

Correlation Between Nutrition-Related Parameters and Frailty in Emergency Department Elderly Patients: Postprint

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Abstract

Background: Nutrition, as an important modifiable factor, is closely associated with the occurrence of frailty. Early identification of frailty through nutritional assessment and subsequent reversal of its development is of great significance for improving clinical outcomes. Currently, research on the predictive value of nutritional indicators for frailty in elderly emergency patients is relatively scarce.

Objective: To investigate the correlation between commonly used clinical nutrition-related parameters and frailty in elderly emergency patients.

Methods: This was a cross-sectional study. Elderly patients aged ≥ 65 years who visited the emergency department of our hospital from January 2021 to October 2021 were enrolled. Nutritional-related parameters were recorded: hemoglobin (HGB), platelets (PLT), albumin (ALB), prealbumin (PA), creatinine, triglycerides (TG), total cholesterol (TC), high-density lipoprotein (HDL), low-density lipoprotein (LDL), glycated hemoglobin (HbA1C), 25-hydroxyvitamin D [25(OH)D], high-sensitivity C-reactive protein (hsCRP), and Nutritional Risk Screening 2002 (NRS2002). The Clinical Frailty Scale (CFS) was used to assess frailty status. Patients were divided into frailty and non-frailty groups, and nutritional-related parameters were compared between the two groups. Logistic regression analysis was used to explore risk factors for frailty occurrence in elderly emergency patients. Receiver operating characteristic (ROC) curves were plotted for each indicator to predict frailty occurrence, and the corresponding area under the curve (AUC) was calculated to compare the predictive value of different nutritional parameters.

Results: A total of 210 elderly emergency patients were included, with a frailty prevalence of 67.6% (142/210). Patients in the frailty group had lower BMI,

HGB, Alb, PA, and 25(OH)D than those in the non-frailty group ($P < 0.05$); hsCRP and NRS2002 were higher in the frailty group than in the non-frailty group ($P < 0.05$). Multivariate logistic regression analysis showed that among nutritional-related parameters, PA [odds ratio (OR)=0.943, 95% confidence interval (95%CI) 0.891-0.998, $P=0.041$], 25(OH)D (OR=0.909, 95%CI 0.844-0.979; $P=0.012$), and NRS2002 (OR=1.701, 95%CI 1.353-2.138; $P < 0.001$) were independent risk factors for frailty occurrence in elderly emergency patients. ROC curve analysis indicated that NRS2002 had the strongest predictive ability for frailty occurrence (AUC 0.835, 95%CI 0.777-0.882).

Conclusion: Frail patients have poor nutritional status, and nutritional status assessment is helpful for early identification of frailty. PA, 25(OH)D, and NRS2002 can effectively predict the occurrence of frailty in elderly emergency patients, among which NRS2002 has the strongest predictive ability.

Full Text

Preamble

Study on Correlation Between Nutrition-Related Parameters and Frailty Among Older Adults in Emergency Department

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Abstract

Background: As an important modifiable factor, nutrition is closely related to the occurrence of frailty. Early identification of frailty through nutritional assessment and subsequent intervention to reverse its progression are of great significance for improving clinical outcomes. However, current research on the predictive value of nutritional indicators for frailty among elderly patients in the emergency department (ED) remains limited.

Objective: To investigate the correlation between commonly used nutrition-related parameters and frailty among older adults in the ED.

Methods: This cross-sectional study enrolled 210 patients aged ≥ 65 years who visited the emergency department between January 2021 and October 2021. Nutritional parameters including hemoglobin (HGB), platelet count (PLT), albumin (ALB), prealbumin (PA), creatinine, triglycerides (TG), total cholesterol (TC), high-density lipoprotein (HDL), low-density lipoprotein (LDL), glycated hemoglobin (HbA1c), 25-hydroxyvitamin D [25(OH)D], high-sensitivity C-reactive protein (hsCRP), and Nutritional Risk Screening 2002 (NRS2002) were recorded. Frailty status was assessed using the Clinical Frailty Scale (CFS), and patients were divided into frail and non-frail groups for comparison of nutritional parameters. Logistic regression analysis was used to identify risk factors for frailty. Receiver operating characteristic (ROC) curves were constructed for each parameter to calculate the corresponding area under the curve (AUC) and compare the predictive value of different nutritional parameters for frailty.

