THE ANATOLIAN JOURNAL OF CARDIOLOGY

Official journal of the TURKISH SOCIETY OF CARDIOLOGY

Early Urinary Sodium Levels May Predict the Extent of Myocardial Injury and Need for Decongestive Therapy in Non–ST-Elevation Myocardial Infarction

ABSTRACT

Background: Urinary sodium (UNa) has been increasingly studied in heart failure as a marker of diuretic response, but its prognostic role in acute myocardial infarction (MI) remains unclear. The aim was to evaluate whether admission UNa could provide prognostic information in patients with non–ST-elevation MI (NSTEMI).

Methods: This prospective observational study included 47 selected NSTEMI patients admitted to the coronary care unit. Spot urinary sodium was measured at admission and patients were stratified according to the median UNa value (92 mmol/L). Clinical outcomes, including peak troponin, Global Registry of Acute Coronary Events (GRACE) score, need for in-hospital diuretic therapy, and length of stay, were assessed.

Results: Patients with lower UNa (<92 mmol/L) had significantly higher peak troponin levels (median 1089 vs. 350 ng/L, $P = .004$) and a greater need for diuretic therapy during hospitalization (70.8% vs. 26.1%, $P = .002$). Urinary sodium was inversely correlated with peak troponin ($r = -0.37$, $P = .011$) and diuretic requirement ($r = -0.54$, $P < .001$). In multivariable regression, admission UNa remained an independent predictor of myocardial injury. Receiver operating characteristic analysis showed moderate discriminative ability of UNa for both troponin elevation (area under the curve [AUC]: 0.73) and need for diuretic use (AUC: 0.81).

Conclusion: Admission urinary sodium may serve as a simple, non-invasive adjunctive marker for risk stratification in NSTEMI, reflecting the neurohormonal activation. These findings suggest that UNa may complement established tools such as troponin and GRACE score in early evaluation.

Keywords: Neurohormonal activation, NSTEMI, urinary sodium

INTRODUCTION

Acute myocardial infarction (MI) remains a leading cause of morbidity and mortality worldwide, despite advances in early reperfusion strategies and pharmacological therapy. Reliable and easily accessible biomarkers that reflect both myocardial injury and systemic pathophysiology are essential to improve risk stratification in this high-risk population. While serum troponin remains the cornerstone biomarker for the diagnosis, quantification of myocardial necrosis and determining short- and long-term prognosis, recent research has suggested that indices of neurohormonal activation may provide complementary prognostic information by reflecting hemodynamic and inflammatory response to the acute coronary syndrome.[1-4]

Urinary sodium (UNa) has recently gained attention as a practical marker in both acute and chronic heart failure (HF), particularly for evaluating diuretic response, and is now recommended by guidelines.[5,6] Low UNa levels after loop diuretic administration consistently predict poor natriuretic response, insufficient decongestion, and adverse clinical outcomes including rehospitalization and mortality.[7,8] Similarly, lower admission UNa in acute HF has been associated with adverse short- and long-term outcomes, reflecting heightened neurohormonal activity,

ORIGINAL INVESTIGATION

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Received: September 16, 2025
Accepted: December 5, 2025
Available Online Date: December 18, 2025

Cite this article as: Kozluca V, Özyüncü N, Atan Ş, et al. Early urinary sodium levels may predict the extent of myocardial injury and need for decongestive therapy in non–ST-elevation myocardial infarction. *Anatol J Cardiol.* 2026;30(5):306-313.

DOI:10.14744/AnatolJCardiol.2025.5826

poor diuretic response, and increased risk of renal dysfunction.[9] These findings highlight impaired renal sodium excretion as a surrogate of systemic neurohormonal activation and cardiorenal dysfunction. Beyond HF, in the hypertensive population, it has been shown that low UNa excretion, often reflecting low dietary sodium intake, is independently associated with a higher risk of MI, particularly in men. This association is thought to be partly mediated by activation of the renin–angiotensin-aldosterone system (RAAS).[10] Taken together, these findings illustrate the lower limb of the well-described J-shaped relationship between urinary sodium excretion and cardiovascular outcomes, underscoring that low sodium excretion has been associated with increased cardiovascular risk.[11]

