The Geriatric Nutritional Risk Index as a predictor of complications in geriatric trauma patients

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BACKGROUND: Malnutrition is associated with increased morbidity and mortality after trauma. The Geriatric Nutritional Risk Index (GNRI) is a validated scoring system used to predict the risk of complications related to malnutrition in nontrauma patients. We hypothesized that GNRI is predictive of worse outcomes in geriatric trauma patients.

METHODS: This was a single-center retrospective study of trauma patients 65 years or older admitted in 2019. Geriatric Nutritional Risk Index was calculated based on admission albumin level and ratio of actual body weight to ideal body weight. Groups were defined as major risk (GNRI <82), moderate risk (GNRI 82–91), low risk (GNRI 92–98), and no risk (GNRI >98). The primary outcome was mortality. Secondary outcomes included ventilator days, intensive care unit length of stay (LOS), hospital LOS, discharge home, sepsis, pneumonia, and acute respiratory distress syndrome. Bivariate and multivariable logistic regression analyses were performed to determine the association between GNRI risk category and outcomes.

RESULTS: A total of 513 patients were identified for analysis. Median age was 78 years (71–86 years); 24 patients (4.7%) were identified as major risk, 66 (12.9%) as moderate risk, 72 (14%) as low risk, and 351 (68.4%) as no risk. Injury Severity Scores and Charlson Comorbidity Indexes were similar between all groups. Patients in the no risk group had decreased rates of death, and after adjusting for Injury Severity Score, age, and Charlson Comorbidity Index, the no risk group had decreased odds of death (odds ratio, 0.13; 95% confidence interval, 0.04–0.41) compared with the major risk group. The no risk group also had fewer infectious complications including sepsis and pneumonia, and shorter hospital LOS and were more likely to be discharged home.

CONCLUSIONS: Major GNRI risk is associated with increased mortality and infectious complications in geriatric trauma patients. Further studies should target interventional strategies for those at highest risk based on GNRI. (*J Trauma Acute Care Surg.* 2022;93: 195–199. Copyright © 2022 Wolters Kluwer Health, Inc. All rights reserved.)

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KEY WORDS: Malnutrition; nutritional assessment; Geriatric Nutrition Risk Index; geriatric; outcome.

In many surgical patients, malnutrition is correlated with poor clinical outcomes.[1–3] However, the prevalence of malnutrition in geriatric trauma patients is unknown, and its relationship to clinical outcomes is poorly defined. In addition, there are no widely accepted screening tools to identify malnourished geriatric trauma patients or the impact on clinical outcomes. Current management guidelines from American Society for Parenteral and Enteral Nutrition and the American College of Surgeons do not recommend specific nutritional screening strategies, assessment strategies, or interventions to guide clinical care.[4–6]

The Geriatric Nutritional Risk Index (GNRI) was first described in 2005 as a tool to identify medical patients at risk of malnutrition-related morbidity and mortality.[7] This score uses albumin and ideal body weight (IBW), has been prospectively validated in hospitalized geriatric patients, and correlates with frailty and sarcopenia.[8–11] The populations in which this scoring index has been validated have since been expanded, and the GNRI has been shown to be predictive of complications in a large variety of surgical procedures, including orthopedic, surgical oncology, colorectal, and general surgery, but it has been applied to trauma patients in a limited number of studies.[9,12–16]

In this study, we aimed to define the prevalence and severity of malnutrition in geriatric trauma patients using GNRI and to evaluate the association between GNRI and clinical outcomes. We hypothesized that the GNRI can be used to screen geriatric trauma patients and that a low GNRI (high risk of malnutrition) would be associated with worse clinical outcomes.

PATIENTS AND METHODS

After approval by institutional and hospital review boards, a retrospective cohort study was conducted of trauma patients 65 years or older admitted to an urban level 1 trauma center from January 1 to December 31, 2019. This study follows the Strengthening the Reporting of Observational Studies in Epidemiology guidelines for reporting observational studies, and a complete checklist has been uploaded as Supplemental Digital Content (Supplementary Data 1, http://links.lww.com/TA/C410).[17] Demographic, injury, and outcome data were obtained from the institution's trauma registry and supplemented with manual review of the electronic medical record. Only patients who had an albumin level drawn within 24 hours of hospital arrival were included. This stipulation was necessary for calculation of the GNRI.

