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ORIGINAL RESEARCH

The Predictive Value of Geriatric Nutritional Risk Index Combined with the GRACE Score in Predicting the Risk of One Year Poor Prognosis in Elderly Patients with Non-ST Segment Elevation Myocardial Infarction After PCI

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Background: As a nutritional indicator, a lower level of geriatric nutritional risk index (GNRI) has been suggested as a predictor for poor prognosis in acute coronary syndrome (ACS). However, whether GNRI could improve the predictive value of the Global Registry of Acute Coronary Events (GRACE) score for the prognosis in elderly patients with non-ST segment elevation myocardial infarction (NSTEMI) after PCI remains unclear.

Methods: A total of 446 elderly patients with NSTEMI after percutaneous coronary intervention (PCI) were consecutively enrolled. Patients were divided into major adverse cardiovascular and cerebrovascular events (MACCE) group and control group according to the occurrence of MACCE during one year follow up. The clinical parameters including GNRI were compared to investigate the predictors for MACCE. The performance after the addition of GNRI to the GRACE score for predicting MACCE was determined.

Results: A total of 68 patients developed MACCE. In unadjusted analyses, the rate of MACCE was significantly higher in the 93.8<GNRI <102.7 group and GNRI ≤ 93.8 group versus GNRI ≥ 102.7 group. The logistics regression model showed that age, GNRI, and GRACE score were independent predictors for MACCE in elderly patients with NSTEMI after PCI. The addition of the GNRI to the GRACE score significantly improved the prediction of MACCE in elderly patients with NSTEMI after PCI, increasing the C-index from 0.792 to 0.885 ($p < 0.001$); the NRI was 0.094 (95% CI, 0.004–0.177, $p < 0.001$), and the IDI was 0.011 (95% CI, 0.000–0.023, $p < 0.001$).

Conclusion: Combining GNRI and GRACE score could significantly improve the predictive value of one year MACCE in elderly patients with NSTEMI after PCI. By using this combined new risk model, we could easily identify the high-risk populations in clinical practice, so as to better monitor and manage them.

Keywords: geriatric nutritional risk index, GRACE score, major adverse cardiac and cerebrovascular event, non-ST segment elevation myocardial infarction, elderly, PCI

Introduction

Non-ST segment elevation myocardial infarction has been suggested as a critical disease in cardiovascular disease (CVD) worldwide. Even with the optimal medical treatment and well performed percutaneous coronary intervention (PCI), the long term prognosis is still unsatisfactory.[1] Compared with acute ST segment elevation myocardial infarction (STEMI), the clinical condition of NSTEMI is more complex, the determination of culprit vessel is difficult in some cases and the proportion of multi-vessel disease is higher, making the management of NSTEMI more challenging.[2] In clinical practice, an early risk stratification for NSTEMI is of vital importance for the management and clinical outcome assessment of these patients. The Global Registry of Acute Coronary Events (GRACE) risk score is the most widely used model for the

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risk stratification as well as prognostic assessment in NSTEMI.[1] Previous studies have suggested that GRACE score had a high predictive value in short term as well as long term major adverse cardiovascular and cerebrovascular events (MACCE).[3–5]

Previous study has suggested that elderly patients have a higher nutritional risk,[6] which may have a negative impact on clinical prognosis, including a higher risk of mortality and readmission.[7] Recent studies have shown that malnutrition is a predictor for poor long term prognosis in patients with acute myocardial infarction (AMI).[8] As an indicator of nutritional status, a lower level of geriatric nutritional risk index (GNRI) has been suggested to relate to a poor prognosis in coronary artery disease (CAD) after PCI.[9] Although malnutrition is a predictor for poor prognosis in patients with NSTEMI, the current GRACE score does not include variables that could assess the nutritional status of these patients. Therefore, this study attempts to use the GRACE score combined with the nutritional risk assessment model GNRI to predict 1-year MACCE in elderly patients with NSTEMI after PCI, and further evaluate whether this new risk prediction model could improve the predictive value or not.

Methods

Study Population

The study flow chart is showed in Figure 1. A total of 542 elderly patients with NSTEMI after PCI were consecutively recruited from January 2017 to January 2021 in our hospital. NSTEMI was defined according to the 2023 ESC Guidelines for the management of acute coronary syndromes.[1] Sixty-nine patients were excluded according to the exclusion criteria and 27 patients were lost during follow-up. Eventually, 446 elderly patients with NSTEMI after PCI were included in this study. These patients included were followed up for one year to observe the occurrence of the major adverse cardiovascular and cerebrovascular events (MACCE) and then divided into two groups according to the occurrence of MACCE or not. The MACCE were recorded and compared between the three tertiles of GNRI. All the patients with NSTEMI received a regular PCI according to the relevant guideline.[1] The study was conducted according to the principles of the Declaration of Helsinki. The written informed consent was obtained from all the individuals included before the participation in the study.

