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Association between the Naples prognostic score and non-sustained ventricular tachycardia in patients with premature ventricular contractions

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Abstract

Non-sustained ventricular tachycardia (NSVT) is a serious ventricular arrhythmia associated with increased risk of sudden cardiac death. Early recognition of NSVT risk in patients with frequent premature ventricular contractions (PVCs) is important for effective risk evaluation and treatment planning. The Naples Prognostic Score (NPS) is a combined marker used to assess systemic inflammation and nutritional status. This study aimed to explore the relationship between the NPS and the occurrence of NSVT in patients with a high burden of PVCs. In this retrospective, single-center study, patients with ≥500 PVCs on 24-hour ambulatory ECG Holter monitoring were included. NPS was calculated using four specific laboratory markers: total cholesterol, serum albumin, the lymphocyte-to-monocyte ratio (LMR) and the neutrophil-to-lymphocyte ratio (NLR). Patients were grouped as low (0 points), moderate (1–2), or high (3–4) based on NPS. NSVT prevalence was compared among the different NPS categories. In total, 250 patients were evaluated for analysis. There was a significant increase in the prevalence of NSVT across the NPS categories: 8.1% in the low group, 14.3% in the moderate group, and 24.4% in the high group (p=0.038). Multivariable analysis showed that both NPS and prior myocardial infarction were independently associated with NSVT. The results indicate that NPS could be a practical, accessible, and low-cost tool for detecting NSVT risk in patients with frequent PVCs.

Keywords: Premature ventricular contractions, non-sustained ventricular tachycardia, Naples prognostic score, inflammation, nutritional status, risk stratification

Introduction

Ventricular premature contractions (PVCs) are among the most frequently observed even in asymptomatic or low-risk populations. Although often viewed as benign, they can serve as a trigger for more serious ventricular arrhythmias, including non-sustained ventricular tachycardia (NSVT) [1]. NSVT is defined as a brief episode consisting of three or more consecutive PVCs occurring at a heart rate over 100 beats per minute and resolving spontaneously within 30 seconds [2]. NSVT is clinically relevant due to its association with a higher probability of sudden cardiac death, warranting thorough evaluation and risk stratification.

The Naples Prognostic Score (NPS) is an integrated index that reflects both nutritional and inflammatory status by combining serum albumin and total cholesterol levels with the neutrophil-to-lymphocyte ratio (NLR) and lymphocyte-to-monocyte ratio (LMR), thereby offering a comprehensive evaluation of the patient's overall condition [3]. Initially developed to predict postoperative complications in colorectal surgery patients [4], NPS has also been explored as a prognostic marker in cardiology practice. It has demonstrated predictive value for mortality following acute myocardial infarction (MI) [5], prognosis in heart failure patients [6,7], and survival outcomes after transcatheter aortic valve implantation (TAVI) [8]. While inflammation-related scoring systems have shown links to unfavorable cardiovascular outcomes, the potential of the NPS in predicting susceptibility to ventricular arrhythmias has not been thoroughly investigated.

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Reliable and practical prognostic parameters are needed to predict the development of NSVT in patients with PVCs. We hypothesize that the NPS could be a valuable indicator for assessing NSVT risk in these patients. This study aims to assess the prognostic significance of the NPS in predicting NSVT among patients with high burden PVCs.

Material and Methods

Study Design and Participants

This study retrospectively included patients who underwent 24-hour electrocardiogram (ECG) Holter monitoring between January 2022 and December 2024. A high PVC burden was defined as ≥500 PVCs over 24 hours [9-11]. Exclusion criteria included the presence of significant structural heart abnormalities (e.g., hypertrophic cardiomyopathy or a left ventricular ejection fraction <40%), genetic arrhythmic syndromes, chronic inflammatory or autoimmune diseases, active malignancy, and Holter recordings lasting less than 20 hours or of inadequate technical quality. The study protocol was approved by the Marmara University Ethics Committee on April 18, 2025 (protocol no: 09.2025.25-0357). The study was carried out in full accordance with the ethical standards established by the Declaration of Helsinki.

ECG Holter Recording and Analysis

All patients' 24-hour recordings were obtained using a three-channel digital ambulatory ECG Holter device (DMS 9800, USA) according to a standard protocol. The Holter recordings were first analyzed using automated software and then manually verified by an experienced cardiologist blinded to the patients' clinical and laboratory data. NSVT was defined as an episode comprising at least three consecutive PVCs at a rate exceeding 100 beats per minute, with a total duration shorter than 30 seconds [2]. In addition, the recordings encompassed the detection of premature atrial contractions (PACs), episodes of atrial fibrillation (AF), and measurements of the corrected QT interval (QTc) duration.