Results: Among 210 elderly ED patients, the prevalence of frailty was 67.6% (142/210). The frail group had significantly lower BMI, HGB, ALB, PA, and 25(OH)D levels compared to the non-frail group ($P < 0.05$), while hsCRP and NRS2002 scores were significantly higher ($P < 0.05$). Multivariate logistic regression analysis revealed that among nutritional parameters, PA [odds ratio (OR)=0.943, 95% confidence interval (95%CI) 0.891-0.998, $P=0.041$], 25(OH)D (OR=0.909, 95%CI 0.844-0.979; $P=0.012$), and NRS2002 (OR=1.701, 95%CI 1.353-2.138; $P < 0.001$) were independent risk factors for frailty in elderly ED patients. ROC curve analysis indicated that NRS2002 had the strongest predictive ability for frailty (AUC=0.835, 95%CI 0.777-0.882).

Conclusion: Frail patients exhibit poor nutritional status, and nutritional assessment contributes to early identification of frailty. PA, 25(OH)D, and NRS2002 can effectively predict frailty occurrence in elderly ED patients, with NRS2002 demonstrating the strongest predictive capability.

Keywords: Nutrition; Frailty; Clinical Frailty Scale; Emergency Department; Aged

Introduction

According to World Health Organization (WHO) data, China's elderly population will reach 400 million by 2050 [1]. With population aging, the proportion of older patients in emergency departments continues to rise. Domestic surveys indicate that over 60% of critically ill patients in EDs are aged 60 years or older, with malnutrition and nutritional risk affecting up to 50% of elderly emergency patients [2-4]. Malnutrition and frailty are common geriatric syndromes that interact with each other, with malnutrition serving as an independent risk factor for frailty that plays a crucial role in its development. Nutritional intervention may improve or even reverse frailty status. Current nutritional assessment methods include subjective scales, laboratory indicators, anthropometric measurements, and body composition assessment tools. However, EDs priori-

tize critical care management and operate at a fast pace, making complex and time-consuming assessment tools impractical. Consensus on which nutritional assessment indicators are most suitable for emergency patients remains lacking, and research on the correlation between nutritional indicators and frailty in elderly ED patients is relatively scarce. This study aims to investigate the relationship between commonly used nutritional parameters—including routine laboratory indicators and the Nutritional Risk Screening 2002 (NRS2002) scale—and frailty among elderly ED patients.

Methods

Study Population

This study enrolled 210 patients aged ≥ 65 years who presented to the emergency department of China Rehabilitation Research Center between January 2021 and October 2021. Exclusion criteria were: (1) patients requiring emergency surgical intervention; (2) patients with unstable vital signs who died within 24 hours; (3) patients with cachexia; and (4) patients who had taken vitamin D supplements within the previous 3 months. The study was approved by the Ethics Committee of China Rehabilitation Research Center (Approval No.: 2021-093-1). All participants voluntarily enrolled and provided informed consent.

Data Collection

Demographic data including sex, age, body mass index (BMI), and medical history (hypertension, diabetes, coronary artery disease, chronic kidney disease, stroke, and dementia) were recorded for all enrolled patients. Fasting venous blood samples were collected within 24 hours of admission to measure hemoglobin (HGB), platelet count (PLT), albumin (ALB), prealbumin (PA), creatinine, triglycerides (TG), total cholesterol (TC), high-density lipoprotein (HDL), low-density lipoprotein (LDL), high-sensitivity C-reactive protein (hsCRP), glycated hemoglobin (HbA1c), and 25-hydroxyvitamin D [25(OH)D]. Complete blood counts were measured using a Mindray BC-5390 automatic hematology analyzer, biochemical parameters using an Olympus AU 680 automatic biochemical analyzer, and serum 25(OH)D levels using electrochemiluminescence on a Roche cobas e601 automatic immunoassay analyzer.

Scale Assessment

Nutritional Risk Screening 2002 (NRS2002): Developed in 2002 by the Danish Society for Parenteral and Enteral Nutrition expert panel and recommended by the European Society for Parenteral and Enteral Nutrition (ESPEN) and multiple guidelines, NRS2002 is currently the preferred screening tool in emergency settings [5-8]. The scale comprises three components: nutritional status impairment score, disease severity score, and age score (≥ 70 years adds 1 point). Nutritional status and disease severity are each scored from 0

to 3 points. A total score <3 indicates no nutritional risk, while ≥ 3 indicates nutritional risk.

Barthel Index (BI): Developed by Mahoney and Barthel in 1965, this 10-item scale is the most commonly used instrument for assessing basic activities of daily living [9]. Each item is scored based on the level of assistance required (0, 5, 10, or 15 points), with a total possible score of 100. Scores of 100 indicate complete independence; 61-99 indicate basic independence; 41-60 indicate moderate functional impairment requiring assistance; and ≤ 40 indicate severe functional impairment or complete dependence.

