

Association of the Blood Urea Nitrogen-to-Albumin Ratio with Clinical Outcomes in Patients with Cardiorenal Syndrome Presenting to the Emergency Department: A Retrospective Study

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Abstract

Background

Cardiorenal syndrome (CRS) is a complex clinical condition characterized by bidirectional cardiac and renal dysfunction and associated with high morbidity and mortality. Given the limitations of existing cardiac and renal biomarkers, readily accessible prognostic indicators are needed. This study aimed to evaluate the association of the blood urea nitrogen-to-albumin ratio (BAR) with in-hospital mortality, intensive care unit (ICU) admission, and hemodialysis requirement in patients with CRS presenting to the emergency department.

Methods

This single-center retrospective study included 201 adults with cardiorenal syndrome presenting to a tertiary emergency department between May 1, 2023, and April 30, 2025. Clinical and laboratory characteristics were compared using Welch's t-test or the Mann–Whitney U test. Receiver operating characteristic (ROC) analysis evaluated discrimination for hemodialysis within 48 hours; paired areas under the curve (AUCs) were compared using DeLong's test.

Results

Mean age was 73.22 ± 11.99 years ($n = 200$), and 103 patients (51.2%) were female. In-hospital mortality occurred in 67 patients (33.3%), ICU admission in 105 (52.2%), and hemodialysis within 48 hours in 58 (28.9%). Median BAR was higher in patients requiring hemodialysis (2.51 vs. 1.75; $p < 0.001$). The AUC was 0.694 (95% confidence interval, 0.609–0.779). A cutoff of 2.64 yielded 48.3% sensitivity, 88.1% specificity, and a Youden index of 0.364. BAR did not differ significantly by mortality ($p = 0.207$) or ICU admission ($p = 0.209$). Its AUC was not significantly different from that of BUN (0.709; $p = 0.230$), but was higher than that of albumin (0.476; $p < 0.001$).

Conclusions

Higher BAR was associated with early hemodialysis requirement in unadjusted analyses, but superiority over BUN alone was not demonstrated. BAR did not differ significantly by mortality or ICU admission. Independent prognostic value and clinical utility require further evaluation.

Background

Cardiorenal syndrome (CRS) is an acute or chronic clinical condition arising from impaired reciprocal interactions between cardiac and renal function. The interplay of hemodynamic, neurohormonal, and

inflammatory mechanisms contributes to increased morbidity and mortality [1]. CRS occurs across acute and chronic cardiac and renal disease and is relevant to emergency and critical care practice [2].

The pathophysiology of CRS involves multiple interacting factors, including hemodynamic instability, reduced renal perfusion, activation of the renin-angiotensin-aldosterone system (RAAS), sympathetic nervous system activation, endothelial dysfunction, oxidative stress, and systemic inflammation [1]. Predicting the clinical course is a key aspect of management. Cardiac biomarkers, including B-type natriuretic peptide (BNP), N-terminal pro-B-type natriuretic peptide (NT-proBNP), and troponin, as well as renal markers, including blood urea nitrogen (BUN), creatinine, and estimated glomerular filtration rate (eGFR), and lactate levels have been used to assess morbidity and mortality risk [3]. Their interpretation depends on clinical context, and readily accessible biomarkers may complement, rather than replace, clinical assessment. Elevated BUN levels reflect impaired renal perfusion, catabolism, and changes in intravascular volume [4]. Low albumin levels have also been associated with increased mortality risk in cardiac and renal diseases [5].

Previous studies have evaluated BAR as a prognostic marker in sepsis, pneumonia, and gastrointestinal bleeding [6–8]. These findings provide a rationale for examining BAR in patients with CRS; however, its added value over BUN or albumin alone requires direct assessment in this population. This study aimed to examine the association of BAR with in-hospital mortality, ICU admission, and hemodialysis requirement in patients presenting to the emergency department with CRS.

Methods

Study Design

This single-center, retrospective observational study reviewed emergency department records from May 1, 2023, to April 30, 2025, at a tertiary hospital. Record review began on May 1, 2025.

Ethics Approval

Ethics approval

was obtained on April 8, 2025 (approval number: 0337). The study was conducted in accordance with the Declaration of Helsinki. Details of ethics approval and consent are provided under Declarations.

Outcomes

The evaluated outcomes were in-hospital mortality, intensive care unit (ICU) admission, and the need for hemodialysis within the first 48 hours of admission.