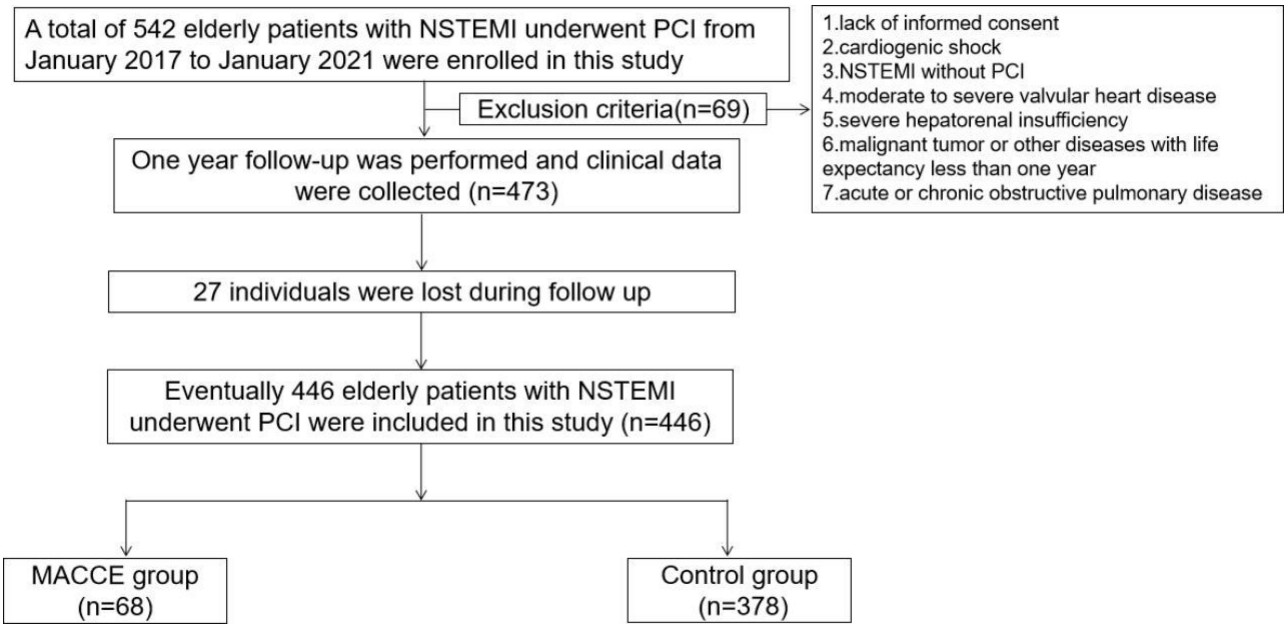

Figure 1 Study flow chart.

Clinical, Laboratory, Angiographic and Procedural Data Assessments, and Definition

The medical records of all the individuals included were recorded including demographics and clinical characteristics, laboratory parameters, angiographic and procedural details. After overnight fasting before the procedure performed, the blood samples were collected and then tested in the central laboratory of our hospital. GNRI was calculated as 1.489*albumin (g/L)+41.7*(actual body weight/ideal body weight).[10] The ideal body weight was calculated as follows: 22*square of height (m^2).[11] When the actual body weight was higher than the ideal weight, the actual body weight/ideal body weight was set to 1.[10] The procedures were performed by the experienced interventional cardiologists according to the relevant guideline.[1] All the patients were prescribed dual antiplatelet.

Follow-Up and Endpoints

Patients were followed up for one year after PCI and the MACCE were recorded. The MACCE was defined as a composite of all-cause mortality, target vessel revascularization (TVR), non-fatal myocardial infarction (AMI) and ischemic stroke. AMI was diagnosed according to the Fourth Universal Definition of MI.[12] TVR was defined as revascularization of any culprit vessel or its main branches. The MACCE was adjudicated by at least two cardiologists and recorded in detail. The follow-up was carried out by outpatient visit, phone call or re-hospitalization. Patients were followed up every 3 month until the MACCE occurred or the one year follow-up completed.

Statistical Analysis

The normality test was performed for the continuous variables. These with normally distributed were displayed as mean ± standard, otherwise the median (interquartile range), which were examined using Student's *t*-test or the non-parametric Mann–Whitney *U*-test respectively. Categorical variables were presented as rates or percentages, which were analyzed using chi-square tests or Fisher's exact test. To better describe the MACCE in different nutritional risk individuals, patients were grouped into tertiles according to GNRI and the MACCE were compared. The relationship between the tertiles of GNRI and MACCE were examined using three multivariable Cox regression models. Model 1 included adjustments for sex, and model 2 included adjustments for hypertension and diabetes mellitus. The univariate analysis was used to determine the risk factors of MACCE, and the logistic regression analysis was performed to explore the independent predictors for MACCE in elderly patient with NSTEMI after PCI. The receiver operating characteristic (ROC) curve was used to investigate the predictive value of GNRI for MACCE in elderly patients with NSTEMI after PCI. The C-index, net reclassification improvement (NRI) and integrated discrimination improvement (IDI) statistical analyses were carried out to confirm the improvement of the addition of GNRI to the GRACE score for the prediction of MACCE in elderly patients with NSTEMI after PCI. The data analysis was performed using SPSS version 22.0. A two-sided P-value of <0.05 were considered statistical significance.

