

ORIGINAL ARTICLE

Increased Blood Urea Nitrogen-To-Creatinine Ratio is an Independent Predictor of Mortality in Patients with End-Stage Renal Disease

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ABSTRACT

Background: End-stage renal disease (ESRD) is the final phase of chronic kidney disease, characterized by severe renal dysfunction that leads to metabolic disturbances in blood urea nitrogen (BUN) and serum creatinine (Scr). Currently, the relationship between the BUN/creatinine ratio (BCR) and all-cause mortality in patients with ESRD remains unclear. This study aimed to investigate the predictive value of BCR for short-term (60-day) and intermediate-term (365-day) all-cause mortality risk in patients with ESRD.

Methods: By using data from the MIMIC-IV database, we included patients with ESRD meeting ICD-9/ICD-10 diagnostic criteria, excluding those aged < 18 years, non-intensive care unit admissions, and those with incomplete information, ultimately enrolling 2,102 patients. The participants were stratified according to the BCR quartiles. Kaplan-Meier survival analysis and multivariate Cox regression were used to compare differences in all-cause mortality between the groups. Restricted cubic spline (RCS) analysis was used to examine the dose-response relationship between BCR and all-cause mortality. Subgroup analysis was used to assess result stability, and receiver operating characteristic (ROC) curves were used to compare the predictive performance of BCR versus individual markers (BUN or Scr).

Results: This study included 2,102 patients with ESRD. The results demonstrated a positive correlation between BCR and 60- and 365-day all-cause mortality rates. Multivariate Cox regression analysis revealed that each one-unit increase in BCR was associated with a 3% higher risk of 60-day all-cause mortality (HR = 1.03, 95% CI: 1.01 - 1.04) and 365-day all-cause mortality (HR = 1.03, 95% CI: 1.01 - 1.04). The RCS analysis showed a linear relationship between BCR and 60-day all-cause mortality (p-overall < 0.001, p-non-linear = 0.237), whereas a non-linear relationship was observed for 365-day all-cause mortality (p-overall < 0.001, p-non-linear = 0.018). The subgroup analysis revealed no significant interaction effects. ROC analysis indicated the superior predictive performance of BCR compared to BUN or Scr alone.

Conclusions: BCR serves as an independent predictor of all-cause mortality risk in patients with ESRD and may provide a novel reference index for clinical prognosis assessment.

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Supplementary Data

Table S1. Baseline demographic characteristics of ESRD patients stratified by BCR quartiles.

	Total (n = 2,102)	Q1 (n = 527)	Q2 (n = 524)	Q3 (n = 526)	Q4 (n = 525)	p-value
Age, years	67.18 (57.26 - 76.73)	62.64 (51.12 - 71.99)	65.81 (56.09 - 75.42)	69.82 (60.29 - 77.84)	70.53 (60.24 - 79.32)	< 0.001
Gender, n (%)						
Male	1,267 (60.28)	319 (60.53)	313 (59.73)	336 (63.88)	299 (56.95)	0.148
Female	835 (39.72)	208 (39.47)	211 (40.27)	190 (36.12)	226 (43.05)	
Race, n (%)						
White	1,132 (53.85)	204 (38.71)	280 (53.44)	319 (60.65)	329 (62.67)	< 0.001
Black	452 (21.50)	178 (33.78)	115 (21.95)	81 (15.40)	78 (14.86)	
Other	518 (24.64)	145 (27.51)	129 (24.62)	126 (23.95)	118 (22.48)	
Laboratory tests						
Hematocrit	28.60 (25.35 - 32.25)	29.95 (26.30 - 33.50)	29.38 (25.91 - 32.94)	27.98 (24.89 - 31.60)	27.50 (24.60 - 30.90)	< 0.001
Hemoglobin g/dL	9.25 (8.15 - 10.35)	9.65 (8.45 - 10.70)	9.40 (8.35 - 10.55)	8.95 (7.95 - 10.11)	8.90 (7.90 - 9.90)	< 0.001
Platelets K/ μ L	178.50 (124.00 - 239.62)	178.50 (130.50 - 240.00)	176.50 (119.25 - 235.88)	178.00 (123.38 - 240.50)	180.00 (120.50 - 242.25)	0.968
WBC K/ μ L	10.40 (7.50 - 14.45)	10.00 (7.40 - 13.90)	10.50 (7.30 - 14.65)	10.35 (7.74 - 14.32)	10.75 (7.55 - 15.40)	0.285
Anion gap mmol/L	18.00 (15.50 - 21.00)	17.50 (15.00 - 20.00)	18.25 (15.12 - 21.50)	18.50 (15.50 - 21.50)	17.50 (15.00 - 21.00)	0.006
Bicarbonate mmol/L	22.50 (19.50 - 25.00)	24.00 (21.00 - 27.00)	22.50 (20.00 - 25.50)	21.50 (18.00 - 24.00)	21.00 (18.00 - 24.00)	< 0.001
Chloride mmol/L	98.50 (95.00 - 103.00)	97.50 (94.50 - 100.50)	98.00 (94.50 - 101.50)	99.50 (95.00 - 104.00)	101.00 (96.00 - 106.00)	< 0.001
Glucose mg/dL	128.00 (103.87 - 171.50)	115.50 (95.50 - 147.00)	125.75 (103.00 - 164.50)	132.00 (106.00 - 183.25)	145.00 (111.00 - 185.25)	< 0.001
Sodium mmol/L	137.00 (134.00 - 139.50)	137.00 (134.50 - 139.00)	136.50 (134.00 - 139.00)	136.50 (133.50 - 140.00)	137.50 (134.00 - 140.00)	0.101
Potassium mmol/L	4.65 (4.15 - 5.20)	4.70 (4.25 - 5.30)	4.70 (4.20 - 5.25)	4.60 (4.15 - 5.15)	4.50 (4.00 - 5.10)	< 0.001
INR	1.30 (1.15 - 1.65)	1.30 (1.10 - 1.60)	1.30 (1.15 - 1.70)	1.30 (1.10 - 1.60)	1.35 (1.15 - 1.83)	0.023
Prothrombin time, seconds	14.40 (12.60 - 18.30)	14.30 (12.45 - 17.55)	14.30 (12.80 - 18.40)	14.30 (12.40 - 17.56)	14.70 (12.63 - 19.70)	0.023
Phosphate mmol/L	5.70 (4.50 - 7.10)	5.60 (4.30 - 7.10)	5.70 (4.50 - 7.30)	5.80 (4.70 - 7.20)	5.50 (4.40 - 6.70)	0.011