Clinical Frailty Scale (CFS): First proposed by Rockwood et al. [10] in 2005 based on the Canadian Study of Health and Aging (CSHA), the CFS uses simple clinical parameters incorporating cognitive impairment and functional status to subjectively categorize patients into nine levels ranging from very fit to terminally ill. Levels 1-4 represent the non-frail group, while levels 5 and above represent the frail group.

All scales were completed jointly by two trained attending emergency physicians within 24 hours of admission.

Statistical Analysis

Data analysis was performed using SPSS 26.0 and MedCalc 20.0 software. Normality tests were conducted for all quantitative data. Normally distributed data were expressed as mean \pm standard deviation ($\bar{x} \pm s$) and compared between groups using independent samples t-tests. Non-normally distributed data were expressed as median (interquartile range) [M (QL, QU)] and compared using Mann-Whitney U tests. Categorical data were expressed as percentages (%) and compared using χ^2 tests. The Hosmer-Lemeshow (HL) statistic was used to test model goodness-of-fit. Logistic regression analysis was employed to identify risk factors for frailty, with odds ratios (OR) and 95% confidence intervals (CI) calculated. Receiver operating characteristic (ROC) curve analysis was used to evaluate the predictive value of different nutritional parameters for frailty. Optimal cutoff values were determined using the maximum Youden index (YI). AUC calculations and comparisons were performed using MedCalc 20.0 with the DeLong method. Statistical significance was set at $P < 0.05$.

Results

Patient Characteristics

A total of 210 elderly ED patients were enrolled and divided into a frail group ($n=142$) and non-frail group ($n=68$) based on CFS ≥ 5 . The median age was 81.5 (71, 86) years, and 54.8% were male. Baseline characteristics are presented in Table 1. Compared to the non-frail group, the frail group showed statistically significant differences in HGB, ALB, PA, hsCRP, BMI, NRS2002 scores, and

25(OH)D levels. No significant differences were observed between groups in PLT, creatinine, TG, TC, HDL, or LDL ($P>0.05$) (Table 1).

Logistic Regression Analysis of Frailty Risk Factors

Using frailty status as the dependent variable, multivariate logistic regression analysis was performed incorporating age, sex, BMI, HGB, ALB, PA, hsCRP, 25(OH)D, and NRS2002 as independent variables. After adjusting for confounding factors, PA (OR=0.943, 95%CI: 0.891-0.998; $P=0.041$), 25(OH)D (OR=0.909, 95%CI: 0.844-0.979; $P=0.012$), and NRS2002 (OR=1.701, 95%CI: 1.353-2.138; $P<0.001$) remained independent risk factors for frailty (Table 2). PA and 25(OH)D were protective factors: each 10 mg/dl increase in PA reduced the odds of frailty by 44.6%, while each 10 ng/ml increase in 25(OH)D reduced the odds by 61.7%. NRS2002 score was a risk factor: each 1-point increase in NRS2002 score increased the odds of frailty by 70.1%.

Predictive Value of Nutrition-Related Parameters for Frailty

The AUC values for PA, 25(OH)D, and NRS2002 in predicting frailty were 0.749, 0.670, and 0.835, respectively. Hosmer-Lemeshow tests indicated good model fit for all three parameters. Using maximum Youden index as the criterion, the optimal cutoff values for predicting frailty were 211.9 mg/L for PA, 7.06 ng/ml for 25(OH)D, and 3 points for NRS2002 (Table 3, Figure 1 [Figure 1: see original paper]). Pairwise comparisons revealed that NRS2002 demonstrated the best predictive performance, superior to both PA ($Z=2.241$, $P=0.025$) and 25(OH)D ($Z=3.400$, $P<0.001$). No significant difference was found between PA and 25(OH)D in predictive ability ($Z=1.668$, $P=0.095$) (Table 4).

Discussion

Malnutrition and frailty are common geriatric syndromes with overlapping pathophysiological mechanisms that affect quality of life and lead to adverse health outcomes [11]. Frail patients more frequently experience malnutrition, and malnourished patients are more prone to developing frailty. As a modifiable factor in frailty, nutrition has garnered increasing attention [12]. While frailty assessment was initially applied in geriatric medicine, particularly for community populations, the unique characteristics of emergency departments have limited its implementation, with relatively few domestic studies on frailty screening in ED settings. Most research on the nutrition-frailty relationship has focused on community and hospitalized patients, with scarce studies examining nutritional assessment and frailty specifically in elderly ED patients. This study is the first to explore the relationship between nutritional parameters and frailty risk in an elderly ED population, utilizing both routine laboratory indicators and nutritional risk screening scales tailored to ED characteristics. Our results demonstrate that NRS2002, PA, and 25(OH)D all possess predictive value for frailty, with NRS2002 showing the highest predictive value while

simultaneously screening for nutritional risk, highlighting the close relationship between nutritional status and frailty development in older adults.