Study Population

Patients aged 18 years or older who presented to the emergency department with CRS confirmed by clinical, laboratory, or echocardiographic findings and for whom follow-up was available were included. Patients younger than 18 years and those without available BUN or albumin measurements or who were receiving maintenance hemodialysis were excluded. Additional exclusion criteria were malignancy, pregnancy, active infection, advanced liver failure, albumin replacement within 48 hours before admission, a history of blood product transfusion, and presentation due to trauma, gastrointestinal bleeding or burns.

Definitions and Measurements

CRS was classified as type 1–5 according to the Ronco classification. Mean arterial pressure was calculated as $(\text{systolic blood pressure} + 2 \times \text{diastolic blood pressure}) / 3$ and recorded as a rounded integer. Recorded eGFR values were analyzed as supplied in the dataset. The 2021 Chronic Kidney Disease Epidemiology Collaboration (CKD-EPI) equation is a creatinine-based method for estimating GFR [9]. BAR was calculated by dividing BUN (mg/dL) by albumin (g/L). Acute kidney injury was defined according to Kidney Disease: Improving Global Outcomes (KDIGO) criteria. Initiation of hemodialysis within the first 48 hours was recorded as an early dialysis requirement [10].

Data Collection

Medical records from the two-year period preceding May 1, 2025, the study initiation date, were retrospectively reviewed. Emergency department records were searched using diagnostic codes for cardiorenal syndrome, heart failure, renal failure, and dyspnea. A total of 2325 records were reviewed, and 826 patients with cardiorenal syndrome were identified. After applying the exclusion criteria, 201 patients were included in the study. Patient selection is summarized in Fig. 1.

Emergency department records from May 1, 2023, to April 30, 2025, were screened using diagnostic codes for cardiorenal syndrome, heart failure, renal failure and dyspnea. Of 2325 records reviewed, 826 patients with cardiorenal syndrome were identified; 625 patients were excluded and 201 were included.

Demographic characteristics, vital signs (SpO_2 , systolic and diastolic blood pressure, mean arterial pressure, and heart rate), comorbidities (hypertension, diabetes mellitus, heart failure, coronary artery disease, chronic kidney disease, and chronic obstructive pulmonary disease [COPD]), laboratory parameters (BUN, albumin, BAR, creatinine, eGFR, lactate, BNP, and troponin), CRS types, ICU admission, in-hospital mortality, and hemodialysis within 48 hours were retrospectively extracted from the hospital and laboratory information management systems. All data were entered into a Microsoft Excel file using a standardized form.

Statistical Analysis

The dataset was reanalyzed using Python with NumPy, SciPy, and scikit-learn. Age, vital signs, and albumin were summarized as mean $\pm$ standard deviation and compared using Welch's two-sample t-test,

without assuming equal variances. BUN, lactate, creatinine, eGFR, BNP, troponin, and BAR were summarized as median (25th–75th percentile) and compared using the two-sided Mann–Whitney U test with tie correction and an asymptotic p value. This approach accommodated skewed laboratory distributions. Categorical variables were summarized as counts and percentages. Age was missing for one patient; age summaries and comparisons used available observations without imputation. All other analyzed variables were complete. BAR was calculated from unrounded BUN (mg/dL)/albumin (g/L), rather than the integer-rounded duplicate variable.

ROC analysis assessed discrimination for hemodialysis within 48 hours. AUC standard errors and 95% confidence intervals were estimated using the DeLong variance method; two-sided tests evaluated AUC against 0.50. Higher BAR and BUN and lower albumin were specified as the risk directions. Paired AUCs were compared using DeLong’s test. The BAR threshold maximized the Youden index (sensitivity + specificity – 1). Sensitivity, specificity, predictive values, accuracy, and balanced accuracy were calculated at that threshold. Statistical significance was defined as $p < 0.05$. All analyses were unadjusted and exploratory, without multiplicity correction or internal or external validation. No multivariable model was fitted.

Use of artificial intelligence

ChatGPT (OpenAI) was used to assist with English language editing and manuscript formatting. All authors approved the final version.

Results

The study included 201 patients with CRS. Of these, 103 (51.2%) were women and 98 (48.8%) were men; the mean age was 73.22 ± 11.99 years among 200 patients with available age data. The most common comorbidities were congestive heart failure ($n = 174$; 86.6%), hypertension ($n = 169$; 84.1%), coronary artery disease ($n = 139$; 69.2%), and diabetes mellitus ($n = 123$; 61.2%). Chronic kidney disease without ongoing dialysis was present in 102 patients (50.7%), and COPD in 38 patients (18.9%) (Table 1).