Results

Baseline and Clinical Characteristics

There were 446 patients were included in this study, of whom, 68 developed MACCE during one year follow-up. Baseline characteristics and laboratory parameters are shown in Table 1. Compared to the individuals in the control group, those in the MACCE group were older and more likely to have lower levels of level of body mass index (BMI), systolic blood pressure (SBP), albumin, and higher levels of uric acid and creatinine ($p < 0.05$ for all). The GNRI [93.8(90.8,99.0) vs 98.3(94.0, 103.7), $p < 0.001$] were significantly lower in the MACCE group and the GRACE score (155.0 ± 13.9 vs 134.9 ± 12.5, $p < 0.001$) were significantly higher in the MACCE group. The proposition of male, current smoker, diabetes mellitus, hypertension, previous heart failure, previous stroke, previous myocardial infarction, previous PCI and heart rate were comparable between the two groups ($p > 0.05$). The lesion characteristics and medication were also comparable between the two groups ($p > 0.05$) (Table 2).

Incidence of MACCE in Patients in Different Nutritional Risk Groups

All the individuals were followed up to one year after PCI. The cumulative incidence of MACCE were displayed in Table 3 according to GNRI tertiles. A total of 68 patients (15.2%) developed MACCE during one year follow up,

Table 1 Baseline and Laboratory Characteristics of the Study Population

Variables	MACCE Group n=68	Control Group n=378	P-value
Age, years	76.0(72.0,80.0)	74.0(66.0,76.0)	<0.001
Gender(male), n(%)	49(72.1)	266(70.4)	0.885
BMI, Kg/m2	23.2±3.0	24.2±3.2	0.016
Current smoker, n(%)	12(17.6)	97(25.7)	0.157
Diabetes Mellitus, n(%)	19(27.9)	97(25.7)	0.764
Hypertension, n(%)	41(60.3)	224(59.3)	0.894
Heart failure, (%)	11(16.2)	63(16.7)	1
Previous Stroke, n(%)	3(4.4)	14(3.7)	0.783
Previous MI, n(%)	10(14.7)	52(13.8)	0.846
Previous PCI, n(%)	12(17.6)	64(16.9)	0.862
SBP, mmHg	116.5±15.5	123.8±16.3	0.001
Heart rate	71.9±10.8	71.8±11.2	0.913
Total cholesterol, mmol/L	4.2±1.0	4.3±1.0	0.727
Triglyceride, mmol/L	1.2(1.1,1.8)	1.5(1.1,2.1)	0.109
LDL-C, mmol/L	2.7±0.8	2.7±0.9	0.759
HDL-C, mmol/L	1.1(1.0,1.3)	1.1(0.9,1.3)	0.402
Uric acid, umol/L	340.2±99.7	311.1±93.9	0.020
FBG, mmol/L	5.5(4.7,6.7)	5.4(4.8,6.0)	0.283
NT-proBNP, pg/mL	2055.3(1525.4, 5925.8)	2022.7(1209.3, 6010.2)	0.262
Creatinine, mmol/L	83.8(69.0,97.8)	68.3(55.0,83.0)	<0.001
LVEF, %	53.3±7.7	52.6±8.1	0.494
Albumin, g/L	35.4±3.5	38.6±3.7	<0.001
GRACE score	155.0±13.9	134.9±12.5	<0.001
GNRI score	93.8(90.8,99.0)	98.3(94.0, 103.7)	<0.001

Abbreviations: BMI, body mass index; SBP, systolic blood pressure; MI, myocardial infarction; LDL-C, low-density lipoprotein cholesterol; HDL-C, high-density lipoprotein cholesterol; FBG, fasting blood glucose; NT-proBNP, N-terminal prohormone of brain natriuretic peptide; LVEF, left ventricular ejection fraction; GNRI, geriatric nutritional risk index.

including 8(7.3%) patients in GNRI≥102.7 group, 32(15.3%) in 93.8 < GNRI<102.7 group and 28(22.0%) in the GNRI≤GNRI ≤ 93.8p. The incidence of target vessel revascularization (TVR), AMI, stroke showed no difference between the two groups. However, compared to the individuals in GNRI≥GNRI ≥ 102.7p, patients with lower GNRI had a higher incidence of all-cause death (11.8% vs 6.2% vs 2.7%, p=0.0p = 0.020 MACCE (22.0% vs 15.3% vs 7.3%, p=0.007) (Table 3). In unadjusted analyses, the rate of MACCE was significantly higher in the 93.8<93.8 < GNRI7 group and GNRI≤GNRI ≤ 93.8p versus GNRI≥GNRI ≥ 102.7p. After multivariable adjustment (Model 1 or Model 2), differences in MACCE rates remained statistically significant between the three groups. (p<0.0p < 0.05all) (Table 4).

