# Original Article

# Association of Blood Urea Nitrogen to Creatinine ratio with in-hospital Outcome in Patients with Acute Myocardial Infarction

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**Abstract**

**Introduction:** Although blood urea nitrogen (BUN) and serum creatinine concentration (SCr) has been widely measured in daily clinical practice, blood urea nitrogen to serum creatinine (BUN-to-SCr) ratio (BCR) to assess prognosis in the patients admitted with acute myocardial infarction (AMI) remains yet understudied. This study aimed to determine the association between the BCR and in-hospital outcome in the patients with AMI admitted to a tertiary hospital, in Bangladesh.

**Methods:** All admitted patients with AMI in the Department of Cardiology, Chittagong Medical College Hospital from May 2023 to August 2024 were included in this prospective observational study. Outcome parameters included in-hospital mortality (IHM), left ventricular failure (LVF), cardiogenic shock (CS), ventricular arrhythmia (VA), conduction abnormality and length of hospital stay.

**Results:** A total of 297 patients with AMI were included in this study. Age ranged between 29 and 90 years with a mean±SD age of 56.5±10.3 years, 70.7% were male and 79.5% were diagnosed as ST-segment elevation myocardial infarction (STEMI). The receiver operating characteristic (ROC) curve analysis established that the area under the curve (AUC) for BCR was 0.782 [95% confidence interval (CI):0.713-0.852, p<0.001] and the threshold level for BCR was 19.50 with the sensitivity and specificity of 79.4% and 70%, respectively, for in-hospital mortality. High BCR at admission was associated with LVF (67.0 % vs. 21.5%, p<0.001), CS (69.8% vs. 25.7%, p<0.001), VA (19.8% vs. 3.7%, p<0.001) and IHM (25.5% vs. 3.7%, p<0.001).After adjusting for additional confounding factors, the BCR remained a significant predictor of IHM (>19.5vs.<19.5: Hazard ratio, 2.718;95% CI,1.137-6.495;p=0.024).

**Conclusion:** A high level of BCR at admission could be a useful predictor of IHM and other major complications in AMI patients. So, routine evaluation of BCR at admission can help to identify high risk cases of AMI with poor outcome.

**Keywords:** acute myocardial infarction, BUN, serum creatinine, BCR in- hospital outcome.

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## Introduction

Risk stratification tools like GRACE and Killip class have been well implemented and proven clinically beneficial to patients with acute myocardial infarction (AMI) [1,2]. However, these scoring systems are complex and must be validated for our setting. Studies indicated that renal function markers, including blood urea nitrogen (BUN), estimated glomerular filtration rate (eGFR) and serum creatinine (SCr) are associated with mortality from cardiovascular diseases (CVD) [3].

However, BUN is a nonspecific marker of renal insufficiency. SCr is affected by extra-renal factors [4]. Therefore, predictions based on BUN or SCr alone might have limitations. To overcome these limitations, the ratio of BUN and SCr (BCR) has been proposed as a better and more helpful marker for reducing the effect of the influencing factors on BUN and SCr individually. The BCR might be a more stable and accurate marker than SCr or BUN individually for evaluating patients of AMI prognosis [5,6].

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As a novel biomarker, the BCR has emerged as an independent prognostic factor for poor outcomes in different conditions, including COVID-19 [7], HF [6,8,9], acute kidney disease (AKI) and chronic kidney injury(CKD) [10], ischemic stroke [11,12], and AMI [13-16]. Regarding cardiac diseases, the relationship between BCR and outcomes was mainly investigated in patients with HF [6,17].The role of BCR as a prognostic marker in patients with AMI remains controversial in the published literature [13-16], which warrants further prospective studies to validate the utility of BCR in risk stratification of AMI patients. In this study the role of BCR at admission was evaluated in predicting in-hospital outcomes of patients with AMI admitted to a cardiology ward of a tertiary-level hospital in Bangladesh.

**Materials and Methods**

This prospective observational study was carried out in the department of Cardiology, Chittagong Medical College Hospital, Chattogram, Bangladesh from May 2023 to August2024. All admitted ST-segment elevation myocardial infarction (STEMI) and non-ST-segment elevation myocardial infarction (NSTEMI) patients during this period were included in this study. Inclusion criteria were: patients admitted to the hospital with a diagnosis of AMI and age more than18years. Exclusion criteria were: AMI patients presenting at admission with complications like acute left ventricular failure (LVF), cardiogenic shock and cardiac arrest due to life-threatening arrhythmia; patients who have known documented cardiomyopathy, congenital heart disease, valvular heart disease, co-morbid severe conditions like chronic liver disease, CKD, carcinoma and previous history of AMI, percutaneous coronary intervention (PCI), coronary artery by-pass surgery (CABG) or stroke; patients of unstable angina.