Table 1
General characteristics of the study population (N = 201)

Characteristic	Summary	Minimum–maximum
Female sex	103 (51.2)	—
Male sex	98 (48.8)	—
Hypertension	169 (84.1)	—
Diabetes mellitus	123 (61.2)	—
Congestive heart failure	174 (86.6)	—
Chronic kidney disease without maintenance dialysis	102 (50.7)	—
Chronic obstructive pulmonary disease	38 (18.9)	—
Coronary artery disease	139 (69.2)	—
Age (years) (n = 200)	73.22 ± 11.99	29.00–95.00
SpO ₂ (%)	92.57 ± 4.74	72.00–99.00
Systolic blood pressure (mmHg)	124.49 ± 29.00	73.00–248.00
Diastolic blood pressure (mmHg)	69.92 ± 16.64	30.00–130.00
MAP (mmHg)	88.12 ± 18.59	52.00–167.00
Heart rate (beats/min)	86.22 ± 21.25	41.00–180.00
BUN (mg/dL)	63.00 (48.00–84.00)	19.00–185.00
Albumin (g/L)	34.00 ± 4.47	18.00–45.00
Lactate (mmol/L)	1.70 (1.00–3.00)	0.30–16.00
Creatinine (mg/dL)	2.55 (2.02–3.34)	1.21–8.30
eGFR (mL/min/1.73 m ²)	21.00 (15.00–28.00)	4.00–89.00
BNP (pg/mL)	1524.00 (865.00–3284.00)	81.00–183456.00
Troponin (ng/L)	31.00 (14.00–110.00)	1.00–45845.00
BAR	1.89 (1.37–2.60)	0.44–5.29

Values are n (%), mean ± SD, or median (25th–75th percentile). BUN, lactate, creatinine, eGFR, BNP, troponin, and BAR are summarized as medians. Age was available for 200 patients; other variables were complete (n = 201). BAR was calculated as BUN (mg/dL)/albumin (g/L) without rounding.

SD, standard deviation; SpO₂, peripheral oxygen saturation; MAP, mean arterial pressure; BUN, blood urea nitrogen; eGFR, estimated glomerular filtration rate; BNP, B-type natriuretic peptide; BAR, blood urea nitrogen-to-albumin ratio; ICU, intensive care unit.

Admission vital signs and laboratory characteristics are presented in Table 1. Mean systolic blood pressure was 124.49 ± 29.00 mmHg, MAP was 88.12 ± 18.59 mmHg, and albumin was 34.00 ± 4.47 g/L. Median BAR was 1.89 (1.37–2.60); the range was 0.44–5.29. The overall BAR mean and standard deviation were 2.03 ± 0.87. Skewed laboratory variables are reported as medians and 25th–75th percentiles.

In-hospital mortality occurred in 67 patients (33.3%). Compared with survivors, non-survivors were older and had lower systolic blood pressure, MAP, and albumin and higher lactate and BNP. BAR was 1.96 (1.54–2.57) versus 1.83 (1.30–2.60) (median [25th–75th percentile]; p = 0.207). Detailed comparisons are shown in Table 2.

Table 2
Clinical and laboratory characteristics according to mortality status

Variable	Survivors (n = 134)	Non-survivors (n = 67)	p
Age (years)	71.86 ± 11.80	75.91 ± 12.00	0.025
SpO ₂ (%)	92.86 ± 4.68	91.99 ± 4.84	0.226
Systolic blood pressure (mmHg)	129.22 ± 29.98	115.03 ± 24.53	< 0.001
Diastolic blood pressure (mmHg)	71.38 ± 17.18	67.00 ± 15.21	0.068
MAP (mmHg)	90.66 ± 19.46	83.06 ± 15.65	0.003
Heart rate (beats/min)	85.04 ± 17.79	88.57 ± 26.88	0.334
BUN (mg/dL)	62.50 (44.50–84.00)	65.00 (50.00–81.00)	0.531
Albumin (g/L)	34.54 ± 4.45	32.93 ± 4.33	0.015
Lactate (mmol/L)	1.50 (0.90–2.40)	2.40 (1.45–4.10)	< 0.001
Creatinine (mg/dL)	2.50 (1.99–3.46)	2.60 (2.10–3.27)	0.915
eGFR (mL/min/1.73 m ²)	21.00 (15.00–30.00)	20.00 (16.00–25.00)	0.303
BNP (pg/mL)	1397.00 (691.50–3116.25)	2235.00 (1212.50–3901.50)	0.008
Troponin (ng/L)	29.50 (14.25–87.75)	38.00 (15.00–281.50)	0.189
BAR	1.83 (1.30–2.60)	1.96 (1.54–2.57)	0.207

Values are mean $\pm$ SD or median (25th–75th percentile). BUN, lactate, creatinine, eGFR, BNP, troponin, and BAR are summarized as medians and compared using the Mann–Whitney U test; other continuous variables are compared using Welch’s t-test. All p values are two-sided, unadjusted, and exploratory.

