Does frailty predict readmission and mortality in diverticulitis? A nationwide analysis

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INTRODUCTION: Diverticulitis is a major health concern in the United States affecting up to 25% of elderly population. It is unknown if frailty increases the risk of recurrent diverticulitis. The aim of our study is to identify the association between frailty and recurrence of diverticulitis.

METHODS: We performed a retrospective analysis of the Nationwide Readmissions Database 2019 and included geriatric (65 years or older) patients admitted for acute complicated diverticulitis (ACD) who were managed nonoperatively between January and June and had a 6-month follow-up. Patients were stratified into nonfrail, prefrail, and frail groups using the five-factor modified frailty index. Primary outcome was readmission due to ACD or acute uncomplicated diverticulitis (AUD) at 1 and 6 months after the admission. Secondary outcome was mortality. Multivariable regression analysis was performed to identify the predictors of recurrent diverticulitis and outcomes.

RESULTS: We identified 10,807 patients (nonfrail, 1,953; prefrail, 4,616; frail, 4,238). No differences were found between the groups in readmissions for recurrent ACD and AUD at 1 month after discharge. However, nonfrail patients and prefrail had higher rates of ACD ($p = 0.009$) and AUD ($p < 0.001$) at 6 months after index admission. Frail patients had higher mortality on index admission ($p < 0.001$) and at 6 months ($p < 0.001$). On multivariable regression analyses, frailty was a predictor of mortality on index (adjusted odds ratio, 1.99; $p < 0.001$) and readmissions (adjusted odds ratio, 3.05; $p < 0.001$).

CONCLUSION: Frailty was not identified as a predictor of developing recurrent diverticulitis; however, frail patients are at increased risk of mortality once they develop diverticulitis. Optimal management for frail patients with diverticulitis must be defined to improve outcomes. (*J Trauma Acute Care Surg.* 2025;00: 00–00. Copyright © 2025 Wolters Kluwer Health, Inc. All rights reserved.)

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

KEY WORDS: Frailty; acute diverticulitis; geriatrics.

Each year, nearly one million older adults are admitted to the hospital for emergency general surgery (EGS) conditions, with over 25% undergoing operative management during their hospitalization.[1] Diverticular disease affects almost 50% adults older than 60 years and more than half of patients 80 years or older.[2] Among these patients, one fourth experience acute colonic diverticulitis, which is associated with increased morbidity and often necessitates prompt medical or surgical intervention.[3]

Frailty, a clinical syndrome characterized by diminished physiological reserve, significantly increases the risk of adverse outcomes in older patients undergoing surgery.[4] This reduction in physiological reserve predisposes frail patients to poor postoperative outcomes. Although acute diverticulitis tends to recur, nonoperative management remains the standard of care, particularly for vulnerable populations.[5]

While the relationship between frailty and outcomes in the context of EGS patients has been studied,[6] the direct impact of frailty on outcomes in acute diverticulitis remains underexplored. The aim of this study was to assess the relationship between frailty and readmissions for acute diverticulitis among older adults. We hypothesized that frailty predisposes patients to recurrent acute diverticulitis and increases mortality in the geriatric population.

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PATIENTS AND METHODS

Study Design and Population

We performed a retrospective analysis of the Nationwide Readmissions Database (NRD) for the year 2019. Nationwide Readmissions Database is a large database that is a part of the Healthcare Cost and Utilization Project. It contains information on both single admissions and patients who are readmitted to the hospital and provides data on 17 million admissions annually from over 30 states regardless of the cause of readmissions, making it the most comprehensive database on patient readmissions in the United States. The NRD uses an anonymous patient identifier to track readmissions within a given calendar year. We adhered to the Strengthening the Reporting of OBservational studies in Epidemiology guidelines (see Supplemental Digital Content, Supplementary Data 1, http://links.lww.com/TA/E587). The institutional review board granted this study exemption from approval because the NRD contains only deidentified data.

