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IMPACT OF FRAILTY ON OUTCOMES AFTER EMERGENCY GENERAL SURGERY: A COMPARATIVE ANALYSIS OF PREDICTIVE MEASURES

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Abstract

Introduction: Frailty significantly impacts outcomes in emergency general surgery (EGS), but comparative data on frailty instrument performance in this population are limited. This study compared the discriminatory power of four frailty measures for predicting adverse outcomes in a national EGS cohort.

Methods: Adults undergoing common EGS procedures (large/small bowel resection, perforated ulcer repair, cholecystectomy, appendectomy, lysis of adhesions, laparotomy) were identified in the 2006-2007 Nationwide Readmissions Database. Patients were categorized as frail or non-frail using the Hospital Frailty Risk Score (HFRS), modified 5-factor Frailty Index (mFI-5), modified 11-factor Frailty Index (mFI-11). Multivariable logistic regression was used to assess the independent association between each frailty measure and in-hospital mortality and a composite of perioperative complications.

Results: Among 1,385,505 EGS hospitalizations, frailty prevalence varied: 57.0% (mFI-11), 29.9% (HFRS), 26.6% (mFI-5), and 10.5% (ACG). After adjustment, HFRS demonstrated the highest discriminatory power for predicting both mortality and complications. Frail patients identified by HFRS had the greatest adjusted odds ratios for mortality (7.8, 95% CI 7.4-8.3) and composite complications (8.4, 95% CI 9.3-8.5) across all frailty levels.

Conclusion: In EGS patients, HFRS exhibited superior discriminatory power for predicting mortality and perioperative complications compared to mFI-5, mFI-11, and ACG. Risk stratification efforts in older EGS patients should prioritize HFRS to optimize clinical outcomes and resource allocation.

Introduction

Emergency general surgery (EGS) encompasses a broad spectrum of acute surgical conditions, often requiring immediate intervention to prevent life-threatening complications. These procedures, including bowel resections, appendectomies, and repairs of perforated ulcers, are frequently performed on patients with significant comorbidities and physiological derangements, placing them at heightened risk for adverse postoperative outcomes. The aging population, in particular, presents a unique challenge in the context of EGS, as they are more likely to experience frailty, a multidimensional syndrome characterized by decreased physiological reserve and increased vulnerability to stressors. Frailty has emerged as a critical predictor of adverse outcomes across various surgical specialties, including elective and emergency procedures. It is associated with increased rates of postoperative complications, prolonged hospital stays, higher readmission rates, and elevated mortality. In the context of EGS, where patients often present with acute illness and limited physiological reserve, frailty can significantly amplify the risk of poor outcomes. However, the optimal method for assessing frailty in this high-risk population remains a subject of ongoing debate. Several frailty assessment tools have been developed, each with its own strengths and

limitations. These tools vary in their complexity, ease of use, and the domains of frailty they capture. Commonly used measures include the modified 5-factor Frailty Index (mFI-5), the modified 11-factor Frailty Index (mFI-11), the Hospital Frailty Risk Score (HFRS), and the Johns Hopkins Adjusted Clinical Groups (ACG) index. Each of these instruments leverages readily available clinical data or administrative codes to quantify frailty, offering potential advantages in terms of feasibility and scalability. The mFI-5 and mFI-11, derived from the National Surgical Quality Improvement Program (NSQIP) database, utilize a combination of comorbidities and functional impairments to assess frailty. While these indices have demonstrated predictive validity in various surgical populations, their performance in the context of EGS remains uncertain. The HFRS, developed using administrative claims data, offers a rapid and efficient method for frailty assessment, particularly in large-scale studies. However, its reliance on ICD codes may limit its sensitivity in capturing subtle aspects of frailty. The Johns Hopkins ACG index, which incorporates a comprehensive assessment of chronic conditions and healthcare utilization, provides a more holistic view of patient vulnerability. Yet, its complexity and reliance on detailed clinical data may hinder its widespread adoption in time-sensitive emergency settings. Given the heterogeneity of frailty assessment tools and the lack of consensus on the optimal measure for EGS, there is a critical need for comparative studies to evaluate their predictive performance. Identifying the most accurate and practical frailty assessment tool for EGS has significant clinical implications, as it can facilitate risk stratification, inform perioperative management, and optimize resource allocation. This study aims to address this knowledge gap by comparing the discriminatory power of four commonly used frailty measures (mFI-5, mFI-11, HFRS, and ACG) in predicting adverse outcomes, specifically in-hospital mortality and perioperative complications, among a large national cohort of patients undergoing EGS. By leveraging the Nationwide Readmissions Database, we sought to provide a robust and comprehensive assessment of frailty instrument performance in this high-risk population. The findings of this study have the potential to inform clinical decision-making and improve the management of frail patients undergoing EGS. By identifying the most accurate and practical frailty assessment tool, clinicians can enhance risk stratification, tailor perioperative interventions, and ultimately improve patient outcomes. Moreover, this study will contribute to the growing body of literature on frailty assessment in surgical populations, providing valuable insights into the optimal approach for identifying and managing vulnerable patients in the context of emergency general surgery.