Neurohormonal activation, involving both sympathetic stimulation and the RAAS, is one of the key determinants of adverse outcomes in acute MI. In addition to worsening hemodynamic instability, this maladaptive response amplifies ischemic complications and increases the risk of arrhythmias, HF, and early mortality.[1,2,12] To date, no study has specifically investigated the impact of admission UNa levels on clinical outcomes in patients with acute MI. Several confounding factors may influence UNa in this setting, including the use of diuretics for congestion, contrast exposure during angiography, and the timing of urine sampling and the invasive management. In STEMI, the urgent need for reperfusion therapy usually precludes measuring baseline UNa. In contrast, in carefully selected NSTEMI patients, this assessment may be both feasible and informative. In this study, the prognostic significance of admission spot UNa was investigated in a carefully selected cohort of NSTEMI patients without prior diuretic use or overt decompensation. Specifically, the association of lower UNa levels with more severe myocardial injury, reflected by higher peak troponin concentrations, and with indicators of clinical risk, including Global Registry of Acute Coronary Events (GRACE) score, extent of coronary artery disease, signs of congestion, and length of hospital stay, was examined. By exploring these associations, this study provides preliminary evidence that early spot UNa measurement may serve as a simple, non-invasive marker of both disease severity and early prognosis in acute NSTEMI.

HIGHLIGHTS

- Admission urinary sodium was evaluated as a prognostic marker in non–ST-elevation myocardial infarction (NSTEMI) patients.
- Lower urinary sodium (UNa) was independently associated with greater myocardial injury (higher peak troponin).
- Patients with lower UNa had a significantly higher need for diuretic therapy during hospitalization.
- Urinary sodium demonstrated moderate discriminative ability in receiver operating characteristic analysis for both ischemic injury and congestion.
- Urinary sodium may provide complementary information to troponin and Global Registry of Acute Coronary Events score in early NSTEMI risk stratification.

METHODS

Study Design and Population

This prospective, observational study was conducted in the Cardiovascular Intensive Care Unit of Ankara University Hospital between September 2023 and April 2024. The study protocol was approved by the Ankara University Ethics Committee (approval date: January 30, 2023, approval code: 18-2023000018-2), conducted in accordance with the Declaration of Helsinki, and written informed consent was obtained from all participants. Consecutive patients aged ≥18 years with a confirmed diagnosis of NSTEMI with planned early coronary angiography established according to current European Society of Cardiology (ESC) guidelines were enrolled.[12] Patients were followed until discharge or in-hospital death.

Patients were excluded if they had active malignancy, severe liver disease, or chronic kidney disease (CKD) with estimated glomerular filtration rate (eGFR) <45 mL/min/1.73 m^2 (Chronic Kidney Disease Epidemiology Collaboration [CKD-EPI] equation). Other exclusion criteria included a known history of chronic or decompensated HF at presentation, hemodynamic instability or cardiogenic shock, urgent indication for primary percutaneous coronary intervention (PCI), ongoing diuretic therapy at admission (including loop diuretics, thiazides, or mineralocorticoid receptor antagonists) or the need for diuretics before urine sampling. Patients receiving antihypertensive regimens that included diuretics were also excluded. Patients with dehydration or hypotension, severe infection, and non-ischemic causes of troponin elevation as judged by the attending physician, patients with MI with non-obstructive coronary arteries (MINOCA) on angiography, electrolyte disturbances (hyponatremia or hypernatremia), or known endocrine disorders affecting sodium balance were also excluded. Finally, patients with recent exposure to nephrotoxic drugs, intravenous contrast agents within the last 7 days, chronic corticosteroid or nonsteroidal anti-inflammatory drug (NSAID) use, or those unable to provide a urine sample before coronary angiography at admission were not eligible for inclusion.

Clinical and Laboratory Assessments

On admission, all patients underwent a comprehensive clinical evaluation including medical history, physical examination, and in-hospital risk was assessed using the GRACE 2.0 score, as recommended by current ESC guidelines.[12] The presence of hypertension, diabetes mellitus, and hyperlipidemia was determined based on established clinical criteria or ongoing treatment. Hypertension was defined as a documented history of elevated blood pressure (≥140/90 mm Hg) or the use of antihypertensive medications. Diabetes mellitus was diagnosed in patients with a prior clinical diagnosis, glycated hemoglobin (HbA1c) ≥6.5%, fasting plasma glucose ≥126 mg/dL, or those on antidiabetic therapy. Hyperlipidemia was identified by a documented history, elevated serum lipid levels according to guideline thresholds, or the use of lipid-lowering medications.