Age was available for 133 patients without the outcome and 67 with the outcome. Recorded eGFR values were used.

SD, standard deviation; SpO₂, peripheral oxygen saturation; MAP, mean arterial pressure; BUN, blood urea nitrogen; eGFR, estimated glomerular filtration rate; BNP, B-type natriuretic peptide; BAR, blood urea nitrogen-to-albumin ratio; ICU, intensive care unit.

ICU admission occurred in 105 patients (52.2%). Patients admitted to the ICU had lower systolic blood pressure and MAP and higher heart rate, lactate, and troponin than those not admitted to the ICU. BAR was 1.97 (1.47–2.60) versus 1.81 (1.30–2.53) (median [25th–75th percentile]; p = 0.209). Detailed comparisons are shown in Table 3.

Table 3
Clinical and laboratory characteristics according to ICU admission

Variable	No ICU admission (n = 96)	ICU admission (n = 105)	p
Age (years)	71.64 ± 12.39	74.64 ± 11.50	0.079
SpO ₂ (%)	92.97 ± 4.41	92.20 ± 5.03	0.249
Systolic blood pressure (mmHg)	131.33 ± 30.01	118.23 ± 26.69	0.001
Diastolic blood pressure (mmHg)	71.51 ± 17.73	68.47 ± 15.52	0.199
MAP (mmHg)	91.45 ± 19.77	85.09 ± 16.97	0.016
Heart rate (beats/min)	82.47 ± 15.54	89.65 ± 24.96	0.014
BUN (mg/dL)	58.00 (44.00–85.25)	65.00 (50.00–80.00)	0.307
Albumin (g/L)	34.30 ± 4.26	33.73 ± 4.66	0.367
Lactate (mmol/L)	1.40 (0.88–1.82)	2.40 (1.40–3.40)	< 0.001
Creatinine (mg/dL)	2.54 (2.02–3.31)	2.56 (2.02–3.34)	0.954
eGFR (mL/min/1.73 m ²)	21.00 (15.75–28.25)	20.00 (15.00–27.00)	0.482
BNP (pg/mL)	1394.50 (693.00–3677.50)	1806.00 (1053.00–3180.00)	0.155
Troponin (ng/L)	24.00 (11.00–47.75)	45.00 (20.00–184.00)	< 0.001
BAR	1.81 (1.30–2.53)	1.97 (1.47–2.60)	0.209

Values are mean ± SD or median (25th–75th percentile). BUN, lactate, creatinine, eGFR, BNP, troponin, and BAR are summarized as medians and compared using the Mann–Whitney U test; other continuous variables are compared using Welch’s t-test. All p values are two-sided, unadjusted, and exploratory.

Age was available for 95 patients without the outcome and 105 with the outcome. Recorded eGFR values were used.

SD, standard deviation; SpO₂, peripheral oxygen saturation; MAP, mean arterial pressure; BUN, blood urea nitrogen; eGFR, estimated glomerular filtration rate; BNP, B-type natriuretic peptide; BAR, blood urea nitrogen-to-albumin ratio; ICU, intensive care unit.

Hemodialysis within 48 hours was required in 58 patients (28.9%). These patients had lower SpO₂ and eGFR and higher BUN, creatinine, BNP, troponin, and BAR than patients not requiring hemodialysis. BAR

was 2.51 (1.63–3.14) versus 1.75 (1.30–2.32) (median [25th–75th percentile]; $p < 0.001$). Detailed comparisons are shown in Table 4. Lactate did not differ significantly between the groups ($p = 0.183$).

Table 4
Clinical and laboratory characteristics according to hemodialysis requirement within 48 hours

Variable	No hemodialysis (n = 143)	Hemodialysis (n = 58)	p
Age (years)	73.01 ± 12.65	73.71 ± 10.29	0.688
SpO ₂ (%)	93.15 ± 4.47	91.14 ± 5.13	0.011
Systolic blood pressure (mmHg)	125.10 ± 26.88	122.97 ± 33.88	0.669
Diastolic blood pressure (mmHg)	70.12 ± 15.98	69.43 ± 18.29	0.803
MAP (mmHg)	88.48 ± 17.37	87.26 ± 21.45	0.702
Heart rate (beats/min)	87.32 ± 20.83	83.50 ± 22.21	0.263
BUN (mg/dL)	57.00 (44.00–75.00)	80.00 (56.25–107.00)	< 0.001
Albumin (g/L)	33.80 ± 4.55	34.52 ± 4.26	0.289
Lactate (mmol/L)	1.70 (1.00–2.55)	2.30 (1.02–3.50)	0.183
Creatinine (mg/dL)	2.31 (1.90–2.79)	3.32 (2.75–4.12)	< 0.001
eGFR (mL/min/1.73 m ²)	23.00 (17.00–30.00)	14.50 (11.00–19.75)	< 0.001
BNP (pg/mL)	1400.00 (820.00–3037.50)	2124.00 (1279.25–4907.25)	0.012
Troponin (ng/L)	26.00 (13.00–88.00)	49.50 (22.25–158.75)	0.038
BAR	1.75 (1.30–2.32)	2.51 (1.63–3.14)	< 0.001