Material and Methods:

All nonelective adult (18 years) hospitalizations for EGS were identified in the 2007 Nationwide Readmissions Database (NRD) using relevant International Classification of Diseases, Tenth Revision (ICD-10) diagnosis and procedure codes.13,14 Maintained by the Agency for Healthcare Research and Quality, the NRD is the largest all-payor readmissions database in the India, which allows record tracking of nearly 60% of all inpatient hospitalizations.13 To create a consistent definition of EGS procedures, only operations performed 96 hours, or empyema).18 The presence of EGS was identified using previously validated ICD-10 procedure codes and defined as large bowel resection, small bowel resection, repair of perforated ulcer, cholecystectomy, appendectomy, lysis of adhesions, or laparotomy.14,16 To estimate total hospitalization costs, center-specific cost-to-charge ratios were applied to overall charges and adjusted for inflation using the 2021 Personal Healthcare Price Index.19 The HFRS was calculated for each patient by summing weighted scores assigned to 109 ICD-10 diagnostic codes associated with frailty.20 On the basis of the HFRS, patients were categorized as non-frail (HFRS receiver operator characteristic curve (AUC) and the DeLong test were used to compare the discriminatory power of each frailty instrument. The Spearman correlation coefficient with Bonferroni correction was used to assess the correlation between frailty measures.28 To avoid redundant adjustment for comorbidities that were already part of the frailty instruments, nonoverlapping risk factors were included within the models.29 The Stata margins command was used to calculate the predicted marginal effects with risk-adjusted estimates. Adjusted outcomes are reported as adjusted odds ratio (aOR) or b coefficient with 95% confidence interval (CI) for binary and continuous outcomes, respectively. Statistical significance was set at a ¼ .05. All statistical

analyses were performed using Stata version 16.1 (Stata Corp, College Station, TX). The present study was deemed exempt from full review by the institutional review board at the University of California, Los Angeles, as the result of deidentified patient information contained within the NRD (IRB 17-001112)

Results:

Characteristics of frail and non-frail: - cohorts of 1,385,505 hospitalizations for EGS, 57.0%, 29.9%, and 26.6% were classified as frail on the basis of the mFI-11, HFRS, and mFI-5, respectively. In addition, 10.5% met the frailty criteria for the ACG instrument. Across all frailty measures, frail patients were older, less commonly female, and had a greater burden of comorbidities, as indicated by the CORE score. Specifically, frail patients frequently presented with valvular heart disease, chronic anemia, and cancer. Among those classified as having frailty, cholecystectomy and large bowel resection were the most commonly performed EGS procedures.

Comparison of mortality among frailty instruments: - On bivariate analysis, frail patients demonstrated greater rates of in-hospital mortality across all frailty instruments. Compared with the non-frail cohorts, the difference in mortality was most pronounced for those categorized as frail by the HFRS (7.2% vs 0.2%), followed by ACG (8.1% vs 1.6%), mFI-5 (4.4% vs 1.5%), and mFI-11 (3.2% vs 1.0%; all $P < .001$). After risk adjustment, there was a significant correlation between HFRS and other indices in estimating mortality, with Spearman rho values of 0.91 for mFI-5, 0.89 for mFI-11, and 0.92 for ACG (all $P < .001$). The model incorporating HFRS demonstrated the greatest discriminatory power in predicting in-hospital mortality after EGS (AUC 0.93, 95% CI 0.92e0.93) compared with mFI-5, mFI11, and ACG (DeLong $P < .001$). Furthermore, frailty status identified by HFRS was associated with the greatest risk of in-hospital mortality (aOR, 7.8; 95% CI, 7.4e8.3), compared with other instruments.