A pretested structured case record form including questionnaire and checklist was used to collect data. A twelve lead ECG was done in all patients with suspected ACS, at admission. Initial evaluation of the study population by age, sex, clinical history and physical examination, was performed at admission. Risk factors of AMI like hypertension, smoking, dyslipidemia, diabetes mellitus, and obesity were noted along with medical records. Blood sample was collected from all ACS patients (except STEMI) for high sensitivity Troponin I. About 4 ml of blood was collected into the red top tube for BUN and SCr tests from all patients at admission or as early as possible before any complications ariseand sent to the laboratory (Basic Lab, a private diagnostic centre in front of Chittagong medical college hospital) where BUN level was measured by a urease/glutamate dehydrogenase coupled enzymatic technique, and SCr level was measured by modifying the kinetic Jaffe reaction. Random/Fasting blood glucose level and hemoglobin were also measured in the Chittagong medical college hospital laboratory. Data regarding in-hospital complications like LVF (Shortness of breath or paroxysmal nocturnal dyspnea with lung base crepitation confirmed by doing portable chest X-ray and plasma NT-Pro BNP level), cardiogenic shock (CS), ventricular arrhythmias (Ventricular tachycardia or fibrillation confirmed by ECG or cardiac monitoring respectively), high grade atrioventricular block (confirmed by ECG) and in-hospital mortality (IHM) etc. were noted during hospital stays. Patients were followed up twice daily until their discharge or death (which was earlier) to record the laboratory findings, treatment modalities, complications and length of hospital day.

Data were recorded in the form of Excel worksheet. After completion of data collection, they were fed into SPSS (Statistical Package for Social science) windows version 23.0 for processing and analysis. Quantitative data were presented as either means and standard deviations (SD) or median and interquartile ranges (IQR) depending on their distributions. Frequencies and percent were computed for categorical variables. The discriminatory values of BCR for predicting in-hospital mortality were studied using receiver operating characteristic (ROC) curve analyses with the calculation of area under the curve (AUC) and the optimal threshold value of BCR for predicting mortality was defined. On the basis of threshold value of BCR, low and high BCR group was obtained. Between two groups, comparison of quantitative data were done using Mann-Whitny U test. Categorical data were compared among two groups of BCR values by Chi-square test. A multivariate Cox regression model estimated the hazard ratio (HR) and 95% Confidence interval (CI) for the relationship between BCR and In-hospital mortality. Correlation between two quantitative variables w ere done using Pearson correlation test. The survival curve was expressed as the Kaplan–Meier curve. $P < 0.05$ was considered statistically significant. The Ethical Review Committee of Chittagong Medical College approved the study protocol. The participants provided written informed consent. Every pertinent aspect of the protocol was thoroughly conveyed to the participants prior to the acquisition of their consent.

**Results**

A total of 297 AMI patients were included in this study. Age ranged between 29 and 90 years with a mean±SD age of 56.5±10.3 years. Table 1 showed baseline characteristics of the study subjects. About one-third of the patients were in their 5th decade (33%), followed by 6th decade (27.9%) and 4th decade (25.3%). Out of 297 patients, 210 (70.7%) patients were male and 87 (29.3%) were female with a male to female ratio of 2.4:1.

Table 1: Baseline characteristics of the study subjects (n=297)

| Variables | Frequency | Percentage |
|---|---|---|
| **Age group** | | |
| ≤40 | 23 | 7.7 |
| 41-50 | 75 | 25.3 |
| 51-60 | 98 | 33.0 |
| 61-70 | 83 | 27.9 |
| >70 | 18 | 6.1 |
| **Gender** | | |
| Male | 210 | 70.7 |
| Female | 87 | 29.3 |
| **Risk factors** | | |
| Smoking | 196 | 66.0 |
| Hypertension | 161 | 54.2 |
| Diabetes | 120 | 40.4 |
| Obesity | 34 | 11.4 |
| Dyslipidemia | 32 | 10.8 |
| **Types of AMI** | | |
| STEMI | 236 | 79.5 |
| NSTEMI | 61 | 20.5 |

AMI: acute myocardial infarction; STEMI: ST-segment elevation myocardial infarction; NSTEMI: non-ST-segment elevation myocardial infarction.