Values are mean ± SD or median (25th–75th percentile). BUN, lactate, creatinine, eGFR, BNP, troponin, and BAR are summarized as medians and compared using the Mann–Whitney U test; other continuous variables are compared using Welch’s t-test. All p values are two-sided, unadjusted, and exploratory.

Age was available for 142 patients without the outcome and 58 with the outcome. Recorded eGFR values were used.

SD, standard deviation; SpO₂, peripheral oxygen saturation; MAP, mean arterial pressure; BUN, blood urea nitrogen; eGFR, estimated glomerular filtration rate; BNP, B-type natriuretic peptide; BAR, blood urea nitrogen-to-albumin ratio; ICU, intensive care unit.

BAR showed modest discrimination for hemodialysis within 48 hours (AUC, 0.694; standard error, 0.0434; 95% confidence interval, 0.609–0.779; $p < 0.001$). The sample-derived cutoff of $\text{BAR} \geq 2.64$ yielded 48.3% sensitivity, 88.1% specificity, a Youden index of 0.364, a positive predictive value of 62.2%, and a negative predictive value of 80.8%. Accuracy was 76.6%, whereas balanced accuracy was 68.2%. The AUC for BAR was not significantly different from that of BUN (0.709; paired DeLong $p = 0.230$) but was higher than that of albumin when lower albumin was specified as the risk direction (0.476; $p < 0.001$). Full results are presented in Table 5; the BAR ROC curve is shown in Fig. 2.

Table 5
ROC performance for hemodialysis requirement within 48 hours

Measure	Value
BAR: AUC (95% CI)	0.694 (0.609–0.779)
BUN: AUC (95% CI)	0.709 (0.625–0.794)
Albumin (lower values as risk): AUC (95% CI)	0.476 (0.388–0.563)
BAR versus BUN: paired DeLong p	0.230
BAR versus albumin: paired DeLong p	< 0.001
BAR AUC standard error	0.0434
BAR AUC versus 0.50: p	< 0.001
BAR cutoff (positive if $\text{BAR} \geq$ cutoff)	2.64
Sensitivity (%)	48.3
Specificity (%)	88.1
Youden index	0.364
Positive predictive value (%)	62.2
Negative predictive value (%)	80.8
Accuracy (%)	76.6
Balanced accuracy (%)	68.2
True positives / false negatives	28 / 30
True negatives / false positives	126 / 17

$N = 201$; 58 patients required hemodialysis within 48 hours. AUC, area under the receiver operating characteristic (ROC) curve; CI, confidence interval; BAR, blood urea nitrogen-to-albumin ratio; BUN, blood urea nitrogen. $\text{BAR} = \text{BUN (mg/dL)} / \text{albumin (g/L)}$.

AUC intervals and comparisons use the DeLong variance method. Higher BAR and BUN and lower albumin were defined as the risk directions. The Youden-optimal observed BAR threshold was 2.641025641; ≥ 2.64 yields identical classifications in this sample. Threshold selection and performance estimation used the same dataset without validation. Accuracy and balanced accuracy are distinct measures.

AUC = 0.694 (95% CI, 0.609–0.779). The marked sample-derived cutoff (BAR ≥ 2.64) yielded sensitivity of 48.3%, specificity of 88.1%, and a Youden index of 0.364. BAR was calculated as BUN (mg/dL)/albumin (g/L). AUC, area under the receiver operating characteristic curve; CI, confidence interval; BAR, blood urea nitrogen-to-albumin ratio; BUN, blood urea nitrogen.

Discussion

CRS involves mutually detrimental interactions between cardiac and renal dysfunction and is associated with substantial morbidity and mortality. Volume overload, impaired perfusion, and neurohormonal activation make early risk assessment important in the emergency department. Previous work has examined the prognostic relevance of BUN and albumin [11, 12], providing a rationale for assessing their ratio in CRS. In this cohort, BAR was higher in patients requiring hemodialysis but did not differ significantly according to in-hospital mortality or ICU admission. These unadjusted findings suggest an association with hemodialysis requirement, but do not establish independent prognostic value or clinical utility.