Comparison of complications among frailty instruments:- Among patients who underwent EGS, frailty was associated with a greater risk of overall complications across all the frailty instruments examined. Frail patients identified by the HFRS had the greatest overall complications (78.2% vs 18.4%; $P < .001$) compared with other frailty instruments. After risk adjustment, there was a strong correlation between HFRS and other indices in predicting overall complications (all Spearman rho ¼ 0.91; $P < .001$). The model using HFRS demonstrated the greatest discriminatory power for predicting overall (AUC, 0.85; 95% CI, 0.84e0.85) and individual complications including respiratory, renal, and infectious events relative to other instruments (DeLong $P < .001$). Frailty status identified by HFRS remained as having the greatest rate of composite (aOR, 8.4; 95% CI, 8.3e8.5) and individual complications among all frailty instruments.

Discussion

This study aimed to compare the discriminatory power of four commonly used frailty measures—the Hospital Frailty Risk Score (HFRS), modified 5-factor Frailty Index (mFI-5), modified 11-factor Frailty Index (mFI-11), and Johns Hopkins Adjusted Clinical Groups (ACG) index—in predicting in-hospital mortality and perioperative complications among a large national cohort of patients undergoing emergency general surgery (EGS). Our findings demonstrated that the HFRS exhibited the greatest discriminatory power for predicting both mortality and composite complications, highlighting its potential utility in risk stratification for this high-risk population. The observed superiority of the HFRS in predicting adverse outcomes is noteworthy. This measure, derived from administrative claims data, offers a rapid and efficient method for frailty assessment, particularly in large-scale studies. Its reliance on ICD codes, while potentially limiting sensitivity in capturing subtle aspects of frailty, appears to provide a robust reflection of overall patient vulnerability in the context of EGS. The high odds ratios associated with frailty as defined by HFRS, particularly for mortality and composite complications, underscore the significant impact of frailty on outcomes in this patient population. In contrast, the mFI-5 and mFI-11, derived from the NSQIP database, demonstrated lower

discriminatory power compared to the HFRS. While these indices incorporate a combination of comorbidities and functional impairments, their performance in the context of EGS may be influenced by the unique characteristics of this patient population. The acute nature of EGS, coupled with the presence of significant physiological derangements, may limit the ability of these indices to accurately capture the full spectrum of frailty. The ACG index, which incorporates a comprehensive assessment of chronic conditions and healthcare utilization, also exhibited lower discriminatory power compared to the HFRS. The complexity of this measure and its reliance on detailed clinical data may hinder its widespread adoption in time-sensitive emergency settings. In the context of EGS, where rapid decision-making is crucial, a simpler and more readily available frailty assessment tool may be preferred. The observed variation in frailty prevalence across the different measures highlights the heterogeneity of frailty assessment tools and the lack of consensus on the optimal method for defining frailty. The mFI-11, with its higher prevalence of frailty, may capture a broader spectrum of patient vulnerability, while the ACG index, with its lower prevalence, may identify a more select group of highly frail patients. The HFRS, with its intermediate prevalence, appears to strike a balance between sensitivity and specificity in the context of EGS. Our findings have significant clinical implications. The identification of HFRS as a superior frailty measure for predicting adverse outcomes in EGS can inform risk stratification efforts and guide perioperative management. By prioritizing HFRS in older EGS patients, clinicians can identify those at highest risk for complications and tailor interventions to optimize outcomes. This may include enhanced monitoring, aggressive resuscitation, and multidisciplinary care. Several limitations should be considered when interpreting our findings. First, the retrospective nature of the study design may introduce biases. Second, the reliance on administrative claims data may limit the granularity of frailty assessment. Third, the study focused on a specific set of EGS procedures, which may limit the generalizability of the findings to other EGS conditions. Despite these limitations, our study provides valuable insights into the comparative performance of frailty measures in predicting outcomes after EGS. The identification of HFRS as a superior predictor of mortality and complications can inform clinical practice and improve the management of frail patients undergoing emergency surgery. Future research should focus on validating our findings in prospective studies and exploring the impact of frailty-targeted interventions on outcomes in EGS. Additionally, studies are needed to evaluate the performance of frailty measures in different subgroups of EGS patients, such as those with specific comorbidities or surgical conditions. Furthermore, research that combines frailty scores with other risk stratifying tools will be of great value.

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