Nearly 70 frailty assessment instruments exist, with the Frailty Phenotype (FP) and Frailty Index (FI) being the most representative [13-15]. However, these scales are time-consuming and unsuitable for busy ED environments. Frailty screening in ED patients actually assesses baseline function from the two weeks preceding the emergency visit [16] to identify older adults at risk for adverse health outcomes. The CFS offers simplicity, speed, convenience, and strong reproducibility, making it an important tool for ED frailty assessment [17-19]. Therefore, we selected CFS as our frailty identification instrument, though we acknowledge its origin in Canadian community studies and inherent subjectivity. Using objective indicators to replace complex subjective scales for frailty assessment represents a current research focus, and this study addresses this by evaluating the value of common nutritional parameters for frailty identification.

The first step in nutritional assessment is screening for nutritional risk. NRS2002 is simple, rapid, and demonstrates high inter-rater reliability, making it the preferred nutritional risk screening tool in emergency settings [6]. The NRS2002 incorporates nutritional status impairment, disease severity, and age to screen for existing or potential nutritional risks associated with adverse clinical outcomes (infectious complications, length of stay, readmission rates, treatment completion rates, etc.). Advanced age and poor nutritional status are closely related to frailty development [20-21], and nutritional interventions (including energy, protein, and vitamin D supplementation) can improve weight loss and reduce mortality in malnourished frail elders [22]. However, no previous studies have examined the relationship between NRS2002 scores and frailty in ED settings. Our study demonstrates that NRS2002 effectively predicts frailty, suggesting that early nutritional risk screening in ED patients is valuable not only for nutritional assessment and intervention but also for early frailty identification and prognosis prediction.

Regarding single serum markers, multiple studies have shown that prealbumin is an independent factor for assessing acute changes in nutritional status. The 2019 Global Leadership Initiative on Malnutrition (GLIM) diagnostic criteria include inflammation and disease burden [23-24], and prealbumin, as an acute-phase protein, also predicts inflammatory status. Liang et al. [25] reported that albumin, prealbumin, and hemoglobin correlate with frailty, with prealbumin showing an AUC of 0.693 for frailty prediction. Our study found PA predicted frailty with an AUC of 0.749, though after adjusting for confounders, albumin and hemoglobin showed poor correlation with frailty. This discrepancy may be attributed to our ED population, where the hypermetabolic state in critically ill patients may acutely affect nutritional status.

Vitamin D plays a crucial role in calcium-phosphate balance and bone metabolism regulation. Vitamin D deficiency is common among older adults due to renal insufficiency, reduced sunlight exposure, decreased intake, and impaired absorption [26]. Multiple studies have linked vitamin D with frailty

and all-cause mortality in elderly patients [27-28], though the exact mechanisms remain unclear. Some researchers suggest the relationship is mediated through sarcopenia development [29], with vitamin D supplementation improving muscle strength and balance to reduce frailty risk. Our results show that each 10 ng/ml increase in 25(OH)D reduced frailty odds by 61.7% in elderly ED patients. Ju et al. [30] conducted a systematic review showing that each 25 nmol/L increase in 25(OH)D was associated with an 11% reduction in frailty risk in prospective studies and 12% in cross-sectional studies. Other research demonstrates a linear inverse relationship between 25(OH)D and frailty risk, with supplementation reducing risk. Zhou et al.'s systematic review [31] found low 25(OH)D levels increased frailty risk by 27% compared to high levels, though some studies [32-33] found no association. These inconsistencies may stem from lack of standardized units and cutoff values for 25(OH)D, potentially leading to overestimation or underestimation of the dose-response relationship.

This study has several limitations. First, we used common laboratory indicators and NRS2002 for nutritional assessment without applying malnutrition diagnostic criteria to compare frailty prevalence between malnourished and non-malnourished groups; future studies should incorporate objective anthropometric measurements. Second, this single-center study had a relatively small sample size and potential selection bias. Third, due to the ED setting, we used only the simple and convenient CFS for frailty screening without employing other scales. Future multi-center, large-scale studies are needed to further explore the nutrition-frailty relationship.

Conclusion

Nutritional status is closely associated with frailty in elderly ED patients. Simple and readily available nutritional parameter assessments can facilitate early frailty identification and help screen older adults at risk for adverse health outcomes.

Author Contributions

Shang Na conceptualized the study, collected and organized data, and drafted the initial manuscript. Wang Na and Liu Huizhen provided statistical analysis guidance and revised the manuscript. Liu Lushan and Wang Yahui assisted with data collection. Guo Shubin was responsible for quality control and final approval. All authors confirmed the final version of the manuscript.

Conflict of Interest Statement

All authors declare no conflicts of interest.

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