Table 2 Procedural and Medication Characteristics

Variables	MACCE Group n=68	Control Group n=378	P-value
Radial access, n(%)	66(97.1)	367(97.1)	1
Femoral access, n(%)	2(2.9)	11(2.9)	
LM, n(%)	3(4.4)	15(4.0)	0.968
LAD, n(%)	25(36.8)	147(38.9)	
LCX, n(%)	16(23.5)	93(24.6)	
RCA, n(%)	24(35.3)	123(32.5)	
1-vessel disease, n(%)	11(16.2)	56(14.8)	0.956
2-vessel disease, n(%)	19(27.9)	109(28.8)	
3-vessel disease, n(%)	38(55.9)	213(56.3)	
Ostio lesions, n(%)	14(20.6)	56(14.8)	0.276
Bifurcation lesions, n(%)	13(19.1)	74(19.6)	1
CTO lesions, n(%)	2(2.9)	11(2.9)	1
Aspirin, n(%)	66(97.1)	372(98.4)	0.351
Clopidogrel/Ticagrelor, n(%)	68(100)	378(100)	1
ACEI/ARB/ARNI, n (%)	36(52.9)	192(50.8)	0.793
Beta-blocker, n (%)	45(66.2)	263(69.6)	0.572
Calcium canal blocker, n (%)	15(22.1)	98(25.9)	0.548
Statin, n (%)	67(98.5)	376(99.5)	0.392

Abbreviations: LM, left main; LAD, left anterior descending artery; LCX, left circumflex artery; RCA, right coronary artery; CTO, chronic total occlusion; ACEI, angiotensin converting enzyme inhibitors; ARB, angiotensin II receptor blocker; ARNI, angiotensin receptor II blocker neprilysin inhibitor.

Table 3 Incidence of MACCE by Tertiles of GNRI

Variables	GNRI≥102.7 (n=110)	93.8<GNRI<102.7 (n=209)	GNRI≤93.8 (n=127)	P-value
All cause death, (%)	3(2.7)	13(6.2)	15(11.8)	0.020
TVR, (%)	3(2.7)	15(7.2)	10(7.9)	0.203
AMI, (%)	1(0.9)	2(1.0)	2(1.6)	0.847
Stroke, (%)	1(0.9)	2(1.0)	1(0.8)	0.987
MACCE, (%),	8(7.3)	32(15.3)	28(22.0)	0.007

Abbreviations: TVR, target vessel revascularization; AMI, acute myocardial infarction; MACCE, major adverse cardiovascular and cerebrovascular events.

Association of the Factors with MACCE

The univariate analysis showed that age, SBP, creatinine, albumin, GRACE score, and GNRI were related with MACCE. Then, the logistics regression model discovered that age, GRACE score, and GNRI were independent predictors for MACCE in elderly patients with NSTEMI after PCI (Table 5). The ROC analysis showed that when GNRI was more than 95.1, the

Table 4 Association of GNRI Trajectories with MACCE

GNRI	MACCE (%)	Unadjusted		Model 1		Model 2	
		OR(95% CI)	P value	OR(95% CI)	P value	OR(95% CI)	P value
GNRI≥102.7	8(7.3)	Reference		Reference		Reference	
93.8<GNRI<102.7	32(15.3)	1.192(1.011–2.925)	<0.001	1.194(1.018–2.829)	<0.001	1.201(1.021–2.924)	<0.001
GNRI≤93.8	28(22.0)	2.569(1.142–4.265)	<0.001	2.691(1.132–4.528)	<0.001	2.701(1.204–4.549)	<0.001

Notes: Model 1, logistic regression adjusted for sex. Model 2, further adjusted for hypertension and diabetes mellitus.
Abbreviation: GNRI, geriatric nutritional risk index.

Table 5 Univariate and Multivariate Analysis for Predictors of MACCE

	Univariate Analysis			Multivariate Analysis		
	OR	95% CI	P value	OR	95% CI	P value
Age	1.125	1.022–1.214	0.022	1.124	1.024–1.235	0.032
BMI	0.901	0.728–0.968	0.038	0.910	0.773–1.108	0.488
SBP/10	1.892	1.125–3.024	0.026	1.889	0.902–2.924	0.328
Uric acid/10	1.138	0.826–1.236	0.528			
Creatinine/10	1.425	1.092–1.624	0.029	1.421	0.902–1.609	0.594
Albumin/10	0.802	0.701–0.892	0.024	0.726	0.692–1.102	0.391
GRACE score/10	1.568	1.127–3.027	0.020	1.556	1.117–2.996	0.033
GNRI score/10	0.664	0.502–0.892	0.017	0.649	0.551–0.882	0.010

Abbreviations: BMI, body mass index; SBP, systolic blood pressure; GNRI, geriatric nutritional risk index.

sensitivity and specificity were 60.3% and 69.8%, respectively, and the area under the ROC curve (AUC) was 0.682 (95% confidence interval [CI]: 0.612–0.751; $p < 0.001$).(Figure 2). The addition of the GNRI to the GRACE score significantly improved the prediction of MACCE in elderly patients with NSTEMI after PCI, increasing the C-index from 0.792 to 0.885 ($p < 0.001$); the NRI was 0.094 (95% CI, 0.004–0.177, $p < 0.001$), and the IDI was 0.011 (95% CI, 0.000–0.023, $p < 0.001$) (Table 6).