Inclusion Criteria

We included all geriatric (65 years or older) patients admitted with a diagnosis of acute complicated diverticulitis (ACD) who were managed nonoperatively between January to June and were followed for the next 6 months. We included patients admitted between January and June to ensure a full 6-month follow-up period, as the NRD provides readmission data only for the calendar year.

Patient Stratification

Patients were stratified into nonfrail, prefrail, and frail groups. Frailty was evaluated using the five-factor modified frailty index (mFI-5). This index assigns 1 point for each of the following comorbidities: hypertension (HTN) requiring medication, diabetes mellitus (DM), chronic obstructive pulmonary disease (COPD), congestive heart failure (CHF), and dependent functional status. The mFI-5 is calculated using a cumulative count. Patients were considered nonfrail if the score is 0, prefrail if score is 1, and frail if the score is ≥2.

Data Points

We extracted data related to patient demographics (age, sex), patient comorbidities (HTN, DM, COPD, CHF, dependent functional status), weekend admission, severity of illness, health care coverage, and median household income quartile. Hypertension defined as physician-diagnosed HTN requiring medication, DM defined as having a history of diabetes, COPD defined as a history of emphysema or chronic bronchitis, CHF defined as documented heart failure requiring medications, and depended functional status was defined as requiring assistance with activities of daily living. To measure the severity of illness, we used the NRD-validated variable "all patient redefined diagnosis related groups severity of illness subclass (APRDRG)_Severity." This variable determines the overall severity of illness in terms of physiologic decompensation or loss of organ function and categorizes the patients into four grades: grade 1, minor; grade 2, moderate; grade 3, major; and grade 4, extreme loss of function groups. We also collected data regarding patient complications during index admission and readmission within 6 months, hospital length of stay, and risk of mortality. To calculate the median household income quartile, we used the NRD validated variable ZIPINC_QRTL, which provides a quartile classification of the estimated median household income of residents in the patient's ZIP code.

Outcomes

The primary outcome was readmission due to ACD or acute uncomplicated diverticulitis (AUD) at 1 month and 6 months after the index admission. The secondary outcome was rate of mortality. Complicated diverticulitis was defined as the formation of abscess, fistula, bowel obstruction, or frank perforation in patients diagnosed with diverticulitis.

Statistical Analysis

Descriptive statistics were performed for baseline characteristics of the study population. Kolmogorov-Smirnov test for normality was performed on all continuous variables. Normally distributed variables were presented as means with SDs. Nonnormally distributed variables were presented as medians with interquartile ranges. Categorical variables were reported as counts and proportions. We performed a univariable analysis to determine the association between each variable and the binary outcomes. Pearson's χ^2 test was used for categorical variables to analyze the differences between different groups, the one-way analysis of variance for continuous normally distributed variables, and the Kruskal-Wallis test for continuous skewed variables. To account for potential survivorship bias due to higher mortality among frail patients, we performed a Kaplan-Meier survival analysis to compare recurrence-free survival among frailty groups. Mortality was treated as a censoring event, ensuring that patients who died were excluded from recurrence rate calculations. Differences between groups were assessed using the log-rank (Mantel-Cox) test, with a p value of <0.05 considered statistically significant.

Multivariable Regression Analysis

We performed multivariable binary logistic regression analyses to identify the independent predictors of recurrent diverticulitis. Potential confounding variables were entered into the model based on existing literature and univariable analysis demonstrating $p < 0.2$. The following variables were accounted for patient demographics, comorbidities, weekend admission, severity of illness, health care coverage, and median household income quartile. The results of logistic regression analyses were reported as odds ratios with 95% confidence intervals (CIs). Alpha (α) was set at 5%, and a p value of <0.05 was considered statistically significant. All statistical analyses were performed using the Statistical Package for Social Sciences (version 29; SPSS, Inc., Armonk, NY).

RESULTS

Study Population

Over the study period, 10,807 patients were identified who met the inclusion criteria, of which 4,238 (39.2%) were frail, 4,616 (42.7%) were prefrail, and 1,953 (18%) were nonfrail. A detailed patient flow chart illustrating the classification process and patient distribution is presented in Figure 1.

