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ORIGINAL RESEARCH

Correlation Between Systemic Immune Inflammation Index(SII) and Outcome After Occlusion in Patients with Post-Infarction Ventricular Septal Rupture

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Background: The Systemic Immune-Inflammation Index (SII) is a key indicator for assessing inflammatory status. This study aims to determine the association between SII and prognosis following occlusion in patients with post-infarction ventricular septal rupture (PIVSR).

Methods: A total of 130 patients admitted to Fuwai Central China Cardiovascular Hospital between 2018 and 2023 were included in this retrospective study. Based on the tertiles of the Systemic Inflammatory Index (SII), the patients were categorized into two groups: 65 patients in the low SII group and 65 in the high SII group. Variable screening was performed using the Least Absolute Shrinkage and Selection Operator (LASSO) analysis. We conducted multivariable logistic regression analyses to rigorously assess the independent association between SII and short-term outcomes in PIVSR patients. After variable selection, a nomogram was constructed using R, and Restricted Cubic Splines (RCS) were employed to flexibly model nonlinear relationships. Subsequently, the predictive abilities of the screened variables and SII for the outcome were independently evaluated using Receiver Operating Characteristic (ROC) curve analysis.

Results: A nomogram model incorporating ALT, UREA, NT-proBNP, and SII was developed to predict the short-term prognosis of PIVSR patients following occlusion surgery. ROC curve analysis demonstrated that the area under the curve (AUC) for SII level was 0.702 (95% CI: 0.599–0.804, $P < 0.001$). Incorporating the Systemic Immune-Inflammation Index (SII) significantly improved prognostic accuracy, with Model 2 demonstrating superior discriminatory power (AUC 0.845 vs 0.828) over Model 1.

Conclusion: The Systemic Immune-Inflammation (SII) is a convenient and effective prognostic indicator, and the model incorporating SII can facilitate personalized prognostic assessment for patients with post-infarction ventricular septal rupture (PIVSR).

Keywords: acute myocardial infarction, perforation of ventricular septum, systemic immune inflammation index, interventional occlusion

Introduction

Ventricular septal rupture (VSR) is a rare but life-threatening complication following acute myocardial infarction, often resulting in hemodynamic instability and poor prognosis. Despite significant advancements in interventional therapy and related technologies, which have led to a notable decline in its incidence, the case fatality rate remains persistently high.[1,2] While hemodynamic stability and cardiogenic shock severity were identified as the most clinically significant

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prognostic factors for survival in post-infarction cardiac rupture patients, robust clinical evidence supporting inflammatory blood biomarkers remains substantially limited.[3]

Previous studies have pointed out that inflammatory markers s such as C-reactive protein (CRP), neutrophil-to-lymphocyte ratio (NLR), and platelet-to-lymphocyte ratio (PLR) are closely related to the severity of coronary heart disease and cardiovascular recurrent events.[4–7] The Systemic Immune-Inflammation (SII), which is calculated as Neutrophil count × Platelet count / Lymphocyte count, is a biomarker originating from inflammation. It has the ability to mirror both the local immune response and the systemic inflammation in the human body. Prior research has concluded that the SII has multiple significant implications. It is not only frequently used as a predictor for tumor prognosis,[8,9] but also, in CAD patients after coronary intervention, a higher SII is independently associated with an increased future risk of developing cardiac death, nonfatal MI, nonfatal stroke and hospitalization for heart failure.[10]

Percutaneous interventional occlusion has emerged as a safe and effective treatment for VSR.[11,12] This study focuses on patients who underwent percutaneous interventional ventricular septal rupture (PIVSR) occlusion, aiming to retrospectively analyze their clinical data and outcomes to investigate the relationship between SII and prognosis in this population.

Methods

Patient Selection

This retrospective study included patients diagnosed with post-infarction ventricular septal rupture (PIVSR) who were admitted to Fuwai Central China Cardiovascular Hospital between 2018 and 2023. Among the 248 PIVSR patients initially identified, 31 underwent surgical repair, and 62 received conservative treatment or were ineligible for surgery. An additional 25 patients were excluded due to incomplete clinical data. Ultimately, 130 patients who underwent successful transcatheter ventricular septal rupture closure were included in the analysis.

Inclusion criteria: (1) Definite diagnosis of acute myocardial infarction, including ST-segment elevation myocardial infarction (STEMI) or non-ST-segment elevation myocardial infarction (NSTEMI); (2) Multiple sections by echocardiography confirmed the presence of interrupted septal continuity or left ventriculogram confirmed left to right shunt. (3) The transcatheter ventricular septal rupture repair was successfully completed.

Exclusion criteria: (1) Individuals with ventricular septal defects resulting from congenital abnormalities or mechanical cardiac injury; (2) Coronary artery bypass grafting, heart valve replacement, or cardiac surgery for other reasons are required; (3) Other conditions result in patients with a life expectancy of less than 1 year; (4) Insufficient perfect records or clinical data.

Data Collection

Demographic and clinical data were extracted from the hospital's electronic medical records system. All laboratory tests and examinations were conducted within 24 hours following the diagnosis of post-infarction ventricular septal rupture (PIVSR). Information regarding patient outcomes (discharge in normal or unhealthy condition) was partially obtained from hospitalization records. The collected data included:

1. General conditions at admission: Gender, age, myocardial infarction (MI) site, heart rate, blood pressure, etc.
2. Past medical history: Hypertension, diabetes, cerebrovascular disease, alcohol consumption, and smoking history.
3. Laboratory tests: White blood cell count (WBC), red blood cell count (RBC), platelet count (PLT), C-reactive protein (CRP), NT-proBNP), serum creatinine (SCR), urea, uric acid (UA), estimated glomerular filtration rate (eGFR), thrombin time (TT), prothrombin time (PT), D-dimer (D-D), international normalized ratio (INR), prothrombin activity (PTA), activated partial thromboplastin time (APTT), etc.
4. Echocardiographic results: Ventricular septal perforation location, perforation diameter, left ventricular ejection fraction (LVEF), left ventricular diastolic dimension, ventricular aneurysm, and shunt flow.
5. Treatment details: Operative time, procedure type, coronary angiography results, blood transfusion, intra-aortic balloon pump (IABP), extracorporeal membrane oxygenation (ECMO), and continuous renal replacement therapy (CRRT).