Discussion

The present study demonstrated that GNRI was an independent predictor of one year MACCE in elderly patients with NSTEMI after PCI, so, it is effective and feasible to use GNRI for nutritional risk assessment and stratification in elderly patients with NSTEMI after PCI. The addition of GNRI to GRACE score could significantly improve the ability to correctly distinguish the occurrence of one year MACCE in these specific individuals.

Recently, Naples and IMRS scores are recently used in the prediction of several endpoints in patients with MI.[13–15] We should be aware of the use of artificial intelligence (AI) systems in patients with acute coronary syndrome. Since AI use can make a real difference in prediction models for these patients. Although more and more scores were developed, however, the GRACE score is still the most commonly used model for risk stratification and prognostic assessment in NSTEMI patients, and the age has the highest weight in the GRACE score. Therefore, elderly patients have poorer short-term and long-term prognosis.[1] Previous study has suggested that elderly patients have a higher nutritional risk,[6] which may have a negative impact on clinical prognosis, including a higher risk of mortality and readmission.[7] Moreover, malnutrition not a rare situation in CAD. Basta et al suggested that more than half of the elderly patients with STEMI suffered from malnutrition.[16] In addition, cardiovascular diseases along with a variety of diseases have been proven as risk factors for malnutrition.[17,18] As matter of fact, despite the high incidence of malnutrition and its negative effect on the prognosis, in clinical practice, malnutrition is still

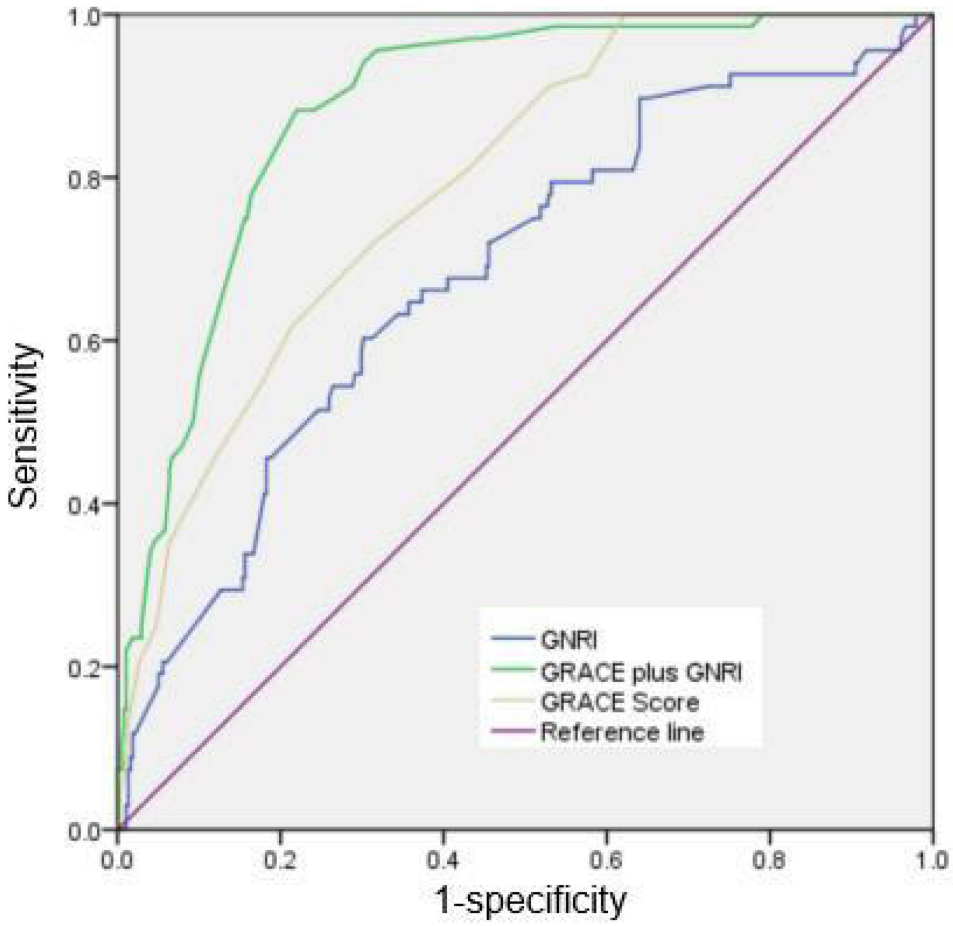

Figure 2 ROC curve showing the distinguishing ability of GNRI and GRACE score for the presence of MACCEs.

underdiagnosed. The main reason is that the definition and the risk assessing model are still not achieved consensus. In recent years, GNRI has been suggested as a nutritional status screening tool in elderly patients.[10] Prof Zhao et al discovered that as an indicator of nutritional risk, a lower level of GNRI was associated with a higher incidence of MACCE in patients with NSTEMI.[19] So in this study, we aimed to investigate the relationship between GNRI and the prognosis of NSTEMI. Similar to previous study, we discovered that GNRI was closely related to MACCE and was an independent predictor for MACCE in elderly patients with NSTEMI after PCI. The patients with MACCE tended to be older and have a lower level of albumin and body mass index (BMI), therefore, the GNRI in MACCE group was significantly lower than in the controls, resulting in a poor prognosis in these individuals.

