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ORIGINAL RESEARCH

Geriatric Nutritional Risk Index in Predicting the Mortality of Fournier's Gangrene: Analysis of 14-Year Statistics of Referral Center

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Abstract: **Introduction:** Fournier's gangrene (FG) is a type of necrotizing fasciitis affecting the external genitalia or perineum. The Geriatric Nutritional Risk Index (GNRI) has been reported as a prognostic factor to evaluate the outcomes of various diseases. This study aimed to investigate the utility of GNRI in predicting the mortality of FG patients. **Methods:** This retrospective cross-sectional study evaluated the patients admitted to a referral hospital, during 14 years, with diagnosis of FG. The role of GNRI in predicting the mortality of these patients was studied. To further investigate the relationship of the GNRI score with patients' prognosis, we controlled for the scores of Fournier's Gangrene Severity Index (FGSI) and Charlson Comorbidity Index (CCI). **Results:** 78 patients with the mean age of 60.79 ± 13.76 (range: 24 -85) years were included in the study (89.74% male). The mortality rate in this series was 23 (29.5%) cases. The survived cases had significantly higher GNRI score ($p < 0.001$), higher Albumin level ($p < 0.001$), higher weight ($p = 0.04$), and lower mortality risk based on FGSI score ($p < 0.001$). In patients with low mortality risk according to FGSI score ($p = 0.036$) and mild comorbidities based on CCI score ($p = 0.030$), the association between GNRI and final prognosis was significant. In contrast, in patients with high mortality risk according to FGSI score ($p = 0.074$) and moderate ($p = 0.118$) and severe ($p = 0.215$) comorbidities by CCI score this association was not significant.
The independent predictors of mortality in FG patients were GNRI score (OR: 1.242, 95%CI: 1.08, 1.41; $p = 0.001$) and FGSI score (OR: 54.614, 95%CI: 6.89, 432.31; $p < 0.001$). The area under the receiver operating characteristic (ROC) curve of GNRI score in predicting the mortality of FG patients was 0.84 (95%CI: 0.75 - 0.93). The sensitivity, specificity, positive predictive value, negative predictive value, positive likelihood ratio, and negative likelihood ratio of GNRI score at the optimal cut-off point (78.5) were, 80%, 77.9%, 60.6%, 90.4%, 3.69, and 0.255 respectively. **Conclusion:** Our findings indicate that among patients with mild FG, as assessed by FGSI score, and those with low comorbidities based on CCI score, the GNRI score in survivors was significantly higher than that in non-survived. Additionally, multivariate regression analysis demonstrated that the GNRI score serves as an independent predictor of patient outcomes.

Keywords: Fasciitis; Genitalia; Geriatrics; Mortality; Nutritional Status; Prognosis; Risk Assessment

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1. Introduction

Fournier gangrene (FG) is a rapidly necrotizing fasciitis that arises from the perineal area and scrotum, and can extend to the groin, thigh, and abdominal wall through the fascial layer, causing organ failure and septic shock. Infection leads to thrombosis of subcutaneous blood vessels, resulting in overlying necrosis of the skin (1). FG is known as a polymicrobial infection caused by different aerobic and anaerobic species, including Escherichia coli and Bacteroides fragilis. These microorganisms collaborate to release enzymes, including collagenases, which lead to rapid destruction and necrosis of tissues (2, 3), progressively spreading the infection from the genital and perineal region to the abdominal wall and vital organs (4).

Early diagnosis, coupled with prompt and adequate intervention, including broad-spectrum antibiotic therapy, aggressive surgical debridement, and hemodynamic stabilization, is essential for successful management (5). The overall

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incidence of FG is 1.6 per 100,000 males, with the highest incidence observed among males aged 50-79 years, at a rate of 3.3 per 100,000. This disease is much more common in men than women (6). The mortality rate of FG remains high, ranging from 20 to 50%, despite significant advances in surgical procedures and critical care (7).

Multiple factors have been linked to poorer outcomes in patients with FG, including advanced age, comorbidities such as alcoholism, diabetes mellitus, and cachexia, delayed diagnosis and treatment, development of necrotizing fasciitis, and laboratory data at diagnosis indicating malnutrition and inflammation (8, 9).