Evaluation of Baseline Demographic, Clinical, and Biochemical Data

Demographic variables such as age and gender, along with major cardiovascular risk factors, history of MI, and medication usage data were retrospectively obtained from patient records. Laboratory analyses encompassed measurements of total and LDL cholesterol, serum albumin, creatinine, and complete blood count parameters including white blood cell (WBC), hemoglobin, platelets, neutrophils, lymphocytes, and monocytes. Based on these values, NLR and LMR were derived. The NPS was calculated by assigning one point for each abnormal parameter related to inflammation and nutrition. Based on the cumulative score, patients were stratified into three categories: low, moderate, and high risk, as illustrated in Figure 1.

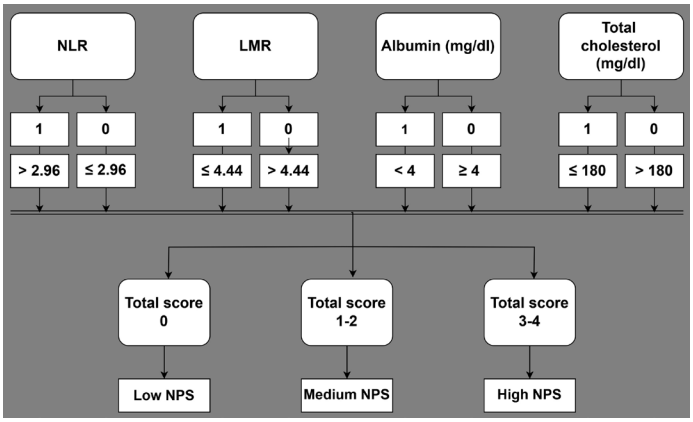

Figure 1. Calculation of the Naples Prognostic Score (NPS); The NPS is calculated from four laboratory parameters: neutrophil-to-lymphocyte ratio (NLR), lymphocyte-to-monocyte ratio (LMR), serum albumin, and total cholesterol levels; A score of 0 or 1 is assigned to each parameter based on the following cut-off values: NLR>2.96 (1 point), LMR≤4.44 (1 point), albumin<4 g/dL (1 point), and total cholesterol≤180 mg/dL (1 point); The total score ranges from 0 to 4 and classifies patients into three groups: low risk (score 0), moderate risk (score 1–2), and high risk (score 3–4)

Statistical Analysis

Statistical analyses were carried out using SPSS software (version 26.0). The normality of continuous data was assessed using the Kolmogorov-Smirnov test. Data were presented as mean±standard deviation (SD) or median/interquartile range (IQR), depending on the normality of distribution. Group comparisons for continuous data were conducted using one-way ANOVA, while categorical variables were analyzed using the chi-square test. To identify independent determinants of NSVT, multivariable logistic regression analysis was performed. A p-value of <0.05 was considered statistically significant.

Results

An overview of baseline demographic and clinical data is provided in Table 1. Patients classified in the high NPS group tended to be significantly older compared to those in the moderate and low NPS groups (70.7±6.2 vs. 63.1±5.9 and 63.5±5.7 years, respectively; p=0.039). Diabetes mellitus (DM) was more frequently observed among patients with high NPS scores (55.6%) compared to those in the low (34.9%) and moderate (35.3%) NPS categories, with a statistically significant difference (p=0.039). There were no significant differences in other clinical characteristics or medication usage among the three groups.

HbA1c and WBC levels were observed to be higher among individuals in the high NPS group (6.7±1.0% and 8.9±2.3 $\times 10^3/\mu L$, respectively) compared to those in the lower NPS categories, with statistically significant differences (p=0.027 and p=0.001, respectively), as presented in Table 2. Serum creatinine, hemoglobin, platelet count, albumin, total cholesterol, and LDL cholesterol levels did not differ significantly among the study groups.

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As shown in Table 3, the prevalence of NSVT demonstrated a stepwise increase across the NPS-based risk groups, occurring in 8.1%, 14.3%, and 24.4% of patients in the low, moderate, and high NPS categories, respectively (p=0.038). The prevalence of AF, PACs, and mean QTc interval values were comparable across the groups, with no statistically significant differences observed.

To determine factors independently associated with the occurrence of NSVT, a multivariable logistic regression analysis was performed. A higher NPS score and a prior MI were independently associated with the presence of NSVT, even after adjusting for age, sex, diabetes mellitus, hypertension, hyperlipidemia, and smoking status (Table 4).