Transthoracic echocardiography was performed within 24 hours using a Vivid 9 ultrasound system (GE Medical Systems,

Milwaukee, WI, USA). Left ventricular ejection fraction (EF) was calculated with the modified Simpson's method according to the American Society of Echocardiography and the European Association of Cardiovascular Imaging recommendations.[13]

Peripheral venous blood and spot urine samples were collected simultaneously on admission, before any intravenous or oral diuretic administration. Patients who required either oral or intravenous diuretic therapy at any point during hospitalization due to clinical signs of congestion were classified as having a need for diuretic treatment. All patients underwent routine coronary care unit laboratory testing at admission, including standard biochemistry, complete blood count, and baseline high-sensitivity cardiac troponin T (hs-cTnT) measurement. Hs-cTnT was measured using the Elecsys Troponin T hs assay (Roche Diagnostics, Mannheim, Germany). Measurements were obtained at admission and then at 24-hour intervals for 2 consecutive days. Both the admission value and the peak troponin level within 48 hours were included in analyses. All samples, including the spot urine, were promptly processed in a certified central laboratory. In patients with an indwelling urinary catheter, urine samples were obtained at the time of catheter insertion. Urinary sodium was analyzed in spot samples and the results were analyzed both as a continuous variable and stratified by the cohort median (92 mmol/L). Renal function was estimated using the CKD-EPI creatinine equation, in line with current recommendations.[14]

Coronary Angiography and Treatment

All included patients were considered high risk and were managed with an early invasive strategy in accordance with ESC guidelines.[12] The time interval from diagnosis to angiography was recorded in hours for each patient. Coronary angiography was performed within 24 hours of admission, and the revascularization strategy (PCI, coronary artery bypass grafting [CABG], or medical therapy) was determined by the Heart Team or the attending interventional cardiologist. Percutaneous coronary intervention was performed by experienced operators in the certified laboratory, with radial access preferred when feasible. All patients received guideline-directed pharmacological therapy.[12]

The number of diseased coronary arteries was determined by visual estimation of luminal stenosis. Significant coronary artery disease was defined as ≥70% diameter stenosis in an epicardial artery with a reference vessel diameter of ≥2.0 mm, or ≥50% stenosis of the left main coronary artery.

Data Collection

Clinical, laboratory, and procedural data were recorded, including baseline and peak troponin levels, echocardiographic parameters, GRACE score, number of diseased coronary vessels, length of hospital stay, and the requirement for decongestive therapy during hospitalization. All patients were monitored throughout their hospital stay until discharge or in-hospital death, and clinical events occurring during this period were systematically documented.

Statistical Analysis

All statistical analyses were performed using IBM SPSS Statistics version 30.0 (IBM Corp., Armonk, NY, USA). Continuous variables were expressed as mean ± SD or as median with interquartile range (IQR), depending on distribution assessed by the Shapiro–Wilk test. Due to the skewed distribution of troponin values, results were reported as median (IQR), and comparisons between groups were performed using the Mann–Whitney *U*-test. Categorical variables were summarized as counts and percentages.

Patients were stratified according to the median UNa concentration (92 mmol/L). Between-group comparisons were performed using the Mann–Whitney *U*-test for continuous variables and the chi-square or Fisher's exact test for categorical variables, as appropriate. Correlations between UNa (as a continuous variable) and clinical parameters, including peak troponin, length of hospital stay, left ventricular EF, GRACE score, and use of angiotensin-converting enzyme inhibitors or angiotensin receptor blockers (ACE/ARB) were evaluated with Pearson's correlation coefficients. Correlation coefficients (r) and *P*-values were reported.

To identify independent predictors of clinical outcomes (peak troponin, hospital stay, EF, and the need for decongestive therapy), adjusted multiple regression analysis models were applied. Covariates included age, sex, diabetes mellitus, hypertension, eGFR, time to coronary angiography, number of diseased vessels, GRACE score, and UNa.

The prognostic value of UNa for categorical outcomes such as the requirement for diuretic therapy was further assessed using receiver operating characteristic (ROC) curve analysis. The area under the curve (AUC) and corresponding 95% confidence intervals were calculated. An optimal urinary sodium cutoff was determined using Youden's index, and sensitivity and specificity were reported.