The severe pain, reduced physical activity, increased dependence, and decline in general health status can predispose patients to malnutrition and are considered contributing factors to poor outcomes during hospitalization (10, 11). As a result, identifying a reliable screening tool for patients at high risk of malnutrition could be valuable for optimizing management and improving outcomes. The Geriatric Nutritional Risk Index (GNRI) is a simple and practical tool that consists of two components: serum albumin and the present body weight to ideal body weight ratio (12). GNRI has been shown to be closely correlated with elevated C-reactive protein levels, which are a marker of systemic inflammation and indicative of an inflammatory status (13). The GNRI has been demonstrated to be a valuable prognostic factor in evaluating the outcomes of various diseases, including chronic obstructive pulmonary disease (COPD) (14), chronic kidney disease (CKD) (13), heart failure (HF) (15), hemodialysis patients (16), and certain malignancies (17, 18). This study aimed to investigate the utility of GNRI as a tool for predicting mortality in patients with FG.

2. Methods

2.1. Study design and setting

This retrospective cross-sectional study evaluated the patients admitted to the Shohada-e-Tajrish Referral Hospital, Tehran, Iran from March 2010 to April 2024 with diagnosis of FG. The role of GNRI in predicting the mortality of these patients was studied. To further investigate the relationship of the GNRI score with patients' prognosis, we controlled for the scores of Fournier's Gangrene Severity Index (FGSI) and Charlson Comorbidity Index (CCI).

The study was approved by the Ethics Committee of Shahid Beheshti University of Medical Sciences (IR.SBMU.RETECH.REC.1400.755). The researchers adhered to the principles of Helsinki declaration regarding ethical issues in clinical research. The private information and identification details of the participants remained confidential with the researchers.

2.2. Participants

The inclusion criteria for this retrospective study encompassed all patients with FG who were admitted to Shohada-e-Tajrish Hospital during the study period and confirmation of FG diagnosis as documented by a qualified medical professional in the patient's medical record at the time of their visit. Patients were excluded from the study if their medical records were incomplete, thereby lacking critical information required for a thorough analysis. The diagnosis of FG was made at the time of the patient's initial visit and duly recorded in the patient's medical file, based on a comprehensive assessment of clinical symptoms, such as erythema, pain, purulent discharge, swelling, and palpable soft tissue induration.

Additionally, relevant imaging studies, including radiography or ultrasonography, were referenced in the medical records to confirm the diagnosis when necessary.

2.3. Data gathering

Patient information, including age, body mass index (BMI), serum albumin level, and comorbidities were extracted from the patients' medical records. Final patient outcomes as well as CCI criteria and FG Severity Index (FGSI) variables were also recorded for each patient. A urologist was responsible for collecting data and calculating the scores.

The GNRI score was calculated from the data entered in the patient's medical records at the first hospital visit, using the following formula: GNRI = 14.89 × serum albumin (g/dL) + 41.7 × (present body weight/ideal body weight)

The ideal body weight was defined as the value calculated from the Lorentz equations as follows (19):

Fore men: Height (cm) – 100 – [(Height - 150)/4]

Fore women: Height (cm) – 100 – [(Height - 150)/2.5]

When a patient's body weight exceeded the ideal body weight, present body weight/ideal body weight was set to 1 (19).

According to the CCI score, patients were divided into three categories: mild (1-2), moderate (3-4), and severe (≥5). The CCI includes 19 criteria that determine the severity of comorbidities (20).

Additionally, the FGSI was used to calculate the severity of disease. Based on this index, patients were divided into two categories: Mild FG or Low Mortality Risk (≤ 9) and Sever FG or High Mortality Risk (> 9). This index includes 9 variables that are used to predict the final condition of FG patients (21).

2.4. Outcome assessment

The main purpose of this study was to investigate the prognostic value of GNRI in predicting the mortality of patients with FG. To examine this effect, the analysis was adjusted for potential confounding variables including: age, gender, patients' comorbidities based on CCI, and the initial severity of disease based on FGSI.

2.5. Statistical methods

The data collected were analyzed using SPSS for Windows, version 28. Results were presented as mean ± SD or frequency (%). Data normality was assessed using the Shapiro-

Wilk test. The relationship between GNRI and outcomes was examined. A receiver operating characteristic (ROC) curve analysis was conducted to assess the predictive value of GNRI for mortality. Screening performance characteristics of GNRI in predicting the FG mortality were also calculated and reported with 95% confidence interval (CI). A p-value of less than 0.05 was considered statistically significant.