Patients were stratified into low and high groups based on the SII.

Informed Consent and Ethics

Due to the retrospective nature of this study, the Institutional Review Board (IRB) waived the requirement for informed consent. All patient data were de-identified by removing direct identifiers (including names, hospital ID numbers, and admission dates) and analyzed using coded identifiers to ensure confidentiality, in compliance with China's Personal Information Protection Law. Data access was restricted to authorized investigators through password-protected systems. All methods were performed in accordance with the Declaration of Helsinki and relevant institutional guidelines. The ethical approval reference is Fuwai Central China Cardiovascular Hospital (2020) Ethics Review No. (3).

Outcome Definition

The primary outcome was defined as in-hospital death from any cause, which included death from any cause within 72 hours after hospital discharge.

Statistical Analysis

Statistical analyses were performed using R for Mac (version 4.2.2; R Foundation for Statistical Computing, Vienna) and SPSS Statistics (version 27.0; IBM Corp., Armonk, NY). Continuous variables were tested for normality using the Kolmogorov–Smirnov test, with variables demonstrating $p < 0.05$ considered non-normally distributed. Accordingly, continuous variables were expressed as mean ± standard deviation for normally distributed variables and as median (interquartile range, IQR) for non-normally distributed variables. The differences between groups were tested by independent samples *t* test or Mann–Whitney *U*-test, as appropriate. All p-values from multiple comparisons were adjusted for false discovery rate (FDR) using the Benjamini-Hochberg procedure in R (version 4.2.2). Variable screening was conducted using Least Absolute Shrinkage and Selection Operator (LASSO) analysis with the glmnet package (version 4.1–7). We implemented 10-fold cross-validation during the LASSO regression modeling process to select the optimal penalty parameter (λ), with model performance evaluated using repeated cross-validation to ensure stability of the selected features. LASSO-selected variables were analyzed using multivariable logistic regression to assess independent relationships with the outcome. Results were reported as adjusted odds ratios (aOR) with 95% confidence intervals. Pearson correlation analysis was then used to assess the linear relationships between the variables selected by LASSO. After assessing variable relationships, R was used to construct a nomogram, and Restricted Cubic Splines (RCS) were adopted to flexibly fit nonlinear relationships. The predictive validity of the screened variables on outcomes was evaluated by the area under the curve (AUC). A two-sided p value of <0.05 was considered statistically significant.

Results

Comparison of Clinical Characteristics Between Different Sll Level Groups

1. A total of 130 PIVSR patients with complete clinical records were included and analyzed, as presented in Table 1. The patients were stratified into two groups based on the median SII value (1079): the low SII group (SII < 1079, n=65) and the high SII group (SII ≥ 1079, n=65). Baseline characteristics, including age, sex, smoking status, alcohol consumption, history of diabetes, hypertension, previous myocardial infarction, systolic blood pressure, ventricular aneurysm, CRRT, ECMO, transfusion, target vascular, PASP, ventricular septal perforation position, perforation diameter, and processing mode, showed no significant differences between the two groups (all $P > 0.05$). However, significant differences were observed in several clinical parameters. The high SII group demonstrated significantly higher values in heart rate, IABP usage, Killip classification, ejection fraction, and bypass flow compared to the low SII group (all $P < 0.05$). Conversely, cardiac output was significantly higher in the low SII group than in the high SII group ($P < 0.05$). Notably, the high SII group had a greater proportion of patients with unfavorable discharge status.

2. Table 2 presents admission hematological profiles for both cohorts, with several biomarkers showing significant intergroup variation. Specifically, the high SII group exhibited significantly elevated levels of WBC, PLT, neutrophils (N), monocytes (M), CRP, NT-proBNP, Hs-cTn, Myo, LDH, glucose (Glu), ALT, AST, urea, uric acid (UA), D-dimer, and APTT compared to the low SII group (all $p < 0.005$). In contrast, lymphocyte (L) and albumin (ALB) levels were

Table 1 Comparison of Clinical Characteristics Between Different SII Level Groups

Variable	SII Group		p-value
	Low, N = 65	High, N = 65	
Age(years)	66 ± 8	67 ± 8	0.374
Sex(male), n(%)	30 (46.2%)	21 (32.3%)	0.106
Drinking, n(%)	10 (15.4%)	10 (15.4%)	>0.999
Smoking, n(%)	19 (29.2%)	11 (16.9%)	0.096
Hypertension, n(%)	30 (46.2%)	35 (53.8%)	0.380
Diabetes, n(%)	19 (29.2%)	25 (38.5%)	0.266
Previous MI, n(%)	19 (29.2%)	12 (18.5%)	0.150
Heart rate(bpm)	86 ± 18	96 ± 17	<0.001
SBP(mmHg)	109 ± 21	106 ± 20	0.456
Ventricular aneurysm, n(%)	46 (70.8%)	46 (70.8%)	>0.999
IABP, n(%)	20 (30.8%)	42 (64.6%)	<0.001
CRRT, n(%)	1 (1.5%)	7 (10.8%)	0.062
ECMO, n(%)	3 (4.6%)	4 (6.2%)	>0.999
Transfusion, n(%)	17 (26.2%)	18 (27.7%)	0.843
Target vascular lesions, n(%)			0.334
LAD	52 (80.0%)	58 (89.2%)	
RCA	10 (15.4%)	6 (9.2%)	
LCX	3 (4.6%)	1 (1.5%)	
Killip's classification, n(%)			0.043
IV	31 (47.7%)	41 (63.1%)	
III	19 (29.2%)	17 (26.2%)	
II	14 (21.5%)	5 (7.7%)	
I	1 (1.5%)	2 (3.1%)	
EF(%)	51 ± 8	54 ± 9	0.04
CO(mL)	71 ± 15	60 ± 17	<0.001
PASP(mmHg)	51 ± 16	53 ± 13	0.432
Perforative position of the ventricular septum, n(%)			>0.999
Apical segment	49 (75.4%)	49 (75.4%)	
Middle segment	3 (4.6%)	4 (6.2%)	
Basal segment	13 (20.0%)	12 (18.5%)	
Perforative diameter,(mm)	13.2 ± 4.7	14.0 ± 4.2	0.316
Bypass flow,(mm)	2.89 ± 2.03	3.66 ± 2.16	0.037
Processing mode, n(%)			0.576
PCI	42 (64.6%)	45 (69.2%)	
PTCA	23 (35.4%)	20 (30.8%)	
Situation, n(%)			0.017
Survival discharge	54 (83.1%)	42 (64.6%)	
Unhealthy discharge	11 (16.9%)	23 (35.4%)	