Out of 297 patients with AMI, the most frequent risk factor was ex- or current smoking, reported by 196 (66%) patients, followed by hypertension present in 161 (54.2%) patients, diabetes mellitus in 120 (40.4%), obesity in 34 (11.4%), patients and dyslipidemia in 32 (10.8%) patients. Out of 297 patients, 236 (79.5%) were diagnosed as STEMI and rest of the 61(20.5%) patients had NSTEMI. The majority of the AMI patients had anterior/antero-septal MI (n=133, 56.4%), followed by inferior MI (n=100, 42.4%), and lateral/posterior MI (n=3, 1.3%). Biochemical findings were summarized in Table 2. The mean BCR on admission was 17.58±6.37.

Table 2: Summary measures of BUN, serum creatinine, eGFR and BCR of the study subjects (n=297)

| Parameters | Median (IQR)/mean±SD/n (%) |
|---|---|
| BUN (mg/dl) | 17.00(13.00-24.25) |
| Serum creatinine (mg/dl) | 1.08±0.17 |
| eGFR (ml/min/m2of BSA) | 71.00(59.00-85.00) |
| BCR | 17.58±6.37 |

BUN: blood urea nitrogen; eGFR: estimated glomerular filtration rate; BSA: body surface area; BCR: blood urea nitrogen-to-creatinine ratio; IQR: inter quartile range; SD: standard deviation

The most frequent complication was cardiogenic shock (41.4%), followed by left ventricular failure (37.7%), and ventricular arrhythmia (14.9%). The median length of stay in the hospital was five days, and the in-hospital mortality rate was 11.4% (34/297) (Table 3).

Table 3: In-hospital outcome of the study subjects (n=297)

| Outcome parameters | Frequency | Percentage |
|---|---|---|
| **Left ventricular failure** | 112 | 37.7 |
| **Cardiogenic shock** | 123 | 41.4 |
| **High grade AV block** | 04 | 1.3 |
| 2nd degree AV block | 2 | .7 |
| 3rd degree AV block | 2 | .7 |
| **Ventricular arrhythmia** | 44 | 14.9 |
| Ventricular tachycardia | 21 | 7.1 |
| Ventricular fibrillation | 7 | 2.4 |
| **In-hospital mortality** | 34 | 11.4 |
| **Length of stay in hospital, days** | | |
| Range | 1.0-9.0 | |
| Median (Inter quartile range) | 5.0 (5.0-7.0) | |

AV: atrioventricular.

A moderate positive (Pearson correlation coefficient r=0.568) and significant (p < 0.001) correlation was found between admission BCR values and total number of complications in the present study (Figure 1).

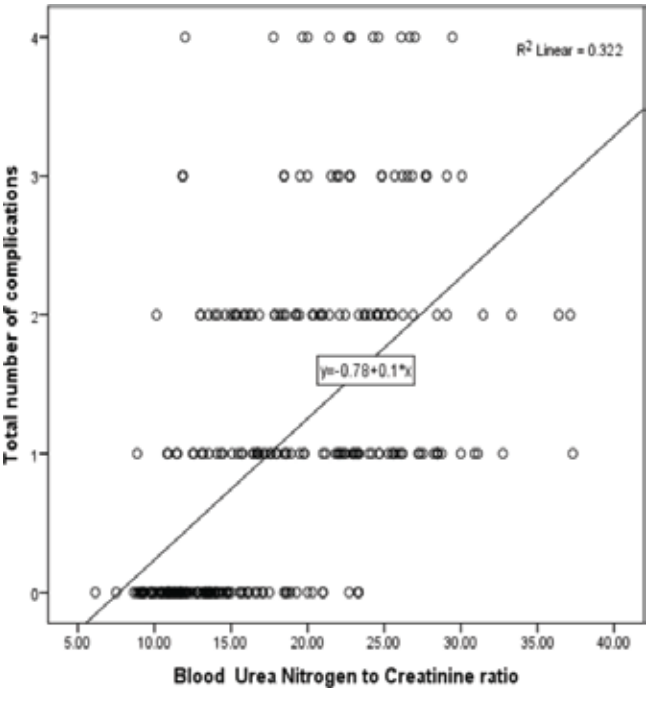


Figure 1: Correlation between admission BCR and total number of complications

Significantly higher proportion of patients with high BCR level at admission had complications (Table 4). In-hospital mortality was more frequent in patients with high BCR than those with low BCR (25.5% vs. 3.7%, p<0.001).