3. Results

3.1. Baseline characteristics of studied cases

During the 14-year review of FG cases who referred to Shohada-e-Tajrish Center, a total of 104 patients' files were examined, of which, 26 cases were excluded due to inadequate documentation, and finally 78 patients were included in the study. The mean age of the patients was 60.79 ± 13.76 (range: 24 -85) years (89.74% male). The mortality rate in this series was 23 (29.5%) cases. Table 1 compares the baseline characteristics as well as CCI, FGSI, and GNRI between survived and non-survived cases.

The two groups were similar regarding age (p = 0.09), gender (p = 0.22), height (p = 0.40), and CCI score (p < 0.409). The survived cases had significantly higher GNRI score (p < 0.001), higher Albumin level (p < 0.001), higher weight (p = 0.04), and lower mortality risk based on FGSI score (p < 0.001).

3.2. Sub group and multi-variate analysis

To further investigate the relationship of the GNRI score with patient prognosis, we controlled for the effects of age, gender, CCI score, and FGSI score.

In patients with low mortality risk according to FGSI score (aOR = 1.22; 95%CI: 1-1.47; p = 0.036) and mild comorbidities based on CCI score (aOR = 1.26; 95%CI: 1.02 - 1.55; p = 0.030) the association between GNRI and final prognosis was significant. In contrast, in patients with high mortality risk according to FGSI score (aOR = 1.35; 95%CI: 0.97 – 1.87; p =0.074) and moderate (aOR = 1.51; 95%CI: 0.9 - 2.55; p = 0.118) and severe (aOR = 1.12; 95% CI: 0.93 - 1.35; p = 0.215) comorbidities based on CCI score this association was not significant.

Based on multivariate regression analysis (Table 2), the independent predictors of mortality in FG patient were GNRI score (OR: 1.242, 95%CI: 1.08, 1.41; p =0.001) and FGSI score (OR: 54.614, 95%CI: 6.89, 432.31; p < 0.001).

3.3. Screening performance characteristics of GNRI

The area under the ROC curve of GNRI score in prediction the mortality of FG patients (figure 1) was 0.84 (95%CI: 0.75 - 0.93). The sensitivity, specificity, positive predictive value, negative predictive value, positive likelihood ratio, and negative likelihood ratio of GNRI score at the optimal cut-off point 78.5, based on ROC curve, were 80% (95%CI: 71% to 88%), 77.9% (95%CI: 68.6% to 87.1%), 60.6% (95%CI: 49.7% to 71.4%), 90.4%(95%CI: 83.8% to 96.9%), 3.69 (95%CI: 2.13 to 6.38), and 0.255 (95%CI: 0.088 to 0.733), respectively.

The area under the curve (AUC) of GNRI is compared with albumin alone in figure 1 (AUC: 0.845 and 0.822 for GNRI and albumin, respectively).

4. Discussion

The findings of our retrospective study on patients with FG, who referred to Shohada-e-Tajrish Hospital over a 14-year period reveal an overall mortality rate of 29.5% (23 out of 78 patients. Notably, among patients categorized with mild FG and low mortality risk, as well as those with mild comorbidities, a significant association was observed between the GNRI and patient prognosis. Furthermore, multivariate regression analysis demonstrated that the GNRI score serves as an independent predictor of mortality in patients with FG.

FG, a rare and potentially life-threatening condition, has a long history dating back to the 10th century when Avicenna first described it. Later, in the 18th century, Baurienne documented the disease. The French dermatologist and venereologist, Jean Alfred Fournier, identified idiopathic perineal gangrene in the late 19th century. This necrotizing infection of the perineum and scrotum can progress rapidly, leading to septic shock and potentially fatal outcomes if left untreated. Early detection and prompt intervention are crucial to prevent complications and ensure patient survival (22).

Several factors have been proposed to predict the prognosis of FG, including the Age-Adjusted CCI, FGSI, Uludag UFGSI, Laboratory Risk Indicator for Necrotizing Fasciitis (LRINEC) score, neutrophil to lymphocyte ratio (NLR), Combined Urology and Plastic Index (CUPI), and surgical APGAR (sAPGAR) (23).

In daily practice, ACCI is commonly used due to its validation and ease of calculation. UFGSI has the highest sensitivity rate (85%) and the lowest specificity rate (67%), while sAPGAR exhibits the highest specificity (91%) and the lowest sensitivity (55%) (23). A study published in 2021 investigated the prognostic significance of the blood urea nitrogen (BUN) to serum albumin ratio in patients with FG, revealing that this ratio serves as an independent predictor of mortality (24).