Abbreviations: MI, myocardial infarction; HR, heart rate; SBP, systolic blood pressure; IABP, intra-aortic balloon pump; CRRT, continuous renal replacement therapy; ECMO, extracorporeal membrane oxygenation; LAD, left anterior descending; LCX, left circumflex artery; RCA, right coronary artery; EF, ejection fraction; CO, cardiac output; PASP, pulmonary artery systolic pressure; PCI, percutaneous coronary intervention; PTCA, percutaneous transluminal coronary angioplasty.

significantly lower in the high SII group. No significant difference was observed in sodium (NA) levels between the two groups. Additionally, comparative analysis of RBC, DBIL, TBIL, HCY, potassium (K), SCR, eGFR, TG, TC, LDL, non-HDL-c, TT, PT, INR, and PTA showed nonsignificant variation across groups.

3. Figure 1A displays the LASSO coefficient profile for variable selection, while Figure 1B illustrates the corresponding cross-validation curve. The vertical dashed line on the right represents λ_1SE (the value of lambda within one standard error of the minimum). Variables with non-zero coefficients at this lambda value were retained for subsequent

Table 2 Comparison of Laboratory Indicators Between Different SII Level Groups

Variable	SII Group		p-value
	Low, N = 65	High, N = 65	
WBC×10^9/L	8.1 ± 3.7	12.8 ± 4.8	<0.001
RBC×10^9/L	3.97 ± 0.53	3.91 ± 0.57	0.531
PLT×10^9/L	198 ± 71	251 ± 80	<0.001
N×10^9/L	4.6 ± 2.4	11.3 ± 4.2	<0.001
L×10^9/L	2.12 ± 1.50	1.21 ± 0.43	<0.001
M×10^9/L	0.61 ± 0.30	0.83 ± 0.33	<0.001
CRP(mg/L)	29 ± 45	80 ± 157	0.014
HBA1c(%)	6.80 ± 1.22	6.95 ± 1.41	0.534
NT-proBNP(pg/mL)	7562 ± 6945	9977 ± 6276	0.04
Hs-CTn(ng/mL)	324 ± 514	1121 ± 2195	0.006
Myo(ng/mL)	145 ± 134	295 ± 277	<0.001
Glu(mmol/L)	7.5 ± 3.1	9.5 ± 3.9	0.002
ALT(U/L)	102 ± 251	282 ± 608	0.03
AST(U/L)	128 ± 523	549 ± 1546	0.041
DBIL(umol/L)	10.4 ± 10.7	8.1 ± 4.8	0.118
TBIL(umol/L)	18 ± 14	16 ± 15	0.318
HCY(umol/L)	29 ± 33	25 ± 14	0.418
ALB(g/L)	38.1 ± 3.8	36.3 ± 4.2	0.011
A/G	1.63 ± 0.37	1.53 ± 0.38	0.122
Na(mmol/L)	139.3 ± 4.6	137.0 ± 6.4	0.019
K(mmol/L)	4.18 ± 0.45	4.27 ± 0.51	0.289
SCR(umol/L)	94 ± 43	110 ± 59	0.067
UREA(mmol/L)	8 ± 4	13 ± 8	<0.001
UA (umol/L)	397 ± 149	475 ± 205	0.015
eGFR(mL/min)	62 ± 19	56 ± 19	0.11
TG(mmol/L)	1.31 ± 0.57	1.52 ± 0.80	0.078
TC(mmol/L)	3.51 ± 0.83	3.72 ± 1.04	0.212
LDL(mmol/L)	2.19 ± 0.57	2.40 ± 0.68	0.057
Non-HDL-c(mmol/L)	2.67 ± 0.73	2.87 ± 0.81	0.144
TT(s)	19 ± 9	23 ± 17	0.064
PT(s)	13.36 ± 7.99	13.47 ± 3.01	0.915
D-D(mg/L)	3.3 ± 3.1	6.1 ± 6.6	0.002
INR	1.18 ± 0.69	1.17 ± 0.27	0.945
PTA(%)	81 ± 22	75 ± 21	0.084
APTT(s)	29 ± 7	34 ± 11	0.002

Abbreviations: WBC, white blood cell; RBC, red blood cell; PLT, Platelet; N, neutrophil; L, lymphocyte; M, monocyte; CRP, C-reactive protein; HBA1c, glycated hemoglobin A1c; NT-proBNP, N-terminal prohormone of brain natriuretic peptide; Hs-CTn, high-sensitivity cardiac troponin, Myo, myoglobin; Glu, glucose; ALT, alanine aminotransferase; AST, aspartate aminotransferase; DBIL, direct bilirubin; TBIL, total bilirubin; HCY, homocysteine; ALB, albumin; A/G, albumin/globulin ratio; Na, sodium; K, potassium; SCR, serum creatinine; UA, uric acid; eGFR, estimated glomerular filtration rate; TG, triglyceride; TC, total cholesterol; LDL, low-density Lipoprotein; non-HDL-c, non-high-density lipoprotein cholesterol; TT, thrombin time; PT, prothrombin time; D-D, D – dimer; INR, international normalized ratio; PTA, prothrombin activity; APTT, activated partial thromboplastin time.

multivariate analysis. Based on this selection process, ALT, UREA and NT-proBNP were identified as significant predictors and included in further analyses.