A two-tailed *P*-value <.05 was considered statistically significant.

RESULTS

A total of 79 patients hospitalized with NSTEMI and planned for early coronary intervention were screened. After exclusions for early diuretic use prior to urine sampling (n = 7), inability to give urine samples before angiography (n = 7), refusal of angiography (n = 6), early transfer to surgery (n = 6), MINOCA as a result of the coronary angiography (n = 5), and 1 intraprocedural death, 47 patients completed the study protocol and were included in the final analysis. During hospitalization, 3 additional patients died—1 from fatal ventricular arrhythmia, 1 from ischemic stroke, and 1 from acute pulmonary edema refractory to therapy. These patients were not excluded from the analysis; however, given the small number of events, no statistical evaluation of mortality was performed.

The final study cohort had a mean age of 64.6 ± 10.5 years, and 36% were female. Hypertension was present in 81%, hyperlipidemia in 68%, diabetes mellitus in 49%, and 53% of patients were active smokers. The mean UNa concentration

on admission was 90.2 ± 32.7 mmol/L, with a median value of 92 mmol/L (IQR: 67.2-107.8). Patients were stratified into 2 groups according to this value: <92 mmol/L (n = 24) and ≥92 mmol/L (n = 23). Baseline demographics, cardiovascular risk factors, time to coronary angiography, and medication use were broadly similar between the groups. However, patients with lower UNa had significantly lower systolic and diastolic blood pressures, lower eGFR, and higher GRACE scores compared with those in the higher UNa group (Table 1).

Regarding clinical outcomes, patients with lower UNa had significantly higher baseline and peak troponin levels compared with those with higher UNa (baseline troponin: 169 vs. 78 ng/L, P = .012; peak troponin: 1089 vs. 350 ng/L, P = .004). They also required decongestive therapy more frequently during hospitalization (70.8% vs. 26.1%, P = .002) and had higher GRACE scores (138.4 ± 16.6 vs. 127.5 ± 18.4, P = .020). These differences are illustrated in Figure 1, showing significantly higher peak troponin concentrations and a greater proportion of patients requiring diuretic therapy in the low UNa group. In contrast, left ventricular EF, length of hospital stay, and the number of diseased coronary vessels did not differ significantly between the groups (Table 1).

Correlation analyses demonstrated that admission UNa was significantly associated with several clinical parameters. Lower UNa correlated strongly with the need for diuretic therapy during hospitalization (r = −0.54, P < .001) and with lower systolic blood pressure on admission (r = +0.71, P < .001). In addition, UNa was inversely related to both peak (r = −0.37, P = .011) and baseline troponin levels (r = −0.36, P = .014), as well as to length of hospital stay (r = −0.35, P = .015). By contrast, no significant correlations were observed between UNa and left ventricular EF or GRACE score (both P > .30). Ongoing use of ACE/ARB therapy, which may theoretically affect renal sodium handling, was not associated with admission UNa levels (P = .744). These relationships are summarized in Table 2 and correlation of UNa with troponin levels, diuretic need, and length of hospital stay are illustrated in Figure 2, which depicts the scatterplots and correlation lines for UNa against each of the examined parameters.