Table 4: In-hospital outcome of study subjects according to threshold level of BCR (n=297).

| Variables | BCR levels | | p value |
|---|---|---|---|
| | Low (<19.50) (n=191) | High (≥19.50) (n=106) | |
| Left ventricular failure | 41 (21.5) | 71 (67.0) | <0.001* |
| Cardiogenic shock | 49 (25.7) | 74 (69.8) | <0.001* |
| Ventricular arrhythmia | 7 (3.7) | 21 (19.8) | <0.001* |
| High grade AV block | 3 (1.6) | 1 (0.9) | 1.00 ‡ |
| In-hospital mortality | 7 (3.7) | 27 (25.5) | <0.001* |
| Hospital LOS, days | 5.0(5.0-6.0) | 6.0(5.0-7.0) | <0.001† |

BCR: blood urea nitrogen-to-creatinine ratio; AV: atrioventricular; LOS: length of stay: IQR: inter quartile range. Data were expressed as n (%) or median (IQR); *Chi-squaretest; †Mann-WhitneyU test. ‡ Fisher exact test.

The ROC analysis established that the AUC for BCR was higher (AUC: 0.782, 95% CI:0.713-0.852, p<0.001) than that of BUN (AUC: 0.780, 95% CI: 0.714-0.845, p<0.001) and that of SCr (0.642,95%CI:0.522-0.725, p=0.019) (Figure 2). The threshold level (that maximized the combined sensitivity and specificity) for BCR was 19.50, compared with 21.55 mg/dl and 1.07 mg/dl for BUN and SCr, respectively. The sensitivity (true positive cases) for threshold levels of BCR, BUN and SCr was 79.4%, 76.5%, and 76.5%, respectively, and the specificity (true negative cases) was 70%, 72.1% and 47.1%, respectively. The Z-test revealed no statistically significant differences between BUN and BCR in the AUCs (P=0.852), but the AUC values of BUN and BCR were better than the value of SCr.

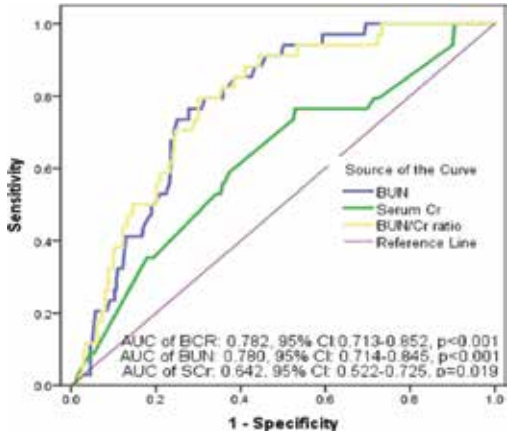


Figure 2: ROC curve of admission BUN, SCr and BCR for predicting in- hospital mortality.

ROC: receiver operating characteristic; BUN: blood urea nitrogen; SCr: surum creatinine; BCR: blood urea nitrogen-to-creatinine ratio.

A weak but positive (Pearson correlation coefficient r=0.287) and significant (p< 0.001) correlation was found between admission BCR values and length of stay in hospitals in the present study (Figure 3).

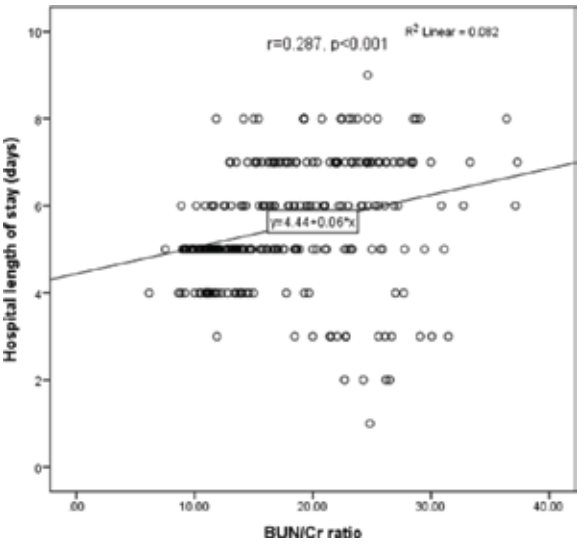


Figure 3: Correlation between admission BCR and length of stay in hospital.