The underlying mechanisms of GNRI on MACCE in elderly patients with NSTEMI were speculated as follows. Firstly, albumin is most abundant protein in human body, which plays a key role in anti-inflammatory and antiplatelet

Table 6 Model Performance After the Addition of GNRI to the GRACE Score for Predicting MACCE

	MACCE					
	C-Index (95% CI)	**p**	**IDI(95% CI)**	**p**	**NRI(95% CI)**	**p**
GRACE	0.792(0.740–0.844)	Ref	Ref	Ref	Ref	Ref
GRACE+GNRI	0.885(0.848–0.921)	<0.001	0.011(0.000–0.023)	<0.001	0.094(0.004–0.177)	<0.001

Abbreviations: IDI, integrated discrimination improvement; NRI, net reclassification improvement; GNRI, Geriatric Nutritional Risk Index.

aggregation. So hypoalbuminemia was associated with inflammation[20,21] and platelet aggregation,[22] which may bring in a poor clinical outcome. Accumulating studies demonstrated that a lower level of albumin is associated with a higher deaths in ACS patients[23] and STEMI.[24] The "obesity paradox" revealed that obesity is associated with better clinical outcomes, while underweight is just the opposite; however, this is not applicable to every clinical situations.[25,26] BMI and serum albumin have been suggested as common nutritional indicators, which are widely used in clinical practice. However, they are affected by various factors, such as retention of sodium and water (heart failure or renal failure), dehydration, inflammation, and other situations.[27,28] As a combined indicator, GNRI is not just a overlap of the albumin and BMI. Previous study has suggested that GNRI could significantly improve the predictive value of deaths than BMI or serum albumin alone.[29,30] Katayama et al discovered that GNRI showed a better performance than albumin in predicting MACCE in patients with CAD underwent rotational atherectomy.[31] In this study, we found that BMI, albumin, and GNRI were related to MACCE in elderly patients with NSTEMI after PCI; however, binary logistic regression analysis showed that only GNRI had a significance. This result further confirmed the better predictive performance of GNRI than BMI and albumin from another perspective. Secondly, patients with malnutrition tended to be frailty, which is characterized as multiple organ or multiple system dysfunction and an increase of susceptibility.[32] The association between frailty and negative outcomes in elderly patients with CVD has been widely demonstrated and well accepted.[33,34] Although in this study, we did not analyze the frailty; however, a negative relationship between GNRI and frailty has been suggested, which may play a role for the negative effect of GNRI.[19]

At present, although GNRI is very easy to obtain in clinical practice, compared with the GRACE score, its value in predicting the prognosis of elderly patients with NSTEMI is limited. Meanwhile, there are no specific nutritional status assessment indicators for elderly patients with NSTEMI in clinical practice. So in this study, we combined the GRACE score and GNRI to acquire a new risk model, which provided a better predictive value in the prognosis of elderly patients with NSTEMI after PCI. GNRI could serve as a prognosis indicator as well as for risk stratification. This study had some limitations. Firstly, this was a single-center study with a relatively small sample size. We did not collect the data of GNRI dynamically. Secondly, although multivariate analyses were carried out, residual covariates may still be present, and this may affect the predictive value. Thirdly, patients with lower level of GNRI did not receive a nutrition support treatment, which may improve the prognosis. Fourthly, this conclusion only restricted to the specific population included and could not be applied to other clinical situations.

Conclusion

We discovered that a higher level of GNRI was related to an increased incidence of MACCE in elderly patients with NSTEMI after PCI. Combining GNRI and GRACE score could significantly improve the predictive value of one year MACCE in elderly patients with NSTEMI after PCI. By using this combined new risk model, we could easily identify the high-risk populations in clinical practice, so as to better monitor and manage them.

Abbreviations

GNRI, geriatric nutritional risk index; GRACE, global registry of acute coronary events; MACCE, major adverse cardiac and cerebrovascular event; NSTEMI, non-ST segment elevation myocardial infarction; PCI, percutaneous coronary intervention; CVD, cardiovascular disease; STEMI, ST segment elevation myocardial infarction; CAD, coronary artery disease; TVR, target vessel revascularization; BMI, body mass index; SBP, systolic blood pressure.

Data Sharing Statement

The datasets generated and analyzed during the current study are not publicly available due to a further study of this area but are available from the corresponding author on reasonable request.