Table 1. Baseline Characteristics and Clinical Outcomes by Urinary Sodium Groups

Variables	Total (n = 47)	UNa < 92 mmol/L (n = 23)	UNa ≥ 92 mmol/L (n = 24)	*P*
Age (years)	64.6 ± 10.5	66.9 ± 9.6	62.2 ± 11.0	.140
Sex (Female/Male)	17/30	8/15	9/15	.540
Hypertension, n (%)	38 (80.9)	19 (82.6)	19 (79.2)	1.000
Diabetes mellitus, n (%)	23 (48.9)	12 (52.2)	11 (45.8)	.886
Hyperlipidemia, n (%)	32 (68.1)	19 (82.6)	13 (54.2)	.075
Smoking, n (%)	25 (53.2)	12 (52.2)	13 (54.2)	1.000
History of coronary artery disease, n (%)	16 (34.0)	7 (30.4)	9 (37.5)	.839
Statin use, n (%)	26 (55.3)	12 (52.2)	14 (58.3)	.896
Beta-blocker use, n (%)	25 (53.2)	15 (65.2)	10 (41.7)	.185
ACE/ARB use, n (%)	32 (68.1)	17 (73.9)	15 (62.5)	.599
Calcium channel blocker use, n (%)	19 (40.4)	7 (30.4)	12 (50.0)	.285
Systolic BP (mm Hg)	132.2 ± 21.0	118.7 ± 16.1	145.2 ± 16.7	<.001
Diastolic BP (mm Hg)	79.4 ± 12.8	71.8 ± 10.0	86.7 ± 11.0	<.001
eGFR (mL/min/1.73m^2)	75.4 ± 19.9	69.8 ± 19.6	80.8 ± 19.0	.059
Creatinine (mg/dL)	1.07 ± 0.29	1.12 ± 0.33	1.03 ± 0.24	.304
Serum sodium (mmol/L)	136.8 ± 2.9	136.7 ± 3.1	137.0 ± 2.8	.724
Baseline troponin* (ng/L)	Median 123 (IQR 41-214)	Median 169 (IQR 91-374)	Median 78 (IQR 32-147)	.012
Peak troponin* (ng/L)	Median 566 (IQR 238-1113)	Median 1089 (IQR 561-1412)	Median 350 (IQR 214-706)	.004
LVEF (%)	46.4 ± 8.6	46.5 ± 9.3	46.2 ± 8.0	.789
GRACE score	132.8 ± 18.2	138.4 ± 16.6	127.5 ± 18.4	.020
Length of stay (days)	4.5 ± 1.5	4.0 ± 1.0	4.9 ± 1.7	.073
Need for diuretic use, n (%)	23 (48.9)	6 (26.1%)	17 (70.8%)	.002
Time to angiography (hours)	9.3 ± 6.3	8.0 ± 5.5	10.7 ± 6.8	.138
No. of diseased coronary arteries	1.81 ± 0.68	1.75 ± 0.68	1.87 ± 0.69	.558

Values are presented as mean ± SD, median (IQR), or number (percentage). Categorical variables were compared using chi-square or Fisher's exact test.
ACE, angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker; BP, blood pressure; eGFR, estimated glomerular filtration rate; GRACE, Global Registry of Acute Coronary Events; LVEF, left ventricular ejection fraction; UNa, urinary sodium.
*Troponin values are shown as median (IQR) due to skewed distribution and compared using the Mann–Whitney U-test.

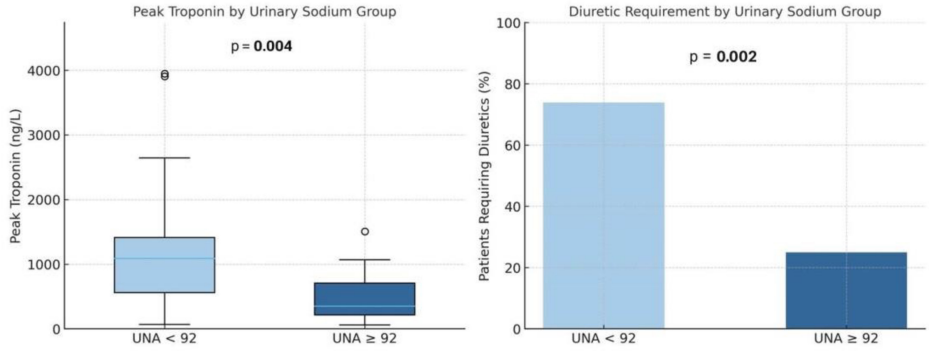

Figure 1. Comparison of clinical outcomes according to admission urinary sodium groups. At the left panel, patients with lower urinary sodium (<92 mmol/L) exhibited significantly higher peak troponin concentrations compared with those with higher urinary sodium (*P* = .004). At the right panel, the proportion of patients requiring diuretic therapy during hospitalization was also significantly greater in the low urinary sodium group (*P* = .002).

In adjusted multiple regression analysis according to age, sex, diabetes mellitus, hypertension, eGFR, time to angiography, number of diseased vessels, and GRACE score, admission UNa was independently and inversely associated with peak troponin levels (β = −11.6, *P* = .007). This indicates that each 1 mmol/L lower UNa corresponded to approximately 11.6 ng/L higher peak troponin. No other covariate reached statistical significance in the model.