Baseline Characteristics

The mean (SD) age of the study cohort was 76 (8) years, and nearly two thirds of patients were female (64.8%). Close to one quarter (24.6%) of patients were admitted to the hospital on weekends, and 8.3% underwent intervention as an elective procedure. Frail patients were more likely to be older ($p < 0.001$) and more likely to be male ($p = 0.010$). Moreover, Medicare constituted the most common health care coverage (90.6%) followed by private insurance (7.6%), and more than 75% of the population had median household income in the higher three quartiles. However, frail patients were more likely to be covered by Medicare and in the lower median household income quartile.

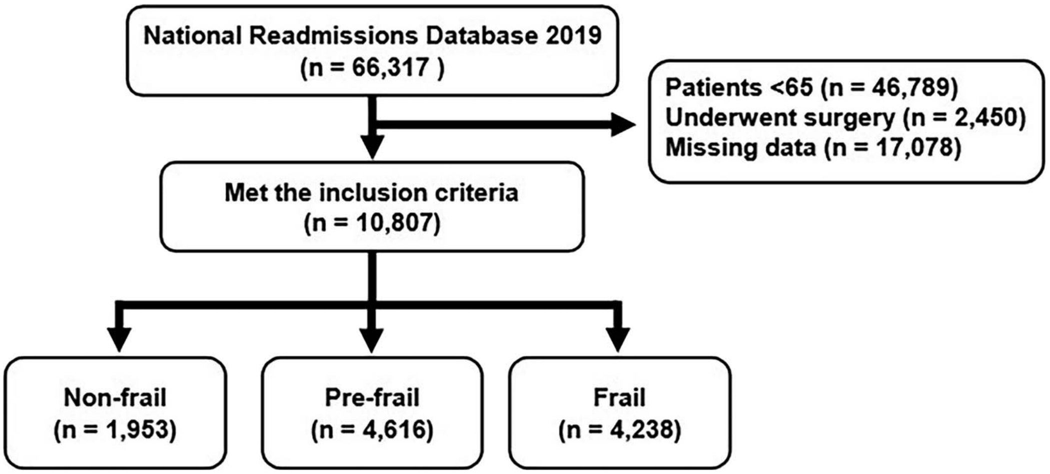

Figure 1. Patient flow chart.

Overall, HTN was the most common comorbidity (75.5%), followed by DM (24.8%), COPD (17.9%), CHF (15%), and dependent functional status (3.2%). Unsurprisingly, patients who were frail had a significantly higher rate of HTN, DM, COPD, CHF, and dependent functional status. Approximately two thirds of the study population presented with minor or moderate severity of illness. However, patients in the frail group had a significantly higher rate of extreme illness severity than the other groups ($p < 0.001$). Table 1 summarizes the baseline characteristics of the study population stratified by frailty status.

Univariable Analysis of Outcomes

Overall, 10.5% (n = 1,134) of patients were readmitted within 1 month, with 936 cases attributed to ACD and 198 to AUD. There was no statistically significant difference between the study groups ($p > 0.05$) in readmission rates at 1 month.