Table S1. Baseline demographic characteristics of ESRD patients stratified by BCR quartiles (continued).

	Total (n = 2,102)	Q1 (n = 527)	Q2 (n = 524)	Q3 (n = 526)	Q4 (n = 525)	p-value
Calcium mmol/L	8.50 (7.95 - 9.00)	8.65 (8.15 - 9.10)	8.50 (7.90 - 9.04)	8.40 (7.85 - 8.85)	8.50 (7.90 - 9.08)	< 0.001
BUN mmol/L	48.50 (33.00 - 71.50)	34.50 (25.00 - 45.50)	44.00 (32.00 - 59.00)	54.75 (42.38 - 75.12)	74.00 (48.00 - 100.50)	< 0.001
Scr μmol/L	5.05 (3.60 - 7.05)	6.70 (5.00 - 9.15)	5.83 (4.25 - 7.94)	4.85 (3.65 - 6.40)	3.50 (2.20 - 4.50)	< 0.001
Vital sign						
Heart rate bpm	81.93 (72.42 - 93.21)	82.94 (74.28 - 92.13)	81.72 (72.25 - 92.83)	81.93 (72.21 - 95.05)	81.09 (71.02 - 93.67)	0.222
SBP mmHg	117.15 (105.28 - 134.69)	116.89 (104.88 - 136.92)	115.46 (104.12 - 133.14)	117.04 (105.79 - 134.98)	118.74 (105.99 - 134.46)	0.595
DBP mmHg	59.47 (51.96 - 68.74)	59.14 (51.96 - 70.51)	59.35 (52.15 - 67.70)	59.92 (52.35 - 69.36)	58.91 (51.60 - 67.40)	0.290
MBP mmHg	75.17 (68.35 - 85.65)	74.83 (68.36 - 86.85)	75.49 (67.43 - 86.28)	75.80 (68.51 - 85.72)	74.52 (68.67 - 84.16)	0.633
Respiratory rate, bpm	18.40 (16.24 - 21.02)	18.03 (16.00 - 20.28)	18.11 (16.17 - 20.81)	18.82 (16.28 - 21.40)	18.88 (16.61 - 21.67)	0.001
Temperature °C	36.74 (36.51 - 36.99)	36.78 (36.52 - 37.05)	36.77 (36.56 - 37.03)	36.74 (36.51 - 36.94)	36.69 (36.45 - 36.94)	< 0.001
Spo2 %	97.47 (96.00 - 98.75)	97.58 (96.12 - 98.81)	97.67 (96.25 - 98.85)	97.32 (96.06 - 98.67)	97.28 (95.63 - 98.58)	0.005
Comorbidities, n (%)						
Myocardial infarct						
No	1,534 (72.98)	395 (74.95)	381 (72.71)	382 (72.62)	376 (71.62)	0.663
Yes	568 (27.02)	132 (25.05)	143 (27.29)	144 (27.38)	149 (28.38)	
Congestive heart failure						
No	1,004 (47.76)	299 (56.74)	258 (49.24)	249 (47.34)	198 (37.71)	< 0.001
Yes	1,098 (52.24)	228 (43.26)	266 (50.76)	277 (52.66)	327 (62.29)	
Peripheral vascular disease						
No	1,709 (81.30)	443 (84.06)	420 (80.15)	421 (80.04)	425 (80.95)	0.297
Yes	393 (18.70)	84 (15.94)	104 (19.85)	105 (19.96)	100 (19.05)	
Cerebrovascular disease						
No	1,812 (86.20)	449 (85.20)	450 (85.88)	452 (85.93)	461 (87.81)	0.645
Yes	290 (13.80)	78 (14.80)	74 (14.12)	74 (14.07)	64 (12.19)	
Dementia						
No	2,042 (97.15)	511 (96.96)	517 (98.66)	504 (95.82)	510 (97.14)	0.051
Yes	60 (2.85)	16 (3.04)	7 (1.34)	22 (4.18)	15 (2.86)	
Chronic pulmonary disease						
No	1,577 (75.02)	410 (77.80)	400 (76.34)	402 (76.43)	365 (69.52)	0.009
Yes	525 (24.98)	117 (22.20)	124 (23.66)	124 (23.57)	160 (30.48)	

Table S1. Baseline demographic characteristics of ESRD patients stratified by BCR quartiles (continued).

	Total (n = 2,102