4. This multivariable analysis (Table 3) demonstrated that following LASSO selection, both NT-proBNP (adjusted OR=2.52, p=0.001) and the Systemic Immune-Inflammation Index (SII; aOR=1.81, p=0.021) emerged as independent

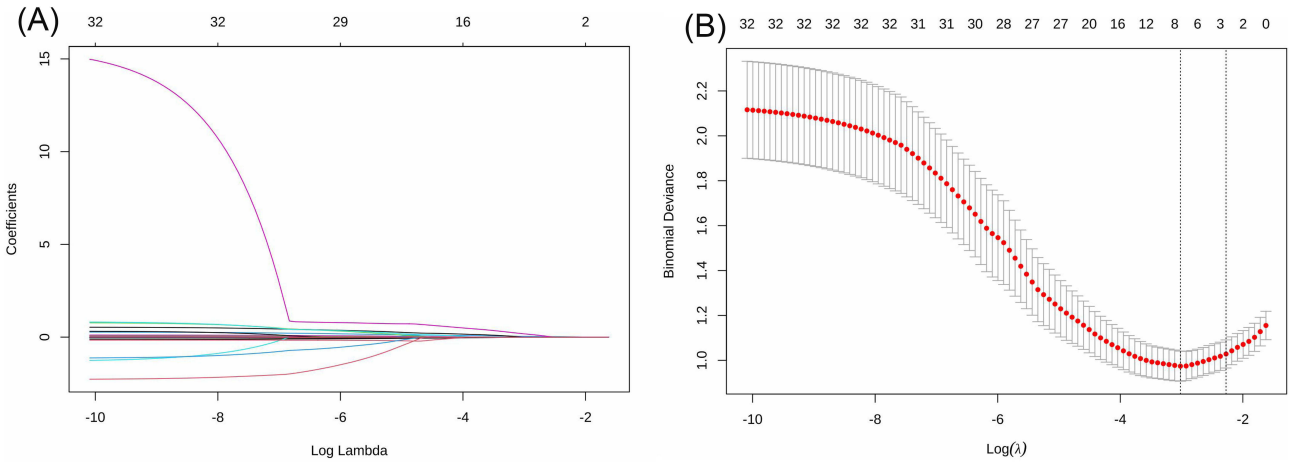

Figure 1 Variables selection using the LASSO analysis. (**A**) LASSO coefficient profiles of the Indicators with statistical differences. Each colored line represented the coefficient of each variables. (**B**) Optimal parameter (λ) selection in the LASSO analysis used tenfold cross validation. λ_1SE on the right side of the dotted line was selected as the final equation screening criterion.

predictors of postprocedural mortality in patients undergoing closure of postinfarction ventricular septal rupture. Although alanine aminotransferase (ALT) and blood urea nitrogen (UREA) showed tentative associations in univariate analyses, these were not sustained after multivariable adjustment.

5. The Pearson correlation analysis presented in the table examines the relationship between the Systemic Inflammation Index (SII) and various hematological and inflammatory markers. The results indicate that SII is significantly correlated with various markers of inflammation and immune response. Specifically, SII showed a strong positive correlation with neutrophils ($r = 0.710$, $p < 0.001$) and moderate positive correlations with white blood cell count (WBC, $r = 0.552$, $p < 0.001$), urea ($r = 0.449$, $p < 0.001$), and NT-proBNP ($r = 0.366$, $p < 0.001$). These findings suggest that SII is a comprehensive indicator of systemic inflammation and stress response. Additionally, SII exhibited a moderate negative correlation with lymphocytes ($r = -0.397$, $p < 0.001$), further supporting the notion that higher SII values are associated with a more pronounced inflammatory state. These findings highlight the potential utility of SII as a prognostic marker in clinical settings. For detailed results, see Table 4.

6. To evaluate the association between the SII and prognosis in patients with post-infarction ventricular septal perforation (PIVSR) following closure, we performed restricted cubic spline regression. The analysis revealed a linear relationship between SII levels and in-hospital mortality, as illustrated in Figure 2. This suggests that higher SII values are consistently associated with an increased risk of mortality in this patient population.

7. A nomogram was constructed using the variables selected through LASSO regression, as depicted in Figure 3. In the nomogram, numerical variables are represented on distinct scoring scales along the axis, with each value corresponding to a specific score. The individual scores for the four variables—ALT, UREA, NT-proBNP, and SII—are summed to

Table 3 Multivariable Logistic Regression Analysis of LASSO-Selected Biomarkers

Variable	β (SE)	Wald χ^2	p-value	OR (95% CI)
SII	0.591 (0.256)	5.325	0.021	1.806 (1.093–2.985)
ALT	0.259 (0.288)	0.805	0.370	1.295 (0.736–2.279)
UREA	0.280 (0.292)	0.920	0.337	1.323 (0.747–2.343)
NT-proBNP	0.925 (0.284)	10.583	0.001	2.521 (1.444–4.402)
Intercept	−1.299 (0.254)	26.206	<0.001	0.273

Abbreviations: SII, systemic immune inflammation index; ALT, alanine aminotransferase; NT-proBNP, N-terminal prohormone of brain natriuretic peptide; OR, odds ratio; CI, confidence interval; SE, standard error.

Table 4 Pearson Correlation

Biomarker	Pearson's r	p-value
WBC	0.552	<0.001
Neutrophils (N)	0.710	<0.001
Monocytes (M)	0.271	0.002
Lymphocytes (L)	−0.397	<0.001
CRP	0.247	0.005
Platelets (PLT)	0.203	0.020
UREA	0.449	<0.001
NT-proBNP	0.366	<0.001

Abbreviations: WBC, white blood cell; N, neutrophil; L, lymphocyte; M, monocyte; CRP, C-reactive protein; PLT, Platelet; NT-proBNP, N-terminal prohormone of brain natriuretic peptide.

yield a total score. The cumulative score provides an estimated risk of death during hospital stay for those with ventricular septal rupture following myocardial infarction.

8. The predictive performance of individual variables for in-hospital mortality was evaluated using receiver operating characteristic (ROC) curve analysis. The area under the curve (AUC) values for SII, ALT, UREA, and NT-proBNP were 0.702 (95% CI: 0.599–0.804), 0.676 (95% CI: 0.568–0.784), 0.698 (95% CI: 0.594–0.802), and 0.831 (95% CI: 0.762–0.891), respectively, as illustrated in Figure 4 and detailed in Table 5.