Finally, ROC curve analyses were performed to evaluate the discriminatory performance of admission UNa. Urinary sodium demonstrated an AUC of 0.73 for predicting elevated peak troponin levels and an AUC of 0.81 for predicting the need for in-hospital diuretic therapy, indicating moderate prognostic ability (Figure 3). While these values do not reach thresholds typically considered diagnostic, they support a potential role for UNa as an adjunctive, easily obtainable marker in the early risk stratification of NSTEMI patients.

DISCUSSION

To the authors' knowledge, this is the first study to show that admission spot UNa provides clinically relevant information in patients presenting with NSTEMI. Lower UNa concentrations were independently associated with greater myocardial injury, reflected by higher peak troponin, and with an increased likelihood of requiring decongestive therapy during hospitalization. These associations were demonstrated in a carefully selected cohort without prior diuretic use or overt decompensated HF, minimizing confounding influences on UNa. In addition, UNa showed moderate discriminative ability in ROC analyses, supporting its potential role as a simple, non-invasive adjunct to early risk stratification in this setting.

Table 2. Correlation of Admission Urinary Sodium Concentration with Clinical and Laboratory Parameters

Parameters	Correlation Coefficient (*r*)	*P*
Need for diuretic use	−0.542	<.001
Systolic blood pressure	+0.705	<.001
Peak troponin	−0.367	.011
Baseline troponin	−0.356	.014
Length of hospital stay	−0.354	.015
Ejection fraction	+0.152	.309
GRACE score	−0.148	.320
ACE/ARB use	−0.049	.744

Correlation analyses were performed using Pearson correlation. *P* < .05 was considered statistically significant. UNa, urinary sodium; GRACE, Global Registry of Acute Coronary Events; ACE, angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker.
ACE, angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker; GRACE, Global Registry of Acute Coronary Events.

Urinary sodium has primarily been studied in HF, where it is recommended by the ESC Heart Failure Guidelines for early assessment of diuretic response, with values <50-70 mmol/L identifying insufficient natriuresis.[6] This approach is attractive because traditional metrics such as daily weight loss and urine volume often provide delayed or inaccurate feedback, potentially postponing timely adjustment of therapy. Studies suggest that spot UNa may be a useful marker of diuretic efficacy, allowing timely adjustment of therapy and proposed cutoff values to identify poor natriuretic response generally range between 50 and 100 mmol/L.[15,16] However, UNa must be interpreted with caution, as it is influenced by multiple factors, including kidney function, dietary sodium intake, prior diuretic therapy, and intravenous sodium administration. In this study, careful patient selection helped to minimize these potential confounders, although inter-individual variability can never be completely eliminated.

Peak troponin was used within the first 48 hours as a marker of myocardial injury. Troponin, a structural protein of the contractile apparatus, is released in a biphasic pattern after MI, with an initial peak at 24 hours. Reperfusion alters this kinetic profile, leading to variability in early values.[17] Ingkanisorn et al[18] were the first to investigate the relationship between early troponin values and infarct size measured by cardiac magnetic resonance imaging in patients with acute coronary syndromes. They reported that peak troponin-I strongly correlated with acute infarct mass in patients who underwent PCI within 6 hours of presentation ($r = 0.83$, $P < .001$).[18] In this study, NSTEMI patients underwent reperfusion on average