Table 1. Comparison of baseline clinical characteristics according to Naples prognostic score groups

	Low (n=86)	Moderate (n=119)	High (n=45)	p value
Age (years)	63.5±5.7	63.1±5.9	70.7±6.2	**0.039**
Male	39 (45.3%)	65 (54.6%)	23 (51.1%)	0.423
DM	30 (34.9%)	42 (35.3%)	25 (55.6%)	**0.039**
HT	58 (67.4%)	90 (75.6%)	36 (80.0%)	0.237
HL	35 (40.7%)	64 (53.8%)	24 (53.3%)	0.150
MI	15 (17.4%)	27 (22.7%)	14 (31.1%)	0.203
Stent/CABG	20 (23.3%)	38 (31.9%)	18 (40.0%)	0.125
Stroke	14 (16.3%)	29 (24.4%)	9 (20.0%)	0.367
Smoker	10 (11.6%)	19 (16.0%)	7 (15.6%)	0.765
ASA	29 (33.7%)	36 (30.3%)	16 (35.6%)	0.770
ACE/ARB	37 (43.0%)	40 (33.6%)	21 (46.7%)	0.208
BB	20 (23.3%)	36 (30.3%)	18 (40.0%)	0.134
Statin	20 (23.3%)	38 (31.9%)	18 (40.0%)	0.125
CCB	20 (23.3%)	36 (30.3%)	13 (28.9%)	0.530

Age is presented as mean±standard deviation (SD), Categorical variables are expressed as number (percentage) within each group; ACE: angiotensin-converting enzyme inhibitor, ARB: angiotensin receptor blocker, ASA: acetylsalicylic acid, BB: beta-blocker, CABG: coronary artery bypass grafting, CCB: calcium channel blocker, DM: diabetes mellitus, HL: hyperlipidemia, HT: hypertension, MI: myocardial infarction

Table 2. Comparison of laboratory parameters across Naples risk score groups

Parameter	Low (n=86)	Moderate (n=119)	High (n=45)	p value
HbA1c (%)	6.2±1.0	6.3±1.0	6.7±1.0	**0.027**
Creatinine (mg/dL)	0.9±0.2	0.9±0.2	0.9±0.2	0.154
WBC (×10³/µL)	7.2±1.6	7.9±2.2	8.9±2.3	**0.001**
Hemoglobin (g/dL)	13.3±1.5	13.1±1.6	13.0±2.2	0.492
Platelet (×10³/µL)	256.0±60.0	246.0±61.0	245.0±62.0	0.562
Albumin (g/dL)	4.2±0.4	4.1±0.4	4.1±0.3	0.263
Total-C (mg/dL)	202.0±38.0	198.0±47.0	192.0±47.0	0.443
LDL-C (mg/dL)	133.0±30.0	124.0±37.0	124.0±35.0	0.139

All values are presented as mean±standard deviation (SD); HbA1c: hemoglobin A1c, LDL-C: low-density lipoprotein cholesterol, Total-C: total cholesterol, WBC: white blood cell count

Table 3. Distribution of arrhythmic findings across Naples risk score groups

Parameter	Low (n=86)	Moderate (n=119)	High (n=45)	p value
NSVT n (%)	7 (8.1)	17 (14.3)	11 (24.4)	0.038
AF n (%)	6 (7.0)	8 (6.7)	6 (13.3)	0.346
SVES n (%)	30 (34.9)	46 (38.7)	13 (28.9)	0.500
Max QTc (ms)	546±84	533±67	540±64	0.529

QTc values are expressed as mean±SD. Categorical variables are shown as number (percentage) within each group; AF: atrial fibrillation, NSVT: non-sustained ventricular tachycardia, QTc: corrected QT interval, SVES: supraventricular extrasystole

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Table 4. Multivariable logistic regression analysis for predictors of NSVT

Variable	OR (95% CI)	p value
Naples score	1.455 (1.052–2.012)	**0.023**
Age	1.011 (0.946–1.081)	0.749
Male sex	1.762 (0.798–3.889)	0.161
Diabetes mellitus	1.017 (0.461–2.242)	0.967
Hypertension	1.521 (0.540–4.281)	0.427
Hyperlipidemia	0.783 (0.339–1.811)	0.568
Smoking status	0.990 (0.348–2.820)	0.985
Myocardial infarction	2.430 (1.079–5.473)	**0.032**

Odds ratios (OR) are presented with 95% confidence intervals (CI); NSVT: non-sustained ventricular tachycardia

Discussion

To our knowledge, this is the first study to evaluate the impact of NPS on the development of NSVT in patients with a high burden of PVCs. Our findings demonstrated that the incidence of NSVT increased significantly with higher NPS risk levels. Moreover, both a high NPS and prior MI were identified as independent predictors of NSVT development. These findings indicate that the NPS may be a useful tool for early risk stratification of ventricular arrhythmias and may help guide clinical management in patients with PVCs.