Figure 4 indicates that a high BCR was significantly associated with a higher mortality than those with low BCR (25.5% vs. 3.7%, p<0.001, Log-rank test).

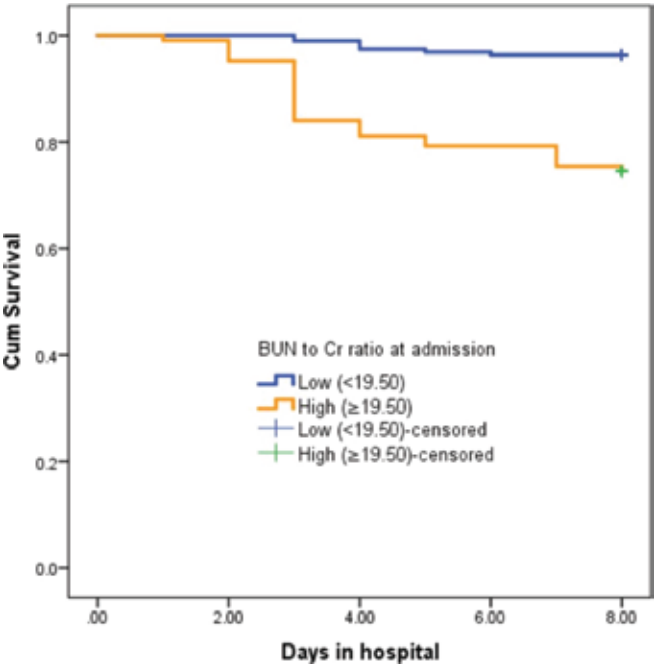


Figure 4: Kaplan-Meier curves of the BCR for predicting in-hospital mortality of study subjects
BCR: blood urea nitrogen-to-creatinine ratio.

As shown in Table 5, after adjustment for age, sex, other risk factors and biochemical parameters, a higher BCR was associated with an increased risk of in-hospital mortality

(adjusted HR, 1.077; 95% CI, 1.016-1.142; p=0.013) and BCR level >19.5 levels was associated with an increased risk of IHM compared with those with admission BCR level <19.5 (adjusted HR, 2.718; 95% CI, 1.137-6.495; p=0.024).

Table 5: Multivariable cox-proportional hazard analysis of predictors for IHM in study subjects.

| Variables | β | HR | 95.0% CI for HR | | p value |
|---|---|---|---|---|---|
| | | | Lower | Upper | |
| Age, years | 0.034 | 1.035 | 0.993 | 1.078 | 0.105 |
| Female sex | 0.916 | 2.499 | 1.197 | 5.216 | 0.015 |
| Dyslipidemia | 0.608 | 1.837 | 0.474 | 7.124 | 0.379 |
| Obesity | 0.900 | 2.459 | 0.478 | 12.645 | 0.282 |
| STEMI | 0.036 | 1.037 | 0.110 | 9.803 | 0.975 |
| Thrombolyzed | 0.329 | 1.390 | 0.567 | 3.405 | 0.471 |
| EF (%) | -0.146 | 0.864 | 0.788 | 0.948 | 0.002 |
| BCR | 0.074 | 1.077 | 1.016 | 1.142 | 0.013 |
| BCR>19.5 | 1.000 | 2.718 | 1.137 | 6.495 | 0.024 |

IHM: in hospital mortality β: beta coefficient, HR: hazard ratio, CI: confidence interval, STEMI: ST segment elevation myocardial infarction; EF: ejection fraction; BCR: blood urea nitrogen-to-creatinine ratio.

**Discussion**

This study was aimed to evaluate the relationship between BCR and in-hospital outcomes in patients with AMI and exploring the value of admission BCR in predicting in-hospital outcomes of patients with AMI in a Bangladeshi tertiary-level hospital.

In the present study most patients (70.7%) were male with a mean age of around 56.5 years. The study found that highest prevalent risk factor was smoking (66%) followed by hypertension (54.2%), diabetes mellitus (40.4%), obesity (11.4%) and dyslipidemia (10.8%) respectively. Similar demographic and risk factors distribution were also reported by other studies conducted in another tertiary hospital in Bangladesh [18,19].