TABLE 1. Baseline Characteristics of the Study Population

Variables	Overall (N = 10,807)	NF (n = 1,953)	PF (n = 4,616)	F (n = 4,238)	*p*
Demographics					
Age, mean (SD), y	76 (8)	73 (7)	75 (7)	77 (7)	**<0.001**
Sex, female, n (%)	6,998 (64.8)	1,300 (66.6)	3,025 (65.5)	2,673 (63.1)	**0.010**
Illness severity, n (%)					**<0.001**
Minor	2,839 (26.3)	822 (42.1)	1,471 (31.9)	546 (12.9)	
Moderate	4,454 (41.2)	737 (37.7)	1,940 (42)	1,777 (41.9)	
Major	2,408 (22.3)	277 (14.2)	869 (18.8)	1,262 (29.8)	
Extreme	1,106 (10.2)	117 (6)	336 (7.3)	653 (15.4)	
Comorbidities, n (%)					
HTN	8,155 (75.5)	0 (0)	4,033 (87.4)	4,122 (97.3)	**<0.001**
Diabetes	2,677 (24.8)	0 (0)	205 (4.4)	2,472 (58.3)	**<0.001**
COPD	1,938 (17.9)	0 (0)	268 (5.8)	1,670 (39.4)	**<0.001**
CHF	1,616 (15)	0 (0)	73 (1.6)	1,543 (36.4)	**<0.001**
Dependent functional status	347 (3.2)	0 (0)	37 (0.8)	310 (7.3)	**<0.001**
Weekend admission, n (%)	2,658 (24.6)	457 (23.4)	1,155 (25)	1,046 (24.7)	0.373
Primary payer, n (%)					**<0.001**
Medicare	9,783 (90.6)	1,703 (87.2)	4,170 (90.3)	3,910 (92.4)	
Medicaid	68 (0.6)	10 (0.5)	30 (0.6)	28 (0.7)	
Private insurance	818 (7.6)	217 (11.1)	368 (8)	233 (5.5)	
Self-pay	37 (0.3)	9 (0.5)	13 (0.3)	15 (0.4)	
Other	101 (0.9)	14 (0.7)	34 (0.7)	52 (1)	
Median household income quartile, n (%)					**<0.001**
Lower ($1–$37,999)	2,445 (22.6)	339 (17.1)	949 (20.6)	1,157 (27.3)	
Lower-middle ($38,000–$47,999)	2,682 (24.8)	460 (23.5)	1,120 (24.2)	1,102 (26)	
Upper-middle ($48,000–$63,999)	2,943 (27.2)	543 (27.9)	1,314 (28.3)	1,086 (25.6)	
Upper (≥$64,000)	2,737 (25.4)	611 (31.5)	1,233 (26.8)	893 (21.2)	

*Bold font indicates statistical significance ($p < 0.05$).
F, frail; NF, nonfrail; PF, prefrail.

TABLE 2. Univariable Analysis of Outcomes

Variables	Overall (N = 10,807)	NF (n = 1,953)	PF (n = 4,616)	F (n = 4,238)	p
Readmissions at 1 mo, n (%)					
Recurrent ACD	936 (8.7)	156 (8)	411 (8.9)	367 (8.7)	0.450
Recurrent AUD	198 (1.8)	27 (1.4)	88 (1.9)	83 (2)	0.258
Readmissions at 6 mo, n (%)					
Recurrent ACD	1,785 (16.5)	332 (17)	810 (17.5)	643 (15)	**0.009**
Recurrent AUD	591 (5.5)	139 (7.1)	247 (5.9)	178 (4.2)	**<0.001**
Mortality, n (%)					
At index admission	351 (3.2)	38 (1.9)	110 (2.4)	203 (4.8)	**<0.001**
At 6 mo	262 (2.4)	23 (1.2)	73 (1.6)	166 (3.9)	**<0.001**

*Bold font indicates statistical significance ($p < 0.05$).
F, frail; NF, nonfrail; PF, prefrail.

At the 6-month mark, however, nonfrail and prefrail patients exhibited higher rates of ACD and AUD. Mortality rates were significantly higher among frail patients both at the index admission and at the 6-month readmission. Table 2 outlines the univariable analysis of outcomes comparing the three groups. Given the observed differences in mortality among frailty groups, we performed a Kaplan-Meier survival analysis to account for potential survivorship bias. The log-rank (Mantel-Cox) test demonstrated no statistically significant difference in recurrence-free survival among the frailty groups ($p = 0.405$).