The association between NPS and ventricular arrhythmias may be attributed to the effects of systemic inflammation and malnutrition on cardiac structure and electrophysiology. Inflammation promotes arrhythmogenesis by inducing myocardial fibrosis, altering ion channel function, and disrupting autonomic regulation [12], while malnutrition impairs cellular repair and antioxidant defenses, increasing myocardial vulnerability [13]. Prior studies support these mechanisms, showing that higher NPS values predict worse cardiovascular outcomes. Saygi et al. reported that NPS was independently associated with in-hospital mortality, highlighting the potential role of systemic inflammation and nutritional deficiency in adverse cardiac outcomes, including arrhythmic risk, in patients with MI [5]. This supports the growing evidence that systemic inflammation and nutritional imbalance, core elements of the NPS, play a critical role in arrhythmia-related outcomes. Kılıç et al. and Guo et al. likewise reported an association between NPS and increased mortality in heart failure (HF) patients [6,7]. These findings suggest that inflammation and malnutrition contribute to adverse myocardial remodeling and electrical instability. Therefore, the progressive increase in NSVT prevalence across NPS categories observed in our study may reflect the cumulative impact of inflammation and nutritional imbalance, underscoring the potential utility of NPS not only in prognostication but also in guiding arrhythmic risk stratification in clinical practice.

Our findings revealed that patients in the higher NPS categories had markedly increased WBC and HbA1c values, reflecting underlying inflammatory and glycemic dysregulation. Okşen et al. also identified NPS as an independent determinant of postoperative atrial fibrillation (POAF) among patients who had undergone cardiac surgery [14]. National Health and Nutrition Examination Survey (NHANES) data show higher NPS is associated with severe abdominal aortic calcification [15]. These findings suggest that systemic inflammation and nutritional impairment, as reflected by the NPS, may contribute to vascular remodeling. They may also predispose patients to myocardial structural alterations that increase arrhythmic risk.

Oğuz et al. reported a significant association between the modified Naples Prognostic Score (mNPS) and the coronary slow flow phenomenon (CSFP), highlighting the potential relevance of composite inflammatory-nutritional indices in coronary microvascular dysfunction [16]. In this study, a significantly higher prevalence of slow flow in the three major coronary arteries was observed among patients with elevated mNPS values. The mNPS, which integrates parameters of inflammation, nutritional status, and hypercholesterolemia, was shown to have potential in predicting coronary microvascular dysfunction, thereby providing a more comprehensive understanding of the impact of systemic inflammation on subclinical cardiovascular impairment. These findings indicate that disruptions in inflammatory and nutritional homeostasis may contribute not only to macrovascular complications but also impair coronary flow at the microvascular level, thus expanding the prognostic applications of NPS in clinical practice.

It is well recognized that hypercholesterolemia is strongly associated with coronary artery disease [17]; however, its direct arrhythmogenic potential remains unclear in the literature. Total cholesterol levels in the NPS primarily reflect nutritional status. Therefore, higher cholesterol levels may suggest better nutritional health, which could offer protective benefits against arrhythmias by helping to maintain electrolyte balance, especially in high-risk populations prone to arrhythmias, such as those with heart failure.

This study is the first to demonstrate a significant association between the NPS and the occurrence of NSVT in patients with a high burden of PVCs. Unlike prior research that mainly focused on structural heart disease or electrophysiological abnormalities, our findings highlight the potential of a cost-effective and

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practical index in arrhythmia risk assessment. The integration of nutritional and inflammatory markers into a single score may offer a more comprehensive understanding of arrhythmogenesis. The results indicate that both systemic inflammation and nutritional status may significantly contribute to the pathogenesis of ventricular arrhythmias. In this context, the NPS appears to be a useful and easily applicable marker for identifying patients at elevated risk, based on standard laboratory measurement.

Limitations

There are some limitations to this study. Firstly, the retrospective and single-center nature of the study may have introduced selection bias and limited the broader applicability of the findings. Second, the 24-hour Holter monitoring offers only a limited observation window, potentially leading to underdetection of arrhythmic events such as NSVT. Third, the laboratory parameters constituting the NPS were assessed at a single time point, failing to account for possible temporal fluctuations. Despite these limitations, our findings highlight the potential value of NPS in predicting NSVT, warranting confirmation through larger prospective studies.

Conclusion

Our findings demonstrate a significant association between the NPS and NSVT development in patients with high burden PVCs. The NPS may serve as a simple, accessible, and cost-effective tool for early arrhythmic risk assessment. Additional large-scale, prospective studies conducted across multiple centers are needed to better clarify the clinical relevance of the NPS and confirm its predictive value.

Conflict of Interests
The authors declare that there is no conflict of interest in the study.

Financial Disclosure
The authors declare that they have received no financial support for the study.

Ethical Approval
This study was approved by the Ethics Committee of Marmara University on April 18, 2025 (protocol no: 09.2025.25-0357).

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