Outcome Measures

Each patient's GNRI score was determined using the equation described previously by Bouillanne et al.[7] The IBW was calculated according to the Lorentz formula, and the GNRI score was calculated with admission albumin level and ratio of actual body weight to IBW.[7]

Lorentz formula: IBW male = (height − 100 − ((height − 150)/4)

IBW female = (height − 100 − ((height − 150)/2)

GNRI score: GNRI = [1.489 × albumin (g/L)] + [41.7 × (weight/IBW)]

Groups were defined as major risk (GNRI <82), moderate risk (GNRI 82–91), low risk (GNRI 92–98), and no risk (GNRI >98) based on prior studies.[9,12,14–16] The primary outcome was mortality. Secondary outcomes included intensive care unit

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TABLE 1. Patient Demographics by Nutrition-Related Risk Groups

	Major (n = 24)	Moderate (n = 66)	Low (n = 72)	No (n = 351)	*p*
Age	84 (77–89)	83 (73–88)	84 (73–90)	76 (71–84)	<0.001
	84 (77–89)			76 (71–84)	0.02*
		83 (73–88)		76 (71–84)	0.005**
			84 (73–90)	76 (71–84)	0.004†
Female sex	15 (63%)	40 (61%)	38 (53%)	149 (43%)	0.011
Blunt injury	24 (100%)	66 (100%)	72 (100%)	349 (99%)	0.82
Fall	23 (96%)	62 (94%)	61 (85%)	275 (78%)	0.45
ISS	10 (9–17)	10 (9–17)	14 (9–17)	9 (5–17)	0.09
CCI	5 (4–7)	6 (5–7)	5 (4–6)	5 (4–7)	0.06
Admission albumin	2.2 (1.8–2.7)	2.9 (2.5–3.1)	3.0 (2.7–3.4)	3.4 (3.1–3.7)	<0.001
	2.2 (1.8–2.7)			3.4 (3.1–3.7)	<0.001*
		2.9 (2.5–3.1)		3.4 (3.1–3.7)	<0.001**
			3.0 (2.7–3.4)	3.4 (3.1–3.7)	<0.001†
	2.2 (1.8–2.7)		3.0 (2.7–3.4)		<0.001‡
Body mass index	18 (16–20)	21 (19–23)	23 (20–25)	27 (25–31)	<0.001
	18 (16–20)			27 (25–31)	<0.001*
		21 (19–23)		27 (25–31)	<0.001**
			23 (20–25)	27 (25–31)	<0.001†
	18 (16–20)		23 (20–25)		0.02‡
Race					0.08
White	10 (42%)	34 (52%)	44 (61%)	197 (56%)	
Black	6 (25%)	7 (11%)	8 (11%)	64 (18%)	
Hispanic	1 (4%)	0 (0%)	0 (0%)	4 (1%)	
Other	6 (25%)	25 (38%)	17 (24%)	81 (23%)	

Categorical data are presented as n (%), and continuous data as median (interquartile range).
Post hoc tests of significance, $p < 0.05$.
Post hoc tests:
*Major risk compared with no risk.
**Moderate risk compared with no risk.
†Low risk compared with no risk.
‡Major risk compared with low risk.

(ICU) length of stay (LOS), hospital LOS, sepsis, pneumonia, acute respiratory distress syndrome, 30-day readmission after hospital discharge, unplanned ICU admission, and sacral decubitus ulcer, which were obtained from the prospectively maintained trauma database, where these outcome measures are recorded according to the standardized definitions by the National Trauma Data Bank.[18]

Statistical Analysis

Patients within each GNRI risk category were compared. Median values with interquartile ranges were used to describe continuous data, and discrete data were reported as frequency and percentage. χ^2 and Kruskal-Wallis tests were used to compare categorical and continuous demographic data and outcomes, respectively, with post hoc tests and Bonferroni correction for multiple comparisons. *p* Values <0.05 were considered significant. Multivariable log-binomial regression models were used to assess the relationship between GNRI categories and outcomes of interest. All associations were reported as odds ratios with 95% confidence intervals. Covariates known or suspected to be confounders between GNRI category and outcome were chosen a priori: age, Injury Severity Score (ISS), and Charlson Comorbidity Index (CCI). All data analyses were completed using R version 3.53 (R Core Team, 2013, R: A language and environment for statistical computing; R Foundation for Statistical Computing, Vienna, Austria).