9. As illustrated in Figure 5 and comprehensively detailed in Table 6, we developed and evaluated two multivariate prognostic models using the area under the receiver operating characteristic curve (AUC). Comparative analysis demonstrated that Model 2 exhibited statistically superior performance across all evaluation metrics. Specifically, the discriminatory power of the models improved significantly, with the AUC increasing from 0.828 (95% CI: 0.757–0.899) for Model 1 to 0.845 (95% CI: 0.775–0.915) for Model 2. These findings indicate that incorporating the Systemic Immune-Inflammation Index (SII) into the baseline model meaningfully enhances its prognostic accuracy, thereby establishing Model 2 as a more robust and clinically actionable predictive tool.

Discussions

Ventricular septal rupture (VSR) is a severe complication of acute myocardial infarction. Although its incidence is relatively low, its lethality and disability rate are extremely high, posing a serious threat to the life, health and quality of life of patients.[13] Although interventional therapy has emerged as an effective treatment modality, rapidly improving hemodynamics and alleviating heart failure symptoms, there remains a paucity of research on predicting short-term

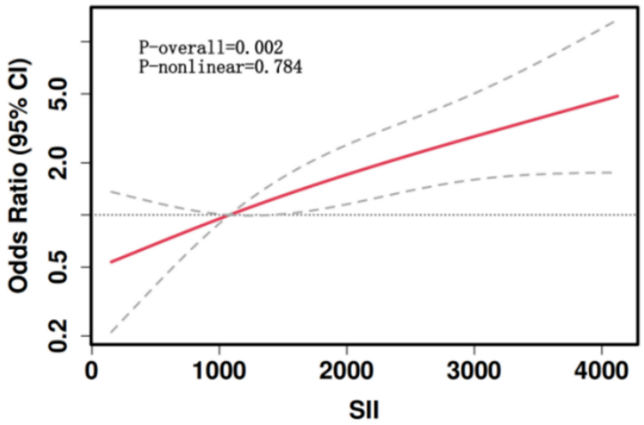

Figure 2 Odds ratios(OR) of In-hospital mortality rate as a function of base line SII.
Abbreviations: SII, systemic immune inflammation index; RCS, restricted cubic spline.

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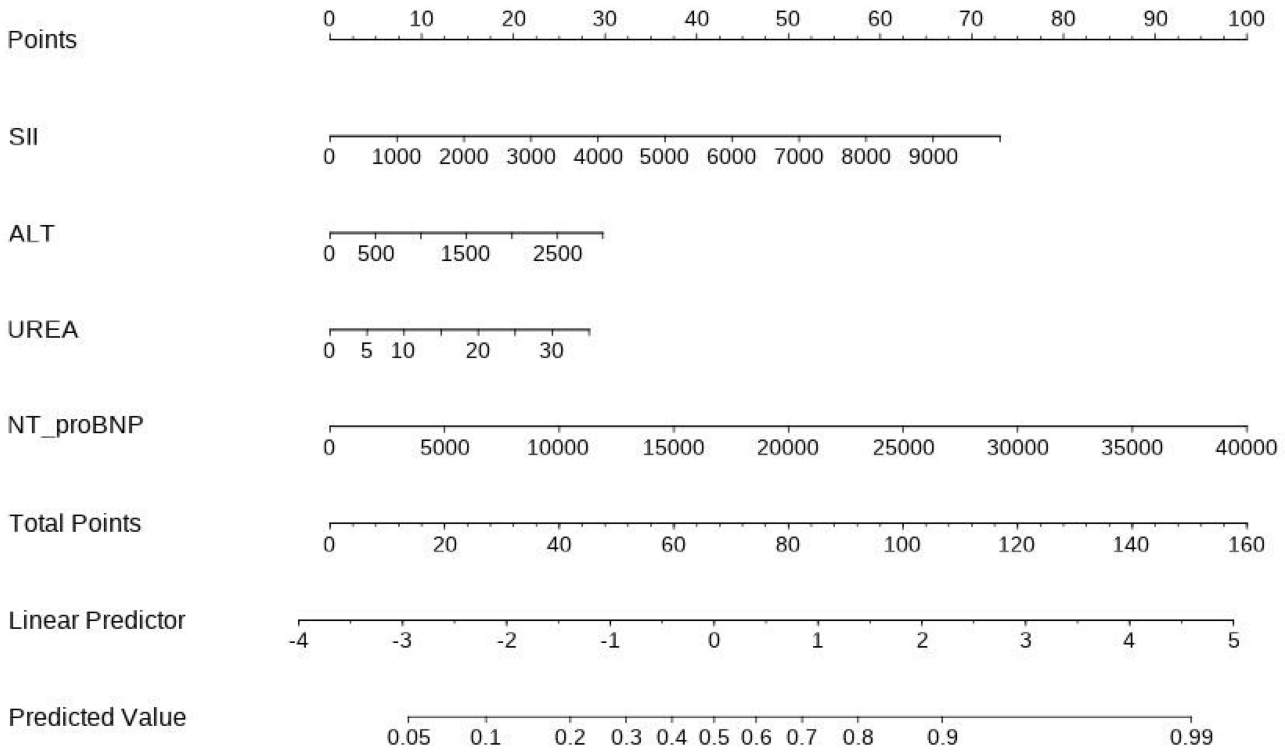

Figure 3 Nomogram for in-hospital mortality in PIVSR patients. The nomogram model includes SII, ALT, UREA and NT-proBNP. Evaluate patients based on the specific data of each variable, and sum up the total points according to the nomogram. Based on these total points, the in-hospital mortality risk of patients can be predicted.
Abbreviations: SII, systemic immune inflammation index; ALT, alanine aminotransferase; NT-proBNP, N-terminal prohormone of brain natriuretic peptide.

prognostic outcomes in patients with post-myocardial infarction ventricular septal rupture (PIVSR) following occlusion surgery.[14] While NLR primarily reflects neutrophil-lymphocyte dynamics and PLR indicates platelet activity, SII's integration of all three lineages provides superior risk stratification by accounting for thrombotic-inflammation crosstalk through platelet-neutrophil interactions. This study addresses this gap by investigating the correlation between the Systemic Immune-Inflammation Index (SII) and short-term outcomes in PIVSR patients after occlusion surgery. Our findings underscore the potential of SII as a convenient and effective prognostic indicator in this high-risk population.

