Inclusion of Sarcopenia Outperforms the Modified Frailty Index in Predicting 1-Year Mortality among 1,326 Patients Undergoing Gastrointestinal Surgery for a Malignant Indication

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BACKGROUND: Although it is a useful metric for preoperative risk stratification, frailty can be difficult to identify in patients before surgery. We sought to develop a preoperative frailty-risk model combining sarcopenia with clinical parameters to predict 1-year mortality using a cohort of patients undergoing gastrointestinal cancer surgery.

STUDY DESIGN: We identified 1,326 patients undergoing hepatobiliary, pancreatic, or colorectal surgery between 2011 and 2014. Sarcopenia defined by psoas density was measured using preoperative cross-sectional imaging. Multivariable Cox regression analysis was performed to identify preoperative risk factors associated with 1-year mortality and used to develop a preoperative risk-stratification score.

RESULTS: Among all patients identified, 640 (48.3%) patients underwent pancreatic surgery, 347 (26.2%) underwent a hepatobiliary procedure, and 339 (25.5%) a colorectal procedure. Using sex-specific cut-offs, 398 (30.0%) patients were categorized as sarcopenic. Sarcopenic patients were more likely to develop postoperative complications vs non-sarcopenic patients (odds ratio [OR] 1.80, 95% CI 1.42 to 2.29; $p < 0.001$). Overall 1-year mortality was 9.4%. On multivariable analysis, independent risk factors for 1-year mortality included increasing age (65 to 75 years: [hazard ratio (HR) 1.81, 95% CI 1.05 to 3.14] greater than 75 years [HR 2.79, 95% CI 1.55 to 5.02]), preoperative anemia hemoglobin < 12.5 g/dL (HR 1.68, 95% CI 1.17 to 2.40), and preoperative sarcopenia (HR 1.98, 95% CI 1.36 to 2.88; all $p < 0.05$). Using these variables, a 28-point weighed composite score was able to stratify patients by their risk for mortality 1 year after surgery (C-statistic = 0.70). The proposed score outperformed other indices of frailty including the modified Frailty Index (C-statistic = 0.55) and the Eastern Cooperative Oncology Group (ECOG) performance score (C-statistic = 0.57) (both $p < 0.05$).

CONCLUSION: Sarcopenia was combined with clinical factors to generate a composite risk-score that can be used to identify frail patients at greatest risk for 1-year mortality after gastrointestinal cancer surgery. (J Am Coll Surg 2016;222:397–409. © 2016 by the American College of Surgeons. Published by Elsevier Inc. All rights reserved.)

Given advances in surgical technique and medical therapy, an increasing number of patients are being considered as surgical candidates for a wide array of gastrointestinal cancers.[1-4] Although perioperative mortality is relatively low, many patients are at risk for adverse postoperative outcomes due to the often complex nature of these procedures.[4-6] Furthermore, with an estimated 70 million patients expected to be 65 years or older

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Abbreviations and Acronyms

ASA = American Society of Anesthesiologists
CCI = Charlson Comorbidity Index
ECOG = Eastern Cooperative Oncology Group
HR = hazard ratio
HUAC = Hounsfield unit average calculation
IQR = interquartile range
mFI = modified Frailty Index
OR = odds ratio
TPA = total psoas area
TPV = total psoas volume

by 2030, preoperative risk assessment and appropriate patient selection for these complex procedures have taken on increased importance.[7] Several studies have noted that physiologic, rather than chronologic, age is more strongly associated with perioperative outcomes.[8-10] Specifically, the evaluation of patient frailty—a physiologic syndrome characterized by a cumulative decline across multiple physiological systems—has been proposed as an important metric to assess perioperative risk.[11-14]

A standard objective assessment of frailty to measure a patient's physiologic reserve can be difficult to define.[15] Frailty can be measured by combining information from a patient's medical history, physical examination, and assessment of physical and functional status.[16] These proposed composite measures are, however, often time-consuming, cumbersome to record, and reliant on multiple subjective measurements.[17,18] For example, the Frailty Index (FI) developed by the Canadian Study of Health and Aging (CSHA) consists of a 70-item scale derived from patient history and physical examination.[19,20] A more recent modified iteration of the frailty index proposed by Obeid and colleagues[21] maps 11 characteristics from the FI to data from the National Surgical Quality Improvement Program (NSQIP). Other groups, including our own, have proposed the use of sarcopenia (muscle wasting) as an alternative, objective, and easy to measure marker for patient frailty.[22-25]

To date, most data on patient physiologic reserve, frailty, and sarcopenia have focused exclusively on short-term outcomes.[13,14,26] Specifically, data on the use of the modified frailty index (mFI), as well as sarcopenia, to determine patient outcomes have been limited to reports on perioperative morbidity and mortality within the first 30 to 90 days after surgery.[21,23] Although information on immediate short-term outcomes is important, data to predict death within 1 year of surgery are also relevant to patients and providers. Given that major gastrointestinal surgery can be associated with some degree of morbidity and loss of quality of life, accurate identification of patients who are the least likely to benefit from surgery would be valuable.[27] Therefore, the objective of this study was to identify factors, as well as to assess the prognostic accuracy of the mFI, in predicting 1-year mortality after hepato-pancreatico-biliary and colorectal surgery. Specifically, we sought to develop a preoperative frailty-risk model using both clinical and morphometric parameters to predict 1-year outcomes of patients after major surgery.

METHODS

Data sources and patient population

Patients undergoing a hepatobiliary, pancreatic, or colorectal resection for malignant disease between January 1, 2011 and December 31, 2014 at the Johns Hopkins Hospital were identified using relevant International Classification of Disease—Clinical Modification (ICD-9-CM) procedure and diagnosis codes. Patients aged less than 18 years and patients undergoing emergent procedures were excluded from the study. For each patient record, detailed sociodemographic, clinicopathologic, and laboratory data were extracted from hospital records. Specifically, sociodemographic and clinicopathologic data that were collected included age, sex, and race, as well as preoperative comorbidity, preoperative functional and performance status, BMI, smoking status, procedure type, year of procedure, duration of ICU stay, length of stay for the index admission, and development of postoperative complications. Preoperative comorbidity was classified according to the Charlson Comorbidity Index (CCI) (CCI = 0 to 2 and CCI $\geq$ 3).[28] Functional and performance status were categorized according to the American Society of Anesthesiologists (ASA) physical classification grade and the Eastern Cooperative Oncology Group (ECOG) performance score, respectively.[29,30] To assess preoperative frailty, the mFI score was calculated for each patient using a composite score derived from 11 conditions identified by the Canadian Study of Health and Aging mapped to the American College of Surgeons NSQIP database.[21] Conditions included diabetes mellitus, COPD, active pneumonia infection, heart disease (defined as either a history of congestive heart failure within 30 days before surgery, or a history of myocardial infarction within the 6 months preceding surgery), hypertension requiring medical treatment, peripheral vascular disease, altered sensorium, cerebrovascular disease (with and without neurologic impairment), and impaired functional status.[21]

Using previously described methodology, an mFI score was calculated for each patient as the proportion of the total number of conditions present from the 11 conditions that were measured.[21] For example, if a patient presented