Multivariable Regression Analysis of Outcomes

After adjusting for confounding factors (patient demographics, Injury Severity Score) in multivariable regression analysis, frailty was not significantly associated with the recurrence of diverticulitis (adjusted odds ratio [aOR], 0.91; 95% CI, 0.79–1.04; $p = 0.157$). However, frailty was significantly associated with increased index admission mortality (aOR, 1.99; 95% CI, 1.39–2.84; $p < 0.001$) and readmission mortality (aOR, 3.05; 95% CI, 1.96–4.77; $p < 0.001$). Table 3 outlines the independent effect of frailty on recurrent diverticulitis and related outcomes.

Subanalysis

When stratifying our patient population by sex, both groups had similar rates of recurrent AUD at 1 month. However, female patients had a significantly higher rates of recurrent ACD at 1 month as well as both recurrent ACD and AUD at 6 months. Nevertheless, both groups had similar rates of mortality. Table 4 demonstrates the subanalysis of outcomes stratified by sex.

TABLE 3. Multivariable Regression Analysis—Independent Effect of Frailty on Recurrent Diverticulitis

	NF vs. PF vs. F		
Outcome Measures	**aOR**	**95% CI**	**p**
Recurrent diverticulitis	0.91	0.79–1.04	0.157
Index admission mortality	1.99	1.39–2.84	**<0.001**
Readmission mortality	3.05	1.96–4.77	**<0.001**

*Bold font indicates statistical significance ($p < 0.05$).
F, frail; NF, nonfrail; PF, prefrail.

DISCUSSION

In this study, we analyzed a national readmission database to explore the relationship between frailty and recurrent acute diverticulitis. Specifically, we examined the impact of frailty status, as defined by the mFI-5, on diverticulitis recurrence and its associated outcomes. Our findings indicate that, while frailty is not a predictor of recurrent diverticulitis, it is linked to higher mortality rates. This study bears importance, as there are limited data on the role of frailty in patients experiencing recurrent diverticulitis and their outcomes.

Evidence indicates that diverticulitis is a recurrent condition, with overall recurrence rates exceeding 30% and complication rates reaching up to 4%.[7] Evidence suggests that over 60% of recurrences occur within the first 6 months following the initial episode,[8] while other studies report that recurrence is most likely within the early months after the initial presentation.[9] In contrast, our study found that most readmissions occurred 6 months or later after the index admission, with only 10% occurring within the first month. This differing trajectory highlights potential variations in the timeline of recurrence, suggesting the need to reevaluate follow-up care strategies for patients at risk of recurrent diverticulitis.

TABLE 4. Subanalysis of Outcomes Stratified by Gender

Variables	Overall (N = 10,807)	Male (n = 3,809)	Female (n = 6,998)	p
Frailty status, n (%)				**0.010**
Frail	4,238 (39.2)	1,565 (41.1)	2,673 (38.2)	
Prefrail	4,616 (42.7)	1,591 (41.8)	3,025 (43.2)	
Nonfrail	1,953 (18.1)	653 (17.1)	1,300 (16.6)	
Readmissions at 1 mo, n (%)				
Recurrent ACD	936 (8.7)	296 (7.8)	640 (9.1)	**0.015**
Recurrent AUD	198 (1.8)	69 (1.8)	129 (1.8)	0.906
Readmissions at 6 mo, n (%)				
Recurrent ACD	1,785 (16.5)	552 (14.5)	1,233 (17.6)	**<0.001**
Recurrent AUD	591 (5.5)	172 (4.5)	419 (6.0)	**0.001**
Mortality, n (%)	632 (5.8)	239 (6.3)	393 (5.6)	0.163

*Bold font indicates statistical significance ($p < 0.05$).