The Role of Inflammation in PIVSR

Numerous clinical studies have demonstrated that inflammation plays a pivotal role in the onset, progression, and prognosis of various diseases, including cardiovascular conditions. Inflammation has been widely recognized as a critical driver in the pathogenesis of cardiovascular diseases, contributing to both acute events and chronic disease states.[15–17] Acute myocardial infarction (AMI) initiates an acute stress response that activates inflammatory cascades, triggering the release of pro-inflammatory cytokines (IL-1β, IL-6) and chemokines which directly induce cardiomyocyte apoptosis and structural damage, while neutrophil-derived proteases degrade extracellular matrix components, compromising the myocardial collagen network's integrity and reducing tissue tensile strength, thereby elevating the risk of ventricular wall rupture.[18,19] As a composite index derived from platelet, neutrophil, and lymphocyte counts, SII provides a comprehensive reflection of systemic inflammatory and immune status. In the context of PIVSR, the rupture of the ventricular septum triggers a rapid stress response, initiating a cascade of inflammatory reactions. These inflammatory processes exacerbate myocardial injury through multiple mechanisms.[20–22] On one hand, Neutrophil-dominated inflammation promotes matrix metalloproteinase-9 release, exacerbating extracellular matrix degradation and adverse remodeling,[23] while inflammatory cytokines and mediators directly damage cardiomyocytes, leading to apoptosis and disruption of cardiac structure and function. On the other hand, inflammation induces microcirculatory disturbances,

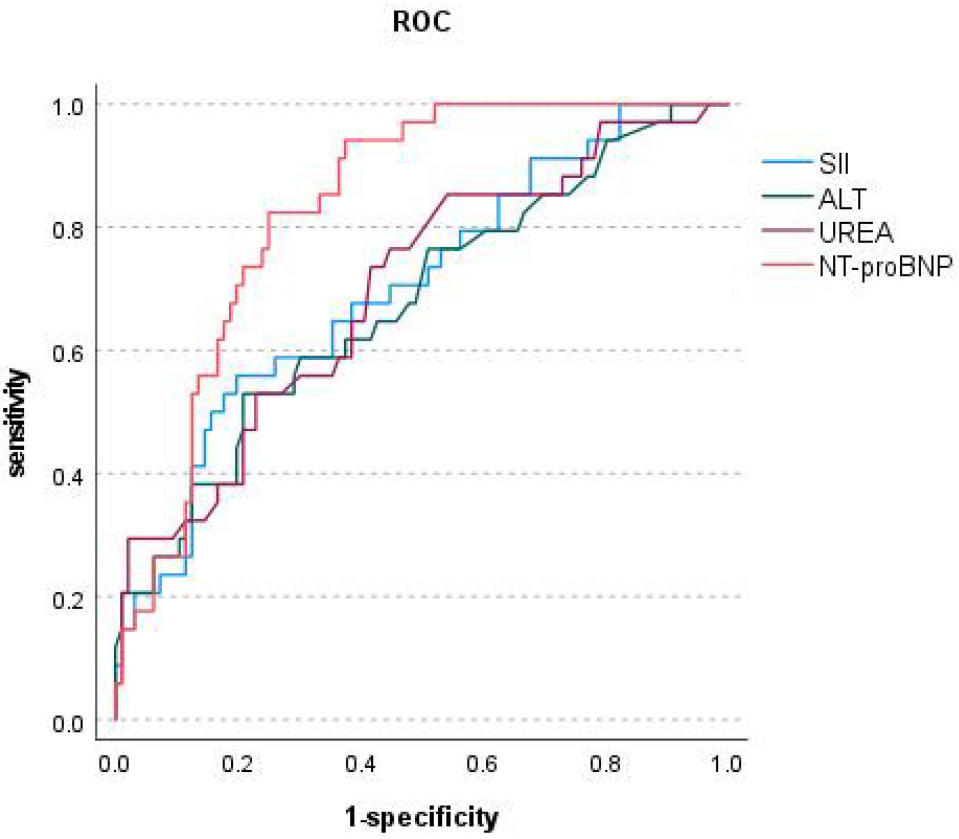

Figure 4 The AUC (Area Under the Curve) for prediction using a single independent variable.
Abbreviations: SII, systemic immune inflammation index; ALT, alanine aminotransferase; NT-proBNP, N-terminal prohormone of brain natriuretic peptide.

causing vasospasm and embolism, which further aggravate myocardial ischemia and hypoxia.[24] This vicious cycle of ischemia and inflammation underscores the importance of SII as a biomarker for risk stratification in PIVSR patients.

Development and Validation of the Nomogram Model

Nomogram models have found extensive application in predicting the prognosis of cardiovascular diseases.[25] To address the need for accurate prognostic tools, we developed a nomogram model incorporating ALT, UREA, NT-proBNP, and SII. The inclusion of SII significantly enhanced the model's predictive performance, as evidenced by a AUC, compared to the model without SII. ROC curve analysis further demonstrated that SII alone had an AUC of 0.702 (95% CI: 0.598–0.805, P < 0.001), indicating its moderate predictive capability. These results highlight the additive value of SII in prognostic assessment and provide clinicians with a practical tool for personalized risk stratification.

Table 5 AUC Values and 95% Confidence Intervals for Variables

Variable	AUC Value	AUC 95% Confidence Interval	p-value
SII	0.702	0.599–0.804	<0.001
ALT	0.676	0.568–0.784	<0.001
UREA	0.698	0.594–0.802	<0.001
NT-proBNP	0.831	0.762–0.891	<0.001

Abbreviations: AUC, Area Under the Curve area; SII, systemic immune inflammation index; ALT, alanine aminotransferase; NT-proBNP, N-terminal prohormone of brain natriuretic peptide.

