperative variables, and 30-day postoperative outcomes for adult patients undergoing surgery. Data are collected and abstracted by trained Surgical Clinical Reviewers at each NSQIP site, and audited to ensure validity.[18]

Approximating frailty

Our retrospective models included markers representative of frailty and its underlying physiologic dysregulation. Specifically, we quantified and operationalized the domains outlined in Robinson's prospective frailty index (ie, impaired cognition, poor nutrition, decreased physical function, chronic disease burden, and geriatric syndromes).[19,20] The models' predictive power was enhanced

Table 1. Procedures by Clinical Classifications Software Code

CCS code	Description	Patients (n = 76,106)	
		n	%
72	Colostomy	1,786	2.3
73	Ileostomy or other enterostomy	5,718	7.5
75	Small bowel resection	4,464	5.9
78	Colorectal resection	38,298	50.3
87	Laparoscopy	2,487	3.3
89	Exploratory laparotomy	2,760	3.6
90	Excision or lysis of peritoneal adhesions	1,837	2.4
96	Other or lower GI therapeutic procedures	9,614	12.6
99	Other or GI therapeutic procedures	9,142	12.0

CCS, Clinical Classifications Software; GI, gastrointestinal.