RESULTS

Patient and Injury Characteristics

Five hundred thirteen geriatric trauma patients admitted to our trauma center in 2019 who had an albumin level drawn within 24 hours of admission were identified for analysis. Median age was 78 (71–86) years. Patients had a median ISS of 10 (6–17), and 99% were injured by a blunt mechanism. The majority of patients were hospitalized after falls (82%). Based on GNRI scores, 24 patients (4.7%) were identified as major risk, 66 (12.9%) as moderate risk, 72 (14%) as low risk, and 351 (68.4%) as no risk (Table 1). Injury Severity Score and CCI were similar between all groups.

Comparison of Nutritional Risk Groups

Body mass index and albumin levels increased GNRI score, with patients in the major risk category having the lowest body mass index and albumin level, consistent with the definition of the GNRI score. In addition, patients in the major risk category were older with a higher percentage of female patients than the no risk category ($p = 0.02$). There were no significant differences in racial distribution between GNRI categories. In analysis of our primary outcome on bivariate analysis, the major risk group had higher rates of death when compared with the no risk group (Table 2). On multivariable logistic regression after adjusting for ISS, age, and CCI, all groups with malnutrition had increased odds of death compared with the no risk group (Table 3).

Patients who died were analyzed as having a 30-day hospital LOS. Overall, patients in the major risk group had higher

TABLE 2. Patient Outcomes by Nutrition-Related Risk Groups

	Major (n = 24)	Moderate (n = 66)	Low (n = 72)	No (n = 351)	*p*
Pneumonia	2 (8%)	0 (0%)	1 (1%)	3 (1%)	0.008
Sepsis	3 (13%)	0 (0%)	1 (1%)	5 (1%)	<0.001
Death	6 (25%)	8 (12%)	7 (10%)	16 (5%)	<0.001
	6 (25%)			16 (5%)	0.001*
ARDS	1 (4%)	0 (0%)	0 (0%)	0 (0%)	<0.001
ICU LOS	1 (0–6)	0 (0–2)	1 (0–3)	0 (0–2)	0.39
Hospital LOS	14 (6–25)	7 (3–11)	6 (3–12)	5 (3–10)	0.002
	14 (6–25)			5 (3–10)	0.01*
30-d Readmission	2 (8%)	9 (14%)	13 (18%)	41 (12%)	0.45
Unplanned ICU admission	3 (13%)	5 (8%)	3 (4%)	11 (3%)	0.08
Sacral decubitus ulcer	0 (0%)	0 (0%)	0 (0%)	1 (0%)	0.93
Nonhome discharge	19 (79%)	39 (59%)	46 (64%)	198 (56%)	0.13

Categorical data presented as n (%), and continuous data as median (interquartile range).
Post hoc tests of significance, $p < 0.05$.
Post hoc tests:
*Major risk compared with no risk.
ARDS, acute respiratory distress syndrome.

TABLE 3. Multivariable Analysis, Mortality

	Odds Ratio	95% Confidence Interval
Major (n = 24)	7.4	2.3–22.0
Moderate (n = 66)	2.9	1.1–7.3
Low (n = 72)	2.3	0.8–5.9

rates of infectious complications including pneumonia and sepsis when compared with the no risk group (Table 2). In addition, the major risk group had longer hospital LOS and was less likely to be discharged home. There were no statistically significant differences in 30-day readmission, unplanned ICU admission, or sacral decubitus ulcers between the groups.

DISCUSSION

The relationship between malnutrition and outcomes in geriatric trauma patients is poorly defined, and there is currently no widely accepted screening tool to identify and predict the malnourished at highest risk for poor outcomes. After controlling for age, ISS, and CCI, geriatric trauma patients with major nutritional risk by GNRI score had higher mortality, more infectious complications, and longer hospital LOS and were less likely to be discharged home.