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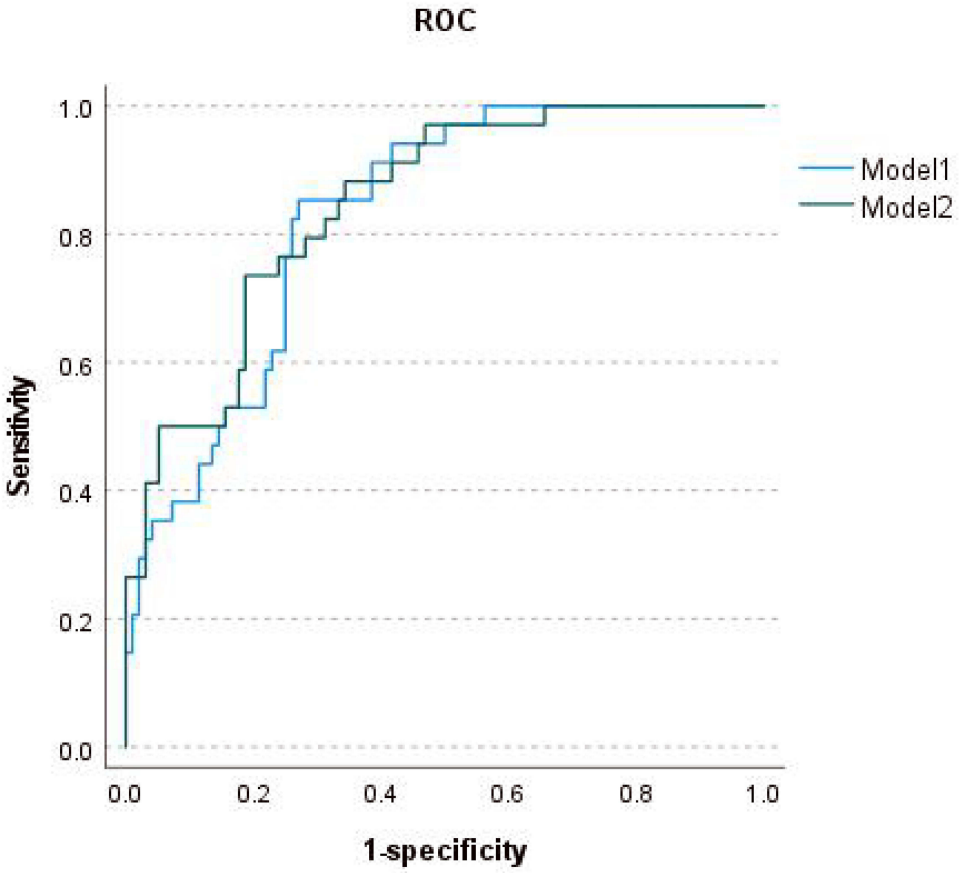

Figure 5 The AUC (Area Under the Curve) Analysis of Model Performance. Model 1: ALT, UREA. and NT-proBNP. Model 2: add SII to model 1.

Clinical Implications

The integration of SII into the nomogram model has significant clinical implications.[26] PIVSR is a life-threatening condition, and early identification of high-risk patients is crucial for optimizing treatment strategies.[27] The nomogram model offers an intuitive and user-friendly tool for clinicians to assess short-term prognosis based on readily available clinical parameters. For instance, patients with elevated SII levels and other risk factors may benefit from more aggressive interventions, such as enhanced anti-inflammatory therapies or targeted myocardial support. Additionally, the cost-effectiveness and accessibility of SII, which can be derived from routine blood tests, make it a practical biomarker for widespread clinical use.

Comparison with Existing Literature

Our findings align with previous studies that have demonstrated the prognostic value of SII in other cardiovascular conditions, such as acute coronary syndrome and heart failure.[28–30] However, this study is among the first to specifically evaluate the utility of SII in PIVSR patients following occlusion surgery. The successful inclusion of SII in our

Table 6 Comparison of Different Prognostic Models on Patients

Model Predictors	AUC	AUC 95% Confidence Interval	p-value
Model 1	0.828	0.757–0.899	<0.001
Model 2	0.845	0.775–0.915	<0.001

Notes: Model 1: ALT, UREA. and NT-proBNP. Model 2: add SII to model 1.
Abbreviation: AUC, Area Under the Curve area.

nomogram model not only validates its role in risk stratification but also opens new avenues for research into the interplay between inflammation and mechanical complications of myocardial infarction.

Limitations and Future Directions

Despite its strengths, this study has several limitations. First, the retrospective design introduces the potential for selection bias, which may affect the generalizability of our findings. Second, the sample size was relatively small, and larger, multicenter studies are needed to validate the predictive performance of the SII-combined nomogram model. Third, the study focused on short-term outcomes, and the long-term prognostic value of SII in PIVSR patients remains unexplored. Future research should investigate whether SII retains its predictive utility over extended follow-up periods and explore the underlying mechanisms linking systemic inflammation to adverse outcomes in PIVSR patients.

Conclusion

In conclusion, our study demonstrates that SII is a valuable prognostic indicator in PIVSR patients undergoing occlusion surgery. The nomogram model incorporating SII, ALT, UREA, and NT-proBNP provides a practical tool for personalized risk assessment. While further validation is needed, our findings suggest that SII could play an important role in optimizing the management of this high-risk patient population.

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Disclosure

The author confirms no potential conflicts of interest, including commercial or financial ties, influenced this research.

References

1. Cubeddu RJ, Lorusso R, Ronco D, et al. Ventricular septal rupture after myocardial infarction. *J Am College Cardiol*. 2024;83(19):1886–1901. doi:10.1016/j.jacc.2024.01.041
2. David TE. Post-infarction ventricular septal rupture. *Ann Cardiothorac Surg*. 2022;11(3):261–267. doi:10.21037/acs-2021-ami-111
3. Sulzgruber P, El-Hamid F, Koller L, et al. Long-term outcome and risk prediction in patients suffering acute myocardial infarction complicated by post-infarction cardiac rupture. *Int J Cardiol*. 2017;227:399–403. doi:10.1016/j.ijcard.2016.11.037
4. Mazhar F, Faucon A-L, Fu EL, et al. Systemic inflammation and health outcomes in patients receiving treatment for atherosclerotic cardiovascular disease. *Eur Heart J*. 2024;45(44):4719–4730. doi:10.1093/eurheartj/ehae557
5. Hou A-C, Zhao J-Y, Wei Y-J, Ou Z-H, Liu C-F. The neutrophil-to-lymphocyte ratio is associated with in-hospital heart failure in patients with ST-segment elevation myocardial infarction treated with primary percutaneous coronary intervention. *Heliyon*. 2024;10(21):e39761. doi:10.1016/j.heliyon.2024.e39761
6. Cupido AJ, Kraaijenhof JM, Burgess S, Asselbergs FW, Hovingh GK, Gill D. Genetically predicted neutrophil-to-lymphocyte ratio and coronary artery disease: evidence from Mendelian randomization. *Circ*. 2022;15:e003553.
7. Zhang C, Li M, Liu L, et al. Systemic immune-inflammation index as a novel predictor of major adverse cardiovascular events in patients undergoing percutaneous coronary intervention: a meta-analysis of cohort studies. *BMC Cardiovasc Disord*. 2024;24(1):189. doi:10.1186/s12872-024-03849-4
8. Yang R, Chang Q, Meng X, Gao N, Wang W. Prognostic value of Systemic immune-inflammation index in cancer: a meta-analysis. *J Cancer*. 2018;9(18):3295–3302. doi:10.7150/jca.25691
9. He J, Liang G, Yu H, Lin C, Shen W. Evaluating the predictive significance of systemic immune-inflammatory index and tumor markers in lung cancer patients with bone metastases. *Front Oncol*. 2024;13:1338809. doi:10.3389/fonc.2023.1338809
10. Yang Y, Wu C-H, Hsu P-F, et al. Systemic immune-inflammation index (SII) predicted clinical outcome in patients with coronary artery disease. *Eur J Clin Investigation*. 2020;50(5):e13230. doi:10.1111/eci.13230
11. Thiele H, Kaulfersch C, Daehnert I, et al. Immediate primary transcatheter closure of postinfarction ventricular septal defects. *Eur Heart J*. 2008;30(1):81–88. doi:10.1093/eurheartj/ehn524