Previous studies have associated BAR with mortality in related clinical populations. Zhao et al. studied 2,125 patients with heart failure in a prospective cohort with a median follow-up of 22 months and reported an adjusted association between higher BAR and mortality [13]. Shi et al. analyzed 12,125 patients with acute kidney injury using the US MIMIC-IV database; the AUCs for 28-day and 365-day mortality were 0.649 and 0.662, respectively [14]. In 1,253 emergency department patients aged 65 years or older, Dundar et al. reported an AUC of 0.793 for in-hospital mortality [15]. Differences in case mix, follow-up, measurement conventions, and statistical adjustment limit direct comparisons with our cohort. In particular, BAR values calculated using albumin in g/dL are ten times those calculated using albumin in g/L, when BUN is expressed in mg/dL in both calculations. Cutoffs should therefore not be compared without checking the units. Our nonsignificant unadjusted mortality comparison does not exclude a prognostic association and requires assessment with appropriate adjustment and sufficient precision.

Renal replacement therapy may be required during the clinical course of CRS [16]. Lin et al. retrospectively studied 1,545 critically ill patients with chronic heart failure and associated BAR with mortality; their study did not establish a threshold for predicting hemodialysis requirement [17]. In a separate cohort of 117 patients with severe COVID-19 pneumonia and acute kidney injury, Acehan reported higher admission BAR in patients subsequently requiring renal replacement therapy [18]. In our cohort, patients requiring hemodialysis had higher BAR, BUN, and creatinine and lower eGFR. The AUC of

0.694 indicates modest discrimination rather than a validated decision rule. Because BUN itself may inform clinical evaluation before dialysis, the observed association may partly reflect renal disease severity and clinician treatment decisions. Paired ROC comparisons showed that BAR had greater discrimination than albumin alone but did not demonstrate superiority over BUN. The selected threshold had high specificity relative to its sensitivity, missing 30 of the 58 patients who required hemodialysis. These findings do not support using BAR alone to exclude early dialysis requirement. Multivariable assessment and validation are still needed to determine its independent and incremental value.

This study has several limitations. Its retrospective, single-center design and restrictive exclusions limit generalizability and may introduce selection bias. Nutritional status, hydration, medication use, liver function, and other potential confounders could not be fully controlled. The reported comparisons are unadjusted and involve multiple variables and outcomes, increasing the possibility of confounding and chance findings. Although paired AUC comparisons were performed, superiority over BUN was not demonstrated, and incremental value beyond a clinical prediction model was not assessed. The same cohort was used to derive the ROC cutoff and assess its performance, without internal or external validation. Hemodialysis is a clinician-dependent outcome that may be influenced by BUN and the severity of renal dysfunction. Creatinine-based eGFR may also be unreliable during rapidly changing kidney function. These limitations warrant cautious interpretation and validation in larger, prospectively defined multicenter cohorts.

Conclusions

Higher BAR was associated with hemodialysis requirement within 48 hours in this retrospective cohort, but no statistically significant differences were observed according to in-hospital mortality or ICU admission. BAR did not demonstrate superior discrimination to BUN alone. Its modest discrimination and low sensitivity at the selected cutoff limit its use as a standalone marker. Independent prognostic value and clinical utility require prospective validation.

Abbreviations

AUC

area under the receiver operating characteristic curve

BAR

blood urea nitrogen-to-albumin ratio

BNP

B-type natriuretic peptide

BUN

blood urea nitrogen

CI

confidence interval

CKD-EPI

Chronic Kidney Disease Epidemiology Collaboration
COPD
chronic obstructive pulmonary disease
CRS
cardiorenal syndrome
eGFR
estimated glomerular filtration rate
ICU
intensive care unit
KDIGO
Kidney Disease: Improving Global Outcomes
MAP
mean arterial pressure
MIMIC-IV
Medical Information Mart for Intensive Care IV
NT-proBNP
N-terminal pro-B-type natriuretic peptide
RAAS
renin-angiotensin-aldosterone system
ROC
receiver operating characteristic
SD
standard deviation
SpO₂
peripheral oxygen saturation.

Declarations

Ethics approval and consent to participate

The study received ethics approval on April 8, 2025 (approval number: 0337) from Izmir Katip Çelebi University, Medical Research Ethics Committee. Individual informed consent was not obtained because the study retrospectively analyzed anonymized records.

Consent for publication

Not applicable.