Out of 297 patients, 236 (79.5%) were diagnosed as STEMI and rest of the 61(20.5%) patients had NSTEMI. While NSTEMI is generally more common among hospitalized patients with AMI [20], some studies have found STEMI to be more prevalent in specific populations or settings. Vora et al. [21] found that STEMI was more common in older patients with significant coronary artery disease. Chang et al. [22] highlighted that STEMI patients often have single-vessel disease, which might contribute to their higher prevalence in specific cohorts. Moreover, a real-world registry-based study found that out of 21,827 hospitalized patients with AMI, STEMI diagnosis was established in 73.2% of the patients and NSTEMI in 26.8%[23].

Out of 297 patients with AMI, the most frequent in-hospital complication was cardiogenic shock (41.4%), followed by left ventricular failure (37.7%) and ventricular arrhythmia (14.9%) in the present study. The IHM rate was 11.4% in the present study. In-hospital complications and IHM rate of the present study agreed with a previous study from Bangladesh [19], where the IHM rate was 12.1% after admission, but higher than other studies (8.4% Huang et al. [15] and 4.4% Khera et al. [24] in other countries.

In the present study, the BCR values at admission ranged between 6.0 and 37.3, with a mean value of 17.58±6.37. Patients were categorized into two groups based on threshold BCR levels, the lower BCR groups (<19.5) and higher (>19.5) groups. The present study findings agreed with that of Huang et al. [15], where the mean BCR was 17.3±1.9. In the present study, one-third of the patients had an admission BCR level of more than 19.5. In the study of Huang et al. [15], more than one-third of the patients had a BCR value of more than 18.34, suggesting that high BCR was a common finding in hospitalized patients with AMI.
In addition, diagnostic performance of the admission BCR and an optimal cut-off value for this marker for prediction of in-hospital mortality was done in this study. In general, an AUROC of 0.5 indicates no discriminatory utility (i.e., ability to classify individuals with and without the outcome based on the biomarker), 0.7 to 0.8 is acceptable for discrimination [25]. The ROC plot in the present study suggested that the efficiency of admission BCR in predicting in-hospital mortality was acceptable, with an AUROC of 0.782 (95% CI 0.714-.845). The AUROC value of BCR was similar to the value of BUN (0.780) and better than the AUC value of SCr (0.642). The threshold level for BCR was 19.50, with the sensitivity and specificity of 79.4% and 70%, respectively. In the previous study [15], the AUC for the BCR was 0.619. In the study of Saygitov et al. [26], the discriminatory ability of BUN was better (AUC 0.76) than that of SCr (AUC: 0.69), which was consistent with the present study findings. The cutoff value of BCR to indicate the IHM of patients with AMI in the present study was similar to that in predicting the outcomes of patients with AIS and AF. In patients with AIS complicated by AF, the BCR level at admission shows a J-shaped correlation with the IHM rate, and when BCR exceeds 19.63 mg/dL, the IHM rate increases [11]. Similarly, in the study of Huang et al. [15], the BCR had a predictive value for the prognosis of patients with AMI, and the risk was highest in patients with a high BCR (>19.5).

High BCR levels were associated with LVF (67.0 % vs. 21.5%, p<0.001), cardiogenic shock (69.8% vs. 25.7%, p<0.001), ventricular arrythmia (19.8% vs. 3.7%) and IHM (25.5% vs. 3.7%, p<0.001). In the study of Huang et al. [15], IHM was more frequently observed in patients with higher

BCR levels (1.73%, 2.08% and 4.54% for the first, second and third tertiles, respectively). In AMI, a high BCR may indicate poor renal perfusion and increased neuro-hormonal activation, which are linked to a worse prognosis [27]. A weak but positive (r=0.287) correlation was found between admission BCR values and length of stay in hospitals in the present study. But, a moderate positive (Pearson correlation coefficient r=0.568) and significant ($p < 0.001$) correlation was found between admission BCR values and total number of complications in the present study. The Kaplan-Meier curves show an overall survival benefit for the patients with low BCR (96.3%) at admission than those with high BCR (74.5%).

In Cox proportional analysis, after adjustment for age, sex, other risk factors and biochemical parameters, a higher BCR was associated with an increased risk of In- hospital mortality (adjusted HR, 1.077) and BCR level >19.5 levels were associated with an increased risk of in-hospital mortality compared with those with admission BCR level <19.5 (adjusted HR, 2.718). In an adjusted analysis of Huang et al. [15], the BCR was an independent predictor of IHM in patients with AMI (third vs. first tertile; adjusted HR, 1.50. The pooled analysis of the study of Zhu et al. [16] showed that the highest BCR group was associated with a 77% higher all-cause mortality than the lowest BCR group (pooled HR 1.77; 95% CI 1.52–2.07). Matsue et al. [8] showed that the BCR was elevated in about 25% of the patients and was a predictor of all causes of death at 180 days (HR: 1.86) after adjustment for other variables, including SCr and BUN.