12. Winscott JG, Hillegass WB. Safety and efficacy of paclitaxel drug-coated balloon treatment of femoropopliteal claudicants: data and analytic methods matter. *Cathet Cardio Intervent*. 2020;96(5):1100–1101. doi:10.1002/ccd.29345
13. Damluji AA, van Diepen S, Katz JN, et al. Mechanical complications of acute myocardial infarction: a scientific statement from the American Heart Association. *Circulation*. 2021;144(2). doi:10.1161/CIR.0000000000000985
14. Sánchez-Luna JP, Amat-Santos IJ. Interventional management of mechanical complications in acute myocardial infarction. *Revista Española de Cardiología*. 2023;76(5):362–369. doi:10.1016/j.recesp.2022.11.014
15. Zhang Y, Liu W, Yu H, et al. Value of the systemic immune-inflammatory index (SII) in predicting the prognosis of patients with peripartum cardiomyopathy. *Front Cardiovasc Med*. 2022;9:811079. doi:10.3389/fcvm.2022.811079
16. Li C, Tian W, Zhao F, et al. Systemic immune-inflammation index, SII, for prognosis of elderly patients with newly diagnosed tumors. *Oncotarget*. 2018;9(82):35293–35299. doi:10.18632/oncotarget.24293
17. Cao Y, Li P, Zhang Y, et al. Association of systemic immune inflammatory index with all-cause and cause-specific mortality in hypertensive individuals: results from NHANES. *Front Immunol*. 2023;14:1087345. doi:10.3389/fimmu.2023.1087345
18. Widmer A, Linka AZ, Attenhofer Jost CH, et al. Mechanical complications after myocardial infarction reliably predicted using c-reactive protein levels and lymphocytopenia. *Cardiology*. 2003;99(1):25–31. doi:10.1159/000068448
19. Newby LK. Inflammation as a treatment target after acute myocardial infarction. *N Engl J Med*. 2019;381(26):2562–2563. doi:10.1056/NEJMe1914378
20. Oliveira JB, Soares AASM, Sposito AC. Inflammatory response during myocardial infarction. In: *Advances in Clinical Chemistry*. Vol. 84. Elsevier; 2018:39–79.
21. Sagris M, Theofilis P, Antonopoulos AS, et al. Inflammation in coronary microvascular dysfunction. *Int J Mol Sci*. 2021;22(24):13471. doi:10.3390/ijms222413471
22. Ferhat E, Karabekir E, Gultekin K, et al. Evaluation of the relationship between anti-inflammatory cytokines and adverse cardiac remodeling after myocardial infarction. *Kardiologiia*. 2021;61(10):61–70. doi:10.18087/cardio.2021.10.n1749
23. Zhou W, Lee JCY, Leung ST, et al. Long-term prognosis of patients with coronary microvascular disease using stress perfusion cardiac magnetic resonance. *JACC Cardiovasc Imaging*. 2021;14(3):602–611. doi:10.1016/j.jcmg.2020.09.034
24. Esmon CT. The interactions between inflammation and coagulation. *Br J Haematol*. 2005;131(4):417–430. doi:10.1111/j.1365-2141.2005.05753.x
25. Li P, Yao W, Wu J, et al. Development and validation of a nomogram model for predicting in-hospital mortality in non-diabetic patients with non-ST-segment elevation acute myocardial infarction. *Clin Appl Thromb Hemost*. 2024;30:10760296241276524. doi:10.1177/10760296241276524
26. Wang H, Nie H, Bu G, Tong X, Bai X. Systemic immune-inflammation index (SII) and the risk of all-cause, cardiovascular, and cardio-cerebrovascular mortality in the general population. *Eur J Med Res*. 2023;28(1):575. doi:10.1186/s40001-023-01529-1
27. Ito T. Post infarction ventricular septal rupture: yet hard to treat disease. *Gen Thorac Cardiovasc Surg*. 2017;65(5):243–244. doi:10.1007/s11748-017-0759-z
28. Yin W-H, Chen J-W, Feng A-N, Lin S-J, Young S. Multimarker approach to risk stratification among patients with advanced chronic heart failure. *Clin Cardiol*. 2007;30(8):397–402. doi:10.1002/clc.20171
29. Marchi F, Pylypiv N, Parlanti A, et al. Systemic immune-inflammation index and systemic inflammatory response index as predictors of mortality in ST-elevation myocardial infarction. *J Clin Med*. 2024;13(5):1256. doi:10.3390/jcm13051256
30. Karakayali M, Altunova M, Yakisan T, et al. A Relação entre o Índice de Imuno-Inflamação Sistêmica e Isquemia com Artérias Coronárias Não Obstrutivas em Pacientes Submetidos à Angiografia Coronária. *Arquivos Brasileiros de Cardiologia*. 2024;121(2):e20230540. doi:10.36660/abc.20230540

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