Competing interests

The authors do not declare any financial and non-financial competing interests.

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Author Contribution

Authors' contributions Muhammed Emin Dut, Hüseyin Acar: Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Visualization, Writing – original draft. Ejder Saylav BORA, Melih Şengül: Resources, Project administration, Validation, Writing – review & editing. Osman Sezer Çınaroğlu: Software, Visualization, supervision, Writing –review & editing

Data Availability

The data related to this study are not published online. They will be provided by the corresponding author upon request.

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Figures

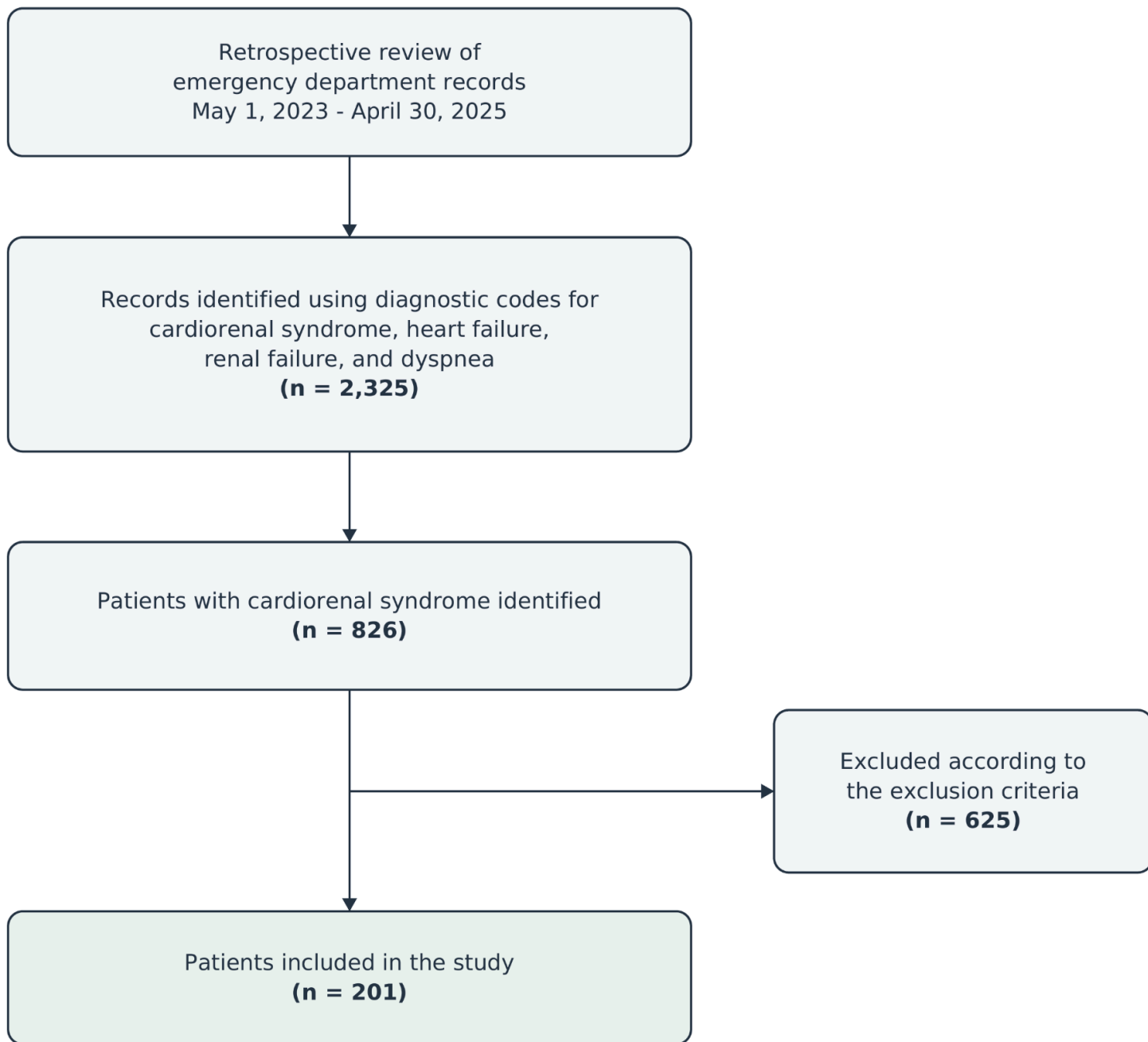


Figure 1

Patient selection flow diagram

Emergency department records from May 1, 2023, to April 30, 2025, were screened using diagnostic codes for cardiorenal syndrome, heart failure, renal failure and dyspnea. Of 2325 records reviewed, 826 patients with cardiorenal syndrome were identified; 625 patients were excluded and 201 were included.