A higher BCR on admission to CCU was significantly associated with an increased risk of IHM and other complications in AMI patients, suggesting that BCR could serve as an independent predictive factor of IHM after AMI. BUN and SCr levels are simple to collect since the calculation of BCR is easy. These results can be used to support other death indices and improve the accuracy of prognosis prediction for patients with AMI. Therefore, the BCR could be utilized to predict the IHM of patients with AMI, as it is cost-effective and easy to apply. By incorporating the BCR into clinical assessments, healthcare providers can better stratify risk and potentially tailor more aggressive or targeted interventions for those patients with AMI at higher risk.

This study has several limitations: patients were selected from a single center; relatively small sample size; other factors like high-protein diet, cachexia, and muscular atrophy which could affect the BCR were not examined in this study; even though blood samples were taken from the patients to test for BUN and SCr level at admission the time at which blood samples were drawn was not standardized for all patients; BUN and SCr data were prospectively collected on the day of admission and ongoing changes in the BCR was not evaluated.

## Conclusion

A high BCR is an independent predictor of In-hospital mortality in patients with AMI. Patients with higher BCR levels more frequently experienced complications including LVF, CS, VA, and had higher Length of stay in the hospital than patients with low BCR at admission. So, Routine use of this marker may benefit to take the treatment plan to prevent complications of AMI patients after hospital admission. However, considering the limitations, multicenter studies with large scale sample size and more detailed prospective observations with long term follow up may be designed. And more comprehensive analysis is needed to validate the findings of present study.

## References


1. Hall M, Bebb OJ, Dondo TB, Yan AT, Goodman SG, Bueno H, et al. Guideline- indicated treatments and diagnostics, GRACE risk score, and survival for non-ST elevation myocardial infarction. European Heart Journal. 2018;39(42):3798-3806.
2. Li D, Cheng Y, Yu J, Jia Y, Li F, Zhang Q, et al. Early risk stratification of acute myocardial infarction using a simple physiological prognostic scoring system: insights from the REACP study. European Journal of Cardiovascular Nursing. 2021;20(2):167-174.
3. Smith GL, Lichtman JH, Bracke MB, Shlipa MG, Phillips CO, DiCapua P, et al. Renal impairment and outcomes in heart failure: systematic review and meta-analysis. Journal of the American College of Cardiology. 2006;47(10):1987-1996.
4. Lyman JL. Blood urea nitrogen and creatinine. Emergency medicine clinics of North America. 1986;4(2):223-233.
5. Otto CM. Heartbeat: Blood urea nitrogen to creatinine ratio predicts outcome in acute heart failure. Heart. 2017;103(6):399-401.
6. Zhu X, Cheang I, Liao S, Wang K, Yao W, Yin T, et al. Blood urea nitrogen to creatinine ratio and long-term mortality in patients with acute heart failure: a prospective cohort study and meta- analysis. Cardiorenal Medicine. 2020;10(6):415-428.
7. Ok F, Erdogan O, Durmus E, Carkci S, Canik A. Predictive values of blood urea nitrogen/creatinine ratio and other routine blood parameters on disease severity and survival of COVID-19 patients. Journal of medical virology. 2021;93(2):786-793.
8. Matsue Y, van der Meer P, Damman K, Metra M, O'Connor CM, Ponikowski P, et al. Blood urea nitrogen-to-creatinine ratio in the general population and in patients with acute heart failure. Heart. 2017;103(6):407-413.
9. Sood MM, Saeed M, Lim V, Cordova F, Komenda P, Malik A, et al. The urea-to-creatinine ratioispredictiveofworseningkidney functioninambulatoryheartfailure patients. Journal of Cardiac Failure. 2015;21(5):412-418.
10. Tanaka S, Ninomiya T, Taniguchi M, Tokumoto M, Masutani K, Ooboshi H, et al. Impact of blood urea nitrogen to creatinine ratio on mortality and morbidity in hemodialysis patients: The Q-Cohort Study. Scientific reports. 2017;7(1):1-9.
11. Li B, Li J, Men X, Yang S, Tian F, Song X, et al.Theassociation of blood urea nitrogen-to-creatinine ratio and in-hospital mortality in acute ischemic stroke patients with atrial fibrillation:data from the MIMIC-IV database. Frontiers in Neurology. 2024;15:e.1331626.
12. Schrock JW, Glasenapp M, Drogell K. Elevated blood urea nitrogen/creatinine ratio is associated with poor outcome in patients with ischemic stroke. Clinical Neurology and Neurosurgery. 2012;114(7):881-884.
13. Bodagh H, Ghanivash A, Yousefzadeh A, Banisefid E, Bodagh M, Khiav SM et al. Asessment of blood urea nitrogen to creatinine ratio as a predictor of mortality in ST-elevation myocardial infarction patients undergoing thrombolytic therapy: a cross-sectional study.