Overall, geriatric patients are at elevated risk of malnutrition because of the prevalence of disease, disability, polypharmacy, inability to chew food adequately, and dysphagia.[19] In the present study, 32% of patients had malnutrition based on GNRI score. Because of comorbidities and age-related physiologic compromise, geriatric patients are also at elevated risk for clinical manifestations of malnutrition after undergoing surgery, including sarcopenia and muscle atrophy.[20,21] Malnutrition can contribute to muscle weakness, frailty, reduced physical function, and resultant decreased quality of life postoperatively.[21] In addition, malnutrition can impair immune function and increase respiratory dysfunction.[22,23] Because of these impairments, associations have been repeatedly demonstrated between malnutrition and adverse clinical outcomes in geriatric patients.[3,19,22,24–26]

Traumatic injury causes a catecholamine-mediated stress response that has been previously described in relationship to hemorrhagic shock and endotheliopathy.[27,28] The European Society for Clinical Nutrition and Metabolism guidelines recommend reducing factors that exacerbate stress-related catabolism; however, this is challenging to limit in injured patients, as traumatic injury inherently causes this exaggerated stress response.[29] This additional catabolic response can directly result in worsening of existing caloric deficits and nutrition-related pathology.[19,20] Overall, more severe injuries lead to a more severe trauma-related inflammatory response, placing multiple injury patients at an elevated risk of postoperative complications secondary to nutritional status.[30] Thus, geriatric multiple injury patients represent an especially high-risk group with multiple risk factors for nutrition-related complications.

While numerous prior studies have demonstrated this link between nutrition and poor clinical outcomes, the optimal method to diagnose malnutrition remains unclear. The GNRI has been prospectively validated in multiple populations, including patients undergoing abdominal surgery.[8–11,13,31] This index was developed specifically as a predictive tool for nutrition-related complications rather than as a diagnostic tool for malnutrition.[7,32] With only three objective parameters required for calculation, the score is easy to calculate in an acute setting and has no subjective measures that require patient or caregiver participation, thus eliminating the bias caused by reporting.[11] Our study aligns with this prior research and suggests that nutrition may be a contributing risk factor to poor outcomes in this vulnerable cohort.[12,14–16]

Prior studies using GNRI in trauma patients have demonstrated an association between GNRI and adverse clinical outcomes in geriatric trauma patients. Su et al.[33] found an independent association between GNRI and mortality in geriatric patients with moderate to severe traumatic brain injury. Other studies corroborated this association between malnutrition and mortality as well as found an association between GNRI, prolonged hospital LOS, and poor functional outcomes.[12,14,34] With this study, we have identified a population that can be identified early in the hospital course as high risk for poor clinical outcomes. Accordingly, this population may benefit from early interventions of nutrition as a modifiable risk factor. The GNRI could be used to stratify patients at risk for poor outcomes on admission and thus aid multidisciplinary teams in determining which patients will benefit from early aggressive nutritional supplementation.[35–37]

Limitations

The primary limitation of this study is its retrospective design that did not allow for assessment of frailty in this cohort. Accordingly, we were not able to assess if malnutrition acted as the causative factor in poor outcomes or if it acted as a surrogate for overall frailty. Second, a number of patients were excluded because of not having an albumin level drawn within 24 hours of admission, which prohibited calculation of GNRI and could have introduced selection bias. This limited our ability to draw conclusions regarding less common outcomes on multivariable analysis. This small study prompts further studies in which albumin is routinely drawn, creating a larger population and thus broadening the heterogeneity of included patients and making these conclusions more generalizable. A prospective study is needed for more complete evaluation of a patient's nutritional status, accounting for recent weight loss, reduced muscle mass, and functional status at home—variables that are difficult to capture retrospectively. Furthermore, the potential benefit of early nutritional intervention was not addressed in our study, and more work is needed to assess if postinjury nutritional interventions can mitigate these poor outcomes.

CONCLUSIONS

Malnutrition as determined by GNRI risk is associated with increased mortality and infectious complications in geriatric trauma patients, an association that remains after controlling for possible confounders including age, ISS, and CCI. In addition, routine measurement of albumin in elderly geriatric patients should be considered to calculate GNRI, which is feasible to use in clinical practice. Further studies should target interventional strategies for those at highest risk based on GNRI.

AUTHORSHIP

All authors have been actively involved in the drafting and critical revision of the manuscript and have approved the final version to be published.

DISCLOSURE

The authors declare no conflicts of interest.

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