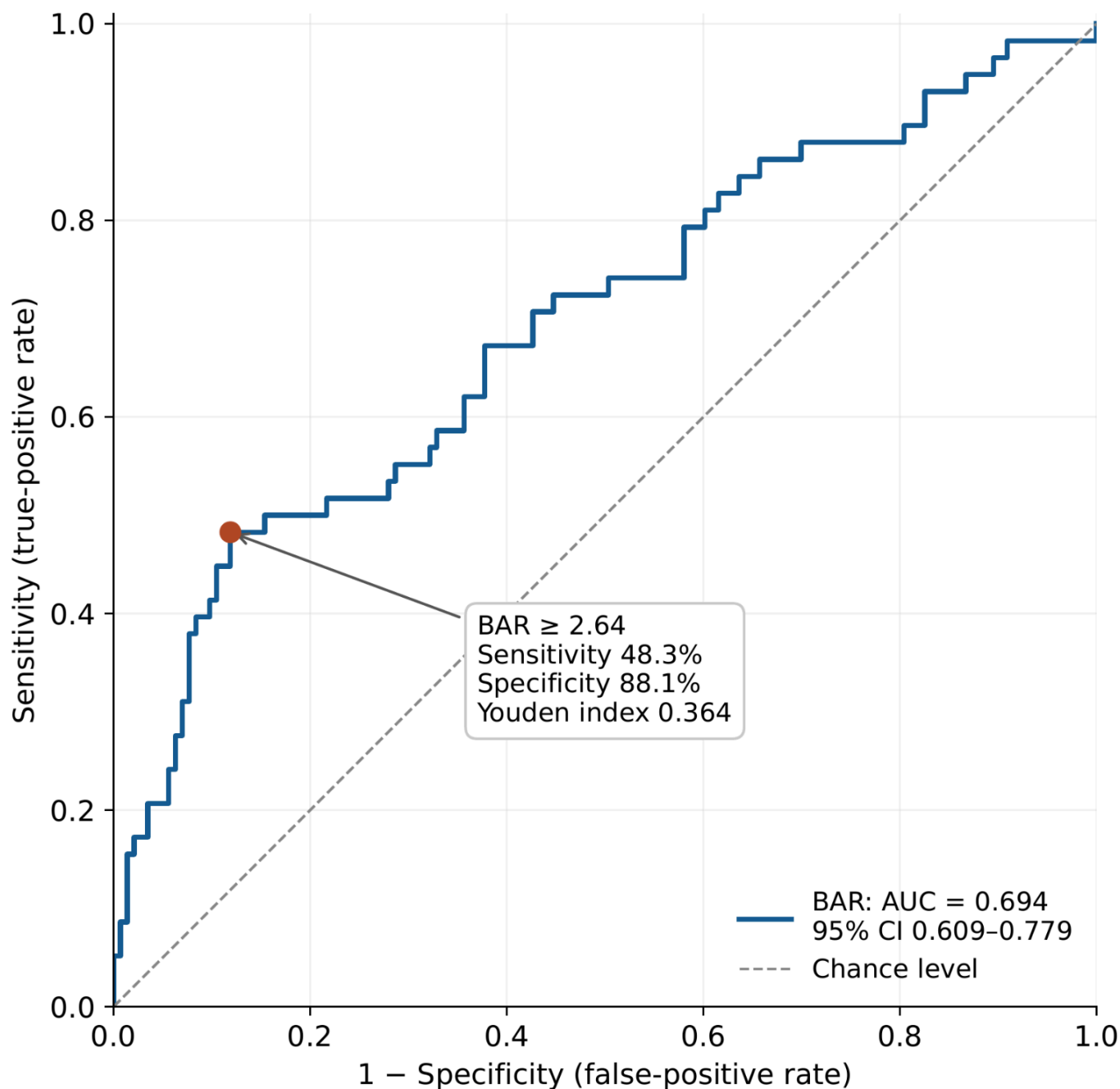


Figure 2

BAR discrimination for hemodialysis within 48 hours

AUC=0.694 (95% CI, 0.609–0.779). The marked sample-derived cutoff (BAR $\geq$ 2.64) yielded sensitivity of 48.3%, specificity of 88.1%, and a Youden index of 0.364. BAR was calculated as BUN (mg/dL)/albumin (g/L). AUC, area under the receiver operating characteristic curve; CI, confidence interval; BAR, blood urea nitrogen-to-albumin ratio; BUN, blood urea nitrogen.