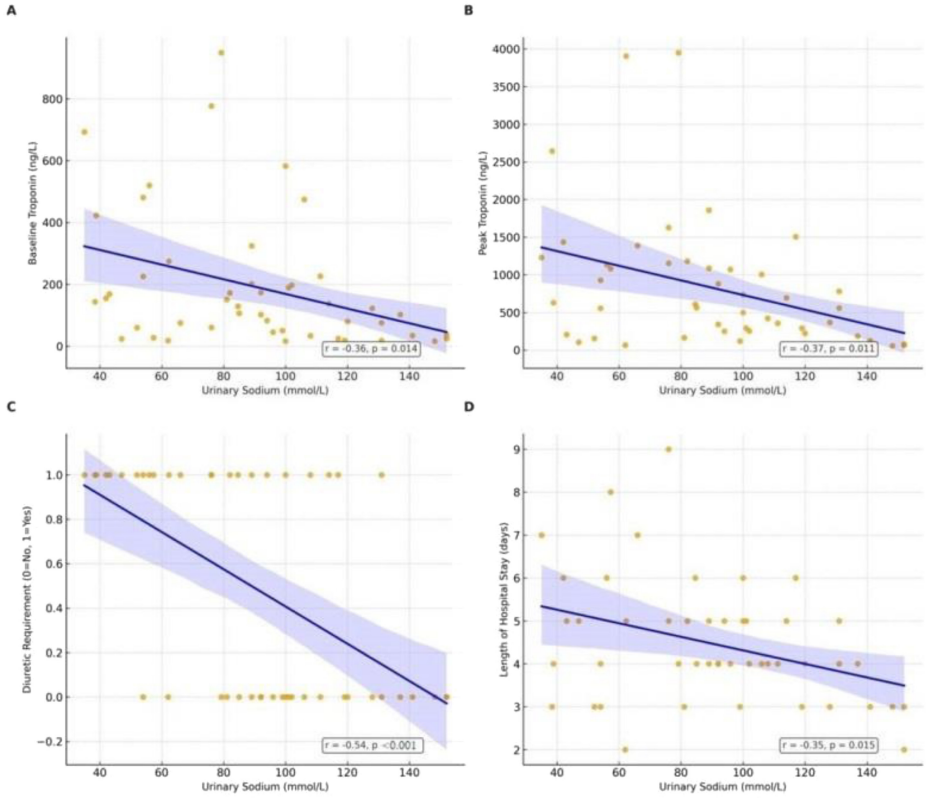

Figure 2. Correlations between admission urinary sodium concentration and (A) baseline troponin, (B) peak troponin, (C) diuretic requirement, and (D) length of hospital stay. Correlation coefficients (*r*) and *P*-values are shown in the panels.

within 9.3 ± 6.3 hours, and peak troponin levels measured within the first 48 hours were used as an indicator of myocardial injury. While not a precise quantification of infarct size, this approach, compatible with routine clinical practice, likely provides a meaningful estimate of the overall burden of myocardial necrosis.

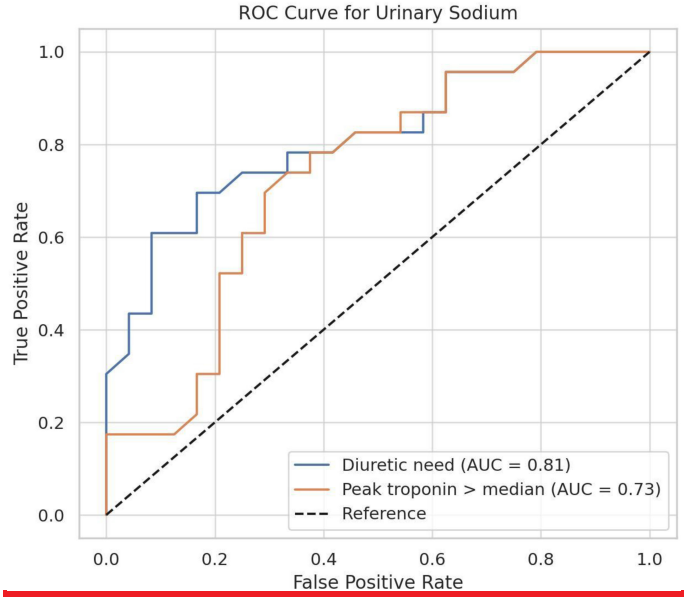

Figure 3. Receiver operating characteristic curve analysis of admission urinary sodium. Urinary sodium demonstrated moderate discriminative ability for predicting both (A) peak troponin levels above the median (AUC = 0.73) and (B) the in-hospital need for diuretic therapy (AUC = 0.81). The dashed line indicates the reference line of no discrimination.

The role of UNa in HF is well established, but its significance in acute MI has not been clearly defined. Myocardial infarction is characterized by a rapid neurohormonal surge, with activation of the sympathetic nervous system and RAAS. Excessive neurohormonal activity has been linked to arrhythmias, impaired ventricular function, and adverse ischemic complications.[19] Previous studies demonstrated that plasma catecholamines, angiotensin II, aldosterone, and atrial natriuretic peptide peak within the first 24 hours of infarction, and although they normalize in most patients, sustained elevations persist in those with left ventricular dysfunction or HF.[20] Neurohormonal activation is a hallmark of the acute phase of MI, and its persistence identifies patients at highest risk for complications and those most likely to benefit from therapies that attenuate these pathways.[21] In HF, impaired renal sodium excretion has been recognized as a surrogate of systemic neurohormonal activation and cardiorenal dysfunction.[7-9] Consistent with this framework, the finding that lower UNa was associated with greater myocardial necrosis and clinical congestion suggests that early disturbances in sodium handling may also reflect maladaptive neurohormonal responses in acute coronary syndromes. Using a median cutoff of 92 mmol/L, UNa demonstrated moderate discriminative ability in ROC analysis, supporting its potential role as a simple adjunctive marker for early risk stratification in NSTEMI. To the authors' knowledge, no studies