In our study population, although the severity of the disease according to the FGSI score was a significant predictor of outcomes, increases in the CCI did not demonstrate a significant association with higher mortality.

The GNRI is a specific index designed to evaluate the nutritional risk of morbidity and mortality in elderly hospital patients (25, 26).

Initially proposed by Bouillanne et al., GNRI categorizes patients into four groups based on their GNRI values: GNRI < 82 (major risk), 82 ≤ GNRI < 92 (moderate risk), 92 ≤ GNRI ≤ 98 (low-risk group), and GNRI > 98 (no risk) (19). GNRI has been utilized for prognostic purposes in chronic diseases (14, 27, 28), and more recently, in studies focusing on malignant tumors (29-31). A meta-analysis conducted by Liu et al., which examined 11,002 patients across 11 studies, demonstrated that GNRI can be utilized as a predictor of postopera-

Table 1: Comparing the baseline characteristics as well as Geriatric Nutritional Risk Index (GNRI), Charlson Comorbidity Index (CCI), and Fournier's Gangrene Severity Index (FGSI) between survived and non-survived cases with Fournier's Gangrene

Variables	Non-survived (N=23)	Survived (N=55)	p-value
Gender			
Male	19 (82.6)	51 (92.7)	0.22
Female	4 (17.4)	4 (7.3)	
Age (year)			
Mean ± SD	64.87 ± 11.63	59.09 ± 14.31	0.09
Height			
Mean ± SD	170.52 ± 4.67	171.87 ± 19.64	0.4
Weight			
Mean ± SD	71.78 ± 14.61	79.73 ± 15.62	0.04
Albumin (g/dL)			
Mean ± SD	2.32 ± 0.07	2.82 ± 0.45	<0.001
GNRI			
Mean ± SD	74.48 ± 5.35	83.36 ± 7.00	<0.001
FGSI			
Low Mortality Risk	6 (26.1)	50 (90.9)	<0.001
High Mortality Risk	17 (73.9)	5 (9.1)	
CCI			
Mild	8 (34.8)	26 (47.3)	0.409
Moderate	10 (43.5)	23 (41.8)	
Severe	5 (21.7)	6 (10.9)	

Data are presented as mean ± standard deviation (SD) or frequency (%).

Table 2: Multivariate analysis of independent predictors of mortality in patients with Fournier's Gangrene

Variables	B (SE)	P-value	OR (95% CI)
Age	-0.034 (0.035)	0.335	0.967 (0.9 - 1.03)
Weight	-0.032 (0.029)	0.269	0.969 (0.91 - 1.02)
GNRI	0.217 (0.068)	0.001	1.242 (1.08 - 1.41)
FGSI (good/bad)	4.000 (1.056)	<0.001	54.614 (6.89 - 432.31)
Constant	-14.311 (6.28)	0.023	

OR: Odds Ratio; FGSI: Fournier's Gangrene Severity Index; GNRI: Geriatric Nutritional Risk Index; CI: Confidence Interval, SE: Standard Error.

tive complications in patients with solid cancer (32).

Our results suggest that the optimal cut off for GNRI in predicting mortality in Fournier gangrene patients is 78.5. This cutoff demonstrates a sensitivity of 80% and specificity of 77.9% making it a valuable tool for predicting mortality in patients with FG.

Previous studies have investigated the prognostic factors of FG, with varying results. Benjelloun et al. found that several factors, including renal failure on admission, older age, the need for postoperative mechanical ventilation, septic shock during hospitalization, and abdominal wall infection were associated with mortality in univariate analysis (7). However, in multivariate analysis, none of these factors were found to be significant independent predictors of mortality. Similarly, Yeniyol et al. conducted a study that examined the relationship between admission and final laboratory parameters, including creatinine, urea, bicarbonate, sodium, potassium, albumin, total protein, lactate dehydrogenase, alkaline phosphatase, leukocyte count, and hematocrit with patient outcomes (33). They found that these laboratory parameters were statistically correlated with patient outcomes.

By identifying patients with high risk of poor outcomes using GNRI score, healthcare providers can make informed treatment decisions and optimize patient management. For example, these patients may require more intensive monitoring or targeted interventions to reduce their risk of complications.