Cardiovascular Biomedicine Journal. 2024;4(1):31-39.

14. Dong C, Xue Y, Fan Y, Zhang R, Feng Y, Wang Y, et al. Prognostic Value ofAdmission Blood Urea Nitrogen/Creatinine Ratio in Patients with STEMI Undergoing Late Percutaneous Coronary Intervention. Research Square, Available from: 2021. https://doi.org/ 10.21203/rs.3.rs- 275679/v1
15. Huang S, Guo N, Duan X, Zhou Q, Zhang Z, Luo L, et al. Association between the blood urea nitrogen to creatinine ratio and in-hospital mortality among patients with acute myocardial infarction: A retrospective cohort study. Exp Ther Med.2022;25(1):36
16. Qian H, Tang C, Yan G. Predictive value of blood urea nitrogen/creatinine ratio in the long-term prognosis of patients with acute myocardial infarction complicated with acute heart failure. Medicine. 2019;98(11): e14845.
17. Zhou Y, Zhao Q , Liu Z, GaoW. Bloodureanitrogen/creatinineratioin heart failure: Systematic review and meta-analysis. Plos one. 2024;19(5):e0303870.
18. Alam MS, Shahabuddin M, Mukid MA, Tazin F, Tarin T, Chowdhury PSR. Comparison of in Hospital Complications and Mortality Between Diabetic and Non-Diabetic Patients Admitted with Acute Anterior MI. Glob Acad J Med Sci. 2023;5(5):251-255.
19. Islam MS, Ara MI, Rahman MHA, Ullah M, Rahman MM, Alam MS, et al. Superiority of Admission Blood Urea Nitrogen over Serum Creatinine in Predicting In-Hospital Outcome of Patients with Acute Coronary Syndrome. Cardiovascular Journal. 2022;14(2):135-142.
20. Montalescot G, Dallongeville J, Van Belle E, Rouanet S, Baulac C, Degrandsart A, et al. STEMI and NSTEMI: are they so different? 1 year outcomes in acute myocardial infarction as defined by the ESC/ACC definition (the OPERA registry). European heart journal. 2007;28(12):1409-1417.
21. Vora AN, Peterson ED, Hellkamp AS, Sutton NR, Panacek E, Thomas L, et al. Care transitions after acute myocardial infarctionfortransferred-inversusdirect-arrivalpatients.Circulation:Cardiovascular Quality and Outcomes. 2016;9(2):109-116.
22. Chang SS, Lu CR, Chen KW, Kuo ZW, Yu SH, Lin SY, et al. Prognosis between ST-Elevation and Non-ST-elevation myocardial infarction in older adult patients. Frontiers in Cardiovascular Medicine. 2022;8:749072.
23. Borrayo-Sanchez G, Rosas-Peralta M, Ramirez-Arias E, Saturno-Chiu G, Estrada-Gallegos J, Parra-Michel R, et al. STEMI and NSTEMI: Real-world Study in Mexico (RENASCA). Archives of medical research.2018;49(8):609-619.
24. Khera R, Haimovich J, Hurley NC, McNamara R, Spertus JA, Desai N, et al. Use of machine learning models to predict death after acute myocardial infarction. JAMA cardiology. 2021;6(6):633-641.
25. Mandrekar JN. Receiver operating characteristic curve in diagnostic test assessment. Journal of Thoracic Oncology. 2010;5(9):1315-1316.
26. Saygitov RT, Glezer MG, Semakina SV. Blood urea nitrogen and creatinine levels at admission for mortality risk assessment in patients with acute coronary syndromes. Emergency Medicine Journal. 2010;27(2):105-109.
27. Sun D, Wei C, Li Z. Blood urea nitrogen to creatinine ratio isassociated with in-hospital mortality among critically ill patients with cardiogenic shock. BMC Cardiovascular Disorders. 2022;22(1):e.258.