In this study, we used the mFI-5, consistent with prior studies investigating frailty in trauma patients using the NRD.[10–12] While we acknowledge that the mFI-5 is a limited surrogate for true physiologic frailty, particularly in patients with well-controlled comorbidities, its use is dictated by the variables available within large administrative data sets, which lack functional or performance-based measures.[13–16] Although frailty has been proven to increase the risk of hospital readmission by up to 45%,[17] this analysis revealed that there were no statistically significant differences in readmission rates for ACD and AUD among frail, prefrail, and nonfrail patients at the 1-month mark. This finding suggests that frailty may not have a direct influence on immediate readmission rates following treatment for diverticulitis. Similar findings have been reported, stating that the rates of recurrence of diverticulitis are low after successful medical management.[2] This may indicate that other factors, possibly related to the clinical management of diverticulitis, may play a more significant role than frailty in determining short-term readmission outcomes. Interestingly, at the 6-month mark, our findings reveal that nonfrail and prefrail patients exhibited higher rates of readmission due to recurrent ACD and AUD compared with frail patients. Similar to these observations, existing literature has noted that younger, healthier patients with diverticulitis tend to exhibit higher complication rates.[18]

Frailty is a crucial factor in assessing risk for older patients undergoing EGS. It has consistently proven to be a more reliable predictor of morbidity and mortality than age alone.[2,6] Aligning with the existing literature, our study identified frailty as an independent predictor of mortality, unaffected by confounding factors.[19,20] The effect of frailty on mortality has been extensively described among surgical specialties, with this condition being a predictor of mortality in patients undergoing cardiac surgery,[21] orthopedic procedures,[22] and neurosurgery.[23] In the context of EGS, frailty has also been found to impact mortality rates substantially, even within patients undergoing low-risk procedures.[24] In accordance with this evidence, we found an almost twofold increased risk of mortality on index admission and a threefold increased risk of mortality at 6 months among frail patients with recurrent acute complicated and uncomplicated diverticulitis. Moreover, frail patients exhibited the most severe clinical presentations, with higher rates of extreme illness severity, suggesting that their frailty may have predisposed them to more severe disease progression and, ultimately, death.

Our findings highlight the significant impact of frailty on mortality in elderly patients with diverticulitis, emphasizing the need for individualized risk stratification. While our study does not directly assess whether earlier surgical intervention or minimally invasive approaches improve outcomes, these factors warrant further investigation. Given the increased vulnerability of frail patients, closer follow-up, optimization of comorbidities, and multidisciplinary management may be critical in mitigating risks.

While this study provides valuable insights into the relationship between frailty and recurrent diverticulitis outcomes, it is not without limitations. First, the retrospective nature of the analysis may introduce biases inherent in the data collection process, limiting the ability to establish causation. Additionally, the use of the mFI-5 to categorize frailty may not capture the full spectrum of frailty in older adults, as it is based on a limited number of comorbidities and may not reflect functional status comprehensively. Furthermore, the reliance on the NRD means that patient-specific factors, such as psychosocial elements and lifestyle behaviors, which could influence outcomes, were not accounted for. One limitation of this study is the lack of long-term mortality data beyond the 6-month follow-up period. Since frail patients had higher mortality at both the index admission and readmission, it is possible that deaths occurring outside the study window could further influence readmission rates. Additionally, the NRD does not allow for differentiation between readmissions directly related to diverticulitis and those because of other complications arising from the initial hospitalization. This limitation underscores the need for future studies with more granular data to better characterize the long-term outcomes and causes of readmission in this population.

CONCLUSION

Frailty was not identified as a predictor of recurrent diverticulitis; however, frail patients are at an increased risk of both short- and long-term mortality once they develop the condition. These findings highlight the importance of closely monitoring frail patients during follow-up to better understand and address factors contributing to their outcomes over time.

AUTHORSHIP

O.H., C.C., C.S., L.J.M., and B.J. designed this study. O.H., M.H.K., F.C.D., C.C., T.A., M.A.M., and B.J. searched the literature. O.H., M.A.M., F.C.D., C.S., T.A., L.C., and B.J. collected the data. O.H., M.H.K., L.J.M., L.C., and B.J. analyzed the data. All authors participated in data interpretation and manuscript preparation.

DISCLOSURE

Conflicts of Interest: Author Disclosure forms have been supplied and are provided as Supplemental Digital Content (http://links.lww.com/TA/E588).

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