Ethics Approval and Informed Consent

This study was conducted in compliance with the ethical principles of the Helsinki Declaration and approved by The Affiliated Hospital of Inner Mongolia Minzu University and all the subjects provided their written informed consent before participation.

Disclosure

The authors declared no conflicts of interest in this work.

References

1. Byrne RA, Rossello X, Coughlan JJ, et al.; ESC Scientific Document Group. 2023 ESC Guidelines for the management of acute coronary syndromes. *Eur Heart J*. 2023;44(38):3720–3726. doi:10.1093/eurheartj/ehad191
2. Zhao Q, Zhang TY, Cheng YJ, et al. Triglyceride-glucose index as a surrogate marker of insulin resistance for predicting cardiovascular outcomes in nondiabetic patients with non-ST-segment elevation acute coronary syndrome undergoing percutaneous coronary intervention. *J Atheroscler Thromb*. 2021;28(11):1175–1194. doi:10.5551/jat.59840
3. Fox KA, Carruthers KF, Dunbar DR, et al. Underestimated and under-recognized: the late consequences of acute coronary syndrome (GRACE UK-Belgian Study). *Eur Heart J*. 2010;31(22):2755–2764. doi:10.1093/eurheartj/ehq326
4. Bradshaw PJ, Ko DT, Newman AM, et al. Validity of the GRACE (Global Registry of Acute Coronary Events) acute coronary syndrome prediction model for six month post-discharge death in an independent data set. *Heart*. 2006;92(7):905–909. doi:10.1136/hrt.2005.073122
5. Tang EW, Wong CK, Herbison P. Global Registry of Acute Coronary Events (GRACE) hospital discharge risk score accurately predicts long-term mortality post acute coronary syndrome. *Am Heart J*. 2007;153(1):29–35. doi:10.1016/j.ahj.2006.10.004
6. Somanchi M, Tao X, Mullin GE. The facilitated early enteral and dietary management effectiveness trial in hospitalized patients with malnutrition. *JPEN J Parenter Enteral Nutr*. 2011;35(2):209–216. doi:10.1177/0148607110392234
7. Allard JP, Keller H, Jeejeebhoy KN, et al. Malnutrition at hospital admission-contributors and effect on length of stay: a prospective cohort study from the Canadian malnutrition task force. *JPEN J Parenter Enteral Nutr*. 2016;40(4):487–497. doi:10.1177/0148607114567902
8. Ando T, Yoshihisa A, Kimishima Y, et al. Prognostic impacts of nutritional status on long-term outcome in patients with acute myocardial infarction. *Eur J Prev Cardiol*. 2020;27(19):2229–2231. doi:10.1177/2047487319883723
9. Wada H, Dohi T, Miyauchi K, et al. Prognostic impact of the geriatric nutritional risk index on long-term outcomes in patients who underwent percutaneous coronary intervention. *Am J Cardiol*. 2017;119(11):1740–1745. doi:10.1016/j.amjcard.2017.02.051
10. Bouillanne O, Morineau G, Dupont C, et al. Geriatric nutritional risk index: a new index for evaluating at-risk elderly medical patients. *Am J Clin Nutr*. 2005;82(4):777–783. doi:10.1093/ajcn/82.4.777
11. Sze S, Pellicori P, Kazmi S, et al. Prevalence and prognostic significance of malnutrition using 3 scoring systems among outpatients with heart failure: a comparison with body mass index. *JACC Heart Fail*. 2018;6(6):476–486. doi:10.1016/j.jchf.2018.02.018
12. Thygesen K. Executive Group on behalf of the Joint European Society of Cardiology (ESC)/American College of Cardiology (ACC)/American Heart Association (AHA)/World Heart Federation (WHF) Task Force for the Universal Definition of Myocardial Infarction. Fourth Universal Definition of Myocardial Infarction (2018). *J Am Coll Cardiol*. 2018;72(18):2231–2264. doi:10.1016/j.jacc.2018.08.1038
13. Çınar T, Şaylık F, Akbulut T, et al. Evaluation of intermountain risk score for short- and long-term mortality in ST elevation myocardial infarction patients. *Angiology*. 2023;74(4):357–364. PMID: 35635200. doi:10.1177/00033197221105753
14. Mert Ilker H, Faysal S, Ahmet Çağdaş Y, Murat S, Tufan Ç. Prognostic value of intermountain risk score for short- and long-term mortality in patients with cardiogenic shock. *Coron Artery Dis*. 2023;34(2):154–159. PMID: 36720024. doi:10.1097/MCA.0000000000001219
15. Şaylık F, Çınar T, Selçuk M, Akbulut T, Hayıroğlu Mİ, Tanboğa İH. Evaluation of Naples score for long-term mortality in patients With ST-segment elevation myocardial infarction undergoing primary percutaneous coronary intervention. *Angiology*. 2023;14:33197231170982. doi:10.1177/00033197231170982
16. Basta G, Chatzianagnostou K, Paradossi U, et al. The prognostic impact of objective nutritional indices in elderly patients with ST-elevation myocardial infarction undergoing primary coronary intervention. *Int J Cardiol*. 2016;221:987–992. doi:10.1016/j.ijcard.2016.07.039
17. Damião R, Santos ÁDS, Matijasevich A, et al. Factors associated with risk of malnutrition in the elderly in south-eastern Brazil. *Rev Bras Epidemiol*. 2017;20(4):598–610. doi:10.1590/1980-5497201700040004
18. Damayanthi HDWT, Moy FM, Abdullah KL, et al. Prevalence of malnutrition and associated factors among community-dwelling older persons in Sri Lanka: a cross-sectional study. *BMC Geriatr*. 2018;18(1):199. doi:10.1186/s12877-018-0892-2
19. Zhao Q, Zhang TY, Cheng YJ, et al. Impacts of geriatric nutritional risk index on prognosis of patients with non-ST-segment elevation acute coronary syndrome: results from an observational cohort study in China. *Nutr Metab Cardiovasc Dis*. 2020;30(10):1685–1696. doi:10.1016/j.numecd.2020.05.016
20. Soeki T, Sata M. Inflammatory Biomarkers and Atherosclerosis. *Int Heart J*. 2016;57(2):134–139. doi:10.1536/ihj.15-346
21. Çınar T, Şaylık F, Hayıroğlu Mİ, et al. The association of serum uric acid/albumin ratio with no-reflow in patients with ST elevation myocardial infarction. *Angiology*. 2023;74(4):381–386. doi:10.1177/00033197221110700
22. Çağdaş M, Rencüzoğullari I, Karakoyun S, et al. Assessment of Relationship between c-reactive protein to albumin ratio and coronary artery disease severity in patients with acute coronary syndrome. *Angiology*. 2019;70(4):361–368. doi:10.1177/0003319717743325
23. Kurtul A, Murat SN, Yarlioglues M, et al. Usefulness of Serum albumin concentration to predict high coronary SYNTAX score and in-hospital mortality in patients with acute coronary syndrome. *Angiology*. 2016;67(1):34–40. doi:10.1177/0003319715575220
24. Oduncu V, Erkol A, Karabay CY, et al. The prognostic value of serum albumin levels on admission in patients with acute ST-segment elevation myocardial infarction undergoing a primary percutaneous coronary intervention. *Coron Artery Dis*. 2013;24(2):88–94. doi:10.1097/MCA.0b013e32835c46fd
25. Gruberg L, Weissman NJ, Waksman R, et al. The impact of obesity on the short-term and long-term outcomes after percutaneous coronary intervention: the obesity paradox? *J Am Coll Cardiol*. 2002;39(4):578–584. doi:10.1016/s0735-1097(01)01802-2
26. Akin I, Tölg R, Hochadel M, et al.; DES.DE (German Drug-Eluting Stent) Study Group. No evidence of "obesity paradox" after treatment with drug-eluting stents in a routine clinical practice: results from the prospective multicenter German DES.DE (German Drug-Eluting Stent) Registry. *JACC*. 2012;5(2):162–169. doi:10.1016/j.jcin.2011.09.021
27. Abd Aziz NAS, Teng NIMF, Abdul Hamid MR, et al. Assessing the nutritional status of hospitalized elderly. *Clin Interv Aging*. 2017;12:1615–1625. doi:10.2147/CIA.S140859