To validate our findings and more accurately assess the relationship between GNRI scores and mortality in patients with FG, further prospective multicenter studies with larger sample sizes are warranted.

4.1. Limitations

The limitations of our study may be related to the measurement tools used. Specifically, the FGSI used in this study may not have been the optimal measure of disease severity and mortality risk. Future studies could improve upon our approach by incorporating additional indexes or instruments to gain a more comprehensive understanding of these outcomes.

The retrospective design and limited sample size may have impacted the generalizability of our results. Future studies with larger sample sizes and prospective designs are needed to confirm our findings and explore the predictive value of

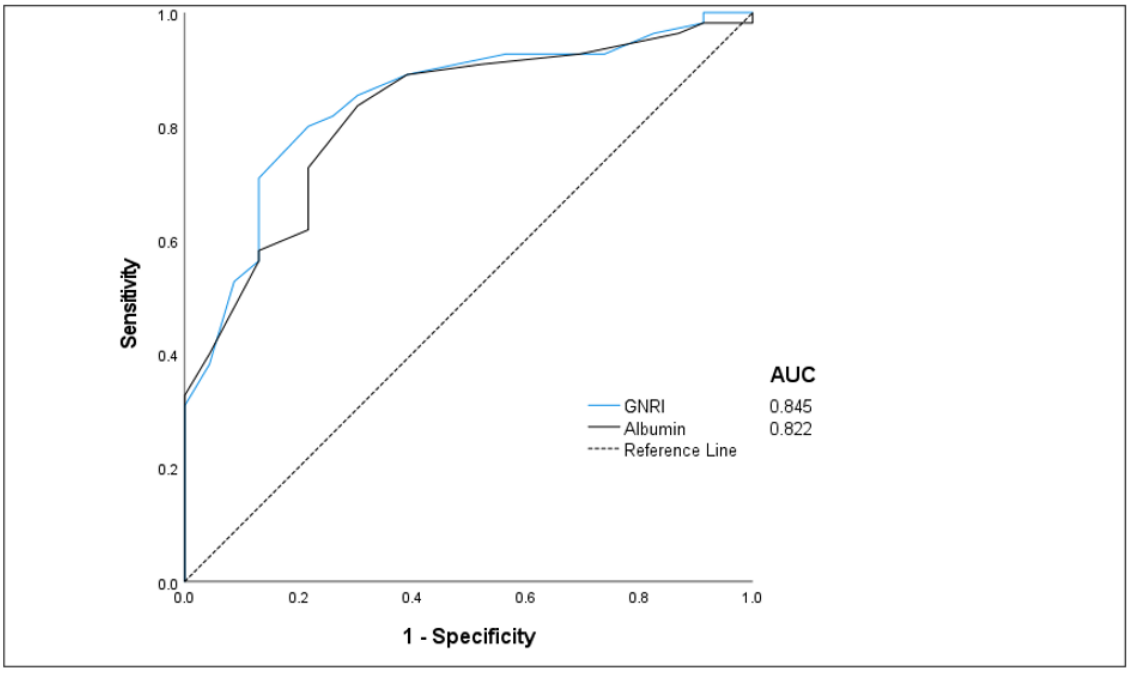

Figure 1: The area under the receiver operating characteristic curve (AUC) of Geriatric Nutritional Risk Index (GNRI) and serum albumin in predicting the mortality of patients with Fournier gangrene.

GNRI in different patient populations.

5. Conclusion

Our findings indicate that among patients with mild FG, as assessed by FGSI score, and those with low comorbidities based on CCI score, the GNRI score in survivors was significantly higher than that in non-survived. Additionally, multivariate regression analysis demonstrated that the GNRI score serves as an independent predictor of patient outcomes.

6. Declarations

6.1. Acknowledgments

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6.2. Conflicts of Interest

The authors declare no conflict of interest.

6.3. Funding

This study did not receive any grants.

6.4. Authors' Contribution

Study design and conceptualization: FA, AAK
Data gathering: AAK, RK, HR, FS
Analysis: MF, SAH
Interpreting the results: SAH, AAK, RK, HR
Drafting: All authors
Review & editing: FA
Critically revised: All authors
All authors read and approved the final version of manuscript.

6.5. Data availability

Data is available on reasonable request to the corresponding author.

6.6. Using artificial intelligence chatbots

No AI chatbots were used for any part of this study.

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