have specifically assessed the prognostic value of admission UNa in acute MI. Prior research has examined other markers of sympathetic activation, such as serum amylase, which has been associated with adverse in-hospital outcomes and GRACE score, or heart rate variability, an indirect measure of autonomic activity shown to predict adverse events after MI.[2,22] In this cohort, lower admission UNa was independently associated with greater myocardial injury, reflected by higher peak troponin concentrations, and with an increased likelihood of requiring decongestive therapy. These findings suggest that early sodium-handling abnormalities may mirror ischemic burden and neurohormonal activation in acute MI. Still, the single-center, limited sample design necessitates interpreting these results as hypothesis-generating pending external validation.

As a result, these findings suggest that admission UNa may provide complementary information in the management of acute MI. As a simple and readily available test, UNa could potentially help identify patients at greater ischemic risk and at higher likelihood of developing congestion during hospitalization. In this regard, UNa may serve as an adjunct to established tools such as troponin and the GRACE score, offering a broader perspective that integrates both myocardial injury and neurohormonal activation. While not diagnostic on its own, its ease of measurement makes it an attractive candidate for incorporation into early risk stratification strategies.

Study Limitations

Several limitations of this study should be acknowledged. First, this was a single-center study with a relatively small sample size, which limits the generalizability of the findings. Second, only selected NSTEMI patients without prior diuretic use, overt decompensated HF, or MINOCA were included, which restricts extrapolation to broader MI populations. Third, although UNa was measured at baseline before diuretic exposure, potential confounders such as dietary sodium intake, subclinical renal dysfunction, or prior non-reported outpatient therapies could not be fully excluded. Fourth, renal function was classified according to Kidney Disease Improving Global Outcomes (KDIGO) 2012 guideline criteria, based on eGFR alone, without assessment of albuminuria as recommended in the updated 2024 KDIGO guideline.[23] Another limitation is that patients presenting with low UNa at admission may have belonged to a subgroup with lower dietary sodium intake due to comorbid conditions or lifestyle factors, which could have influenced the present findings. There was no information on sodium consumption prior to admission, and therefore this potential confounding effect cannot be excluded. Also, detailed information on the duration and dosing of ACE/ARB therapy was not available; however, outpatient combined diuretic users were excluded and ACE/ARB exposure did not demonstrate a significant relationship with UNa. Another limitation was the evaluation of congestion and the subsequent need for diuretic therapy clinically by the attending physician, rather than by objective hemodynamic or imaging criteria. Although this reflects real-world practice and provides a pragmatic approach. Similarly, troponin was measured at baseline, 24 hours, and 48 hours in line with the routine NSTEMI practice; more frequent sampling might have provided a more precise definition of peak troponin. Finally, due to the small number of in-hospital deaths, mortality could not be analyzed as an outcome.

Ethics Committee Approval: Ethics committee approval was received from the Ankara University Ethics Committee (Approval date: January 30, 2023. Approval code: 2023/18-2023000018-2).

Informed Consent: Written informed consent was obtained from all participants.

Peer-review: Externally and internally peer-reviewed.

Author Contributions: Concept – V.K., N.O., S.A., E.T.; Design – V.K., N.O., S.A., E.T.; Supervision – V.K., N.O., E.T.; Resources – S.A., M.E.O., I.M.A.K., K.E.; Materials – S.A., M.E.O., I.M.A.K., K.E.; Data Collection and/or Processing – V.K., N.O., S.A., M.E.O., I.M.A.K., K.E.; Analysis and/or Interpretation – V.K., N.O., S.A., E.T.; Literature Search – M.E.O., I.M.A.K., K.E.; Writing – V.K., N.O., I.M.A.K., K.E., E.T.; Critical Review – V.K., N.O., E.T.

Declaration of Interests: The authors have no conflicts of interest to declare.

Funding: The authors declare that this study received no financial support.

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