28. Zhang Z, Pereira SL, Luo M, et al. Evaluation of blood biomarkers associated with risk of malnutrition in older adults: a systematic review and meta-analysis. *Nutrients*. 2017;9(8):829. doi:10.3390/nu9080829
29. Jia Y, Gao Y, Li D, et al. Geriatric nutritional risk index score predicts clinical outcome in patients with acute ST-segment elevation myocardial infarction. *J Cardiovasc Nurs*. 2020;35(6):E44–E52. doi:10.1097/JCN.0000000000000674
30. Kunimura A, Ishii H, Uetani T, et al. Impact of Geriatric Nutritional Risk Index on cardiovascular outcomes in patients with stable coronary artery disease. *J Cardiol*. 2017;69(1):383–388. doi:10.1016/j.jjcc.2016.09.004
31. Katayama T, Hioki H, Kyono H, et al. Predictive value of the geriatric nutritional risk index in percutaneous coronary intervention with rotational atherectomy. *Heart Vessels*. 2020;35(7):887–893. doi:10.1007/s00380-020-01558-4
32. Xue QL. The frailty syndrome: definition and natural history. *Clin Geriatr Med*. 2011;27(1):1–15. doi:10.1016/j.cger.2010.08.009
33. Cacciatore F, Abete P, Mazzella F, et al. Frailty predicts long-term mortality in elderly subjects with chronic heart failure. *Eur J Clin Invest*. 2005;35(12):723–730. doi:10.1111/j.1365-2362.2005.01572.x
34. Purser JL, Kuchibhatla MN, Fillenbaum GG, et al. Identifying frailty in hospitalized older adults with significant coronary artery disease. *J Am Geriatr Soc*. 2006;54(11):1674–1681. doi:10.1111/j.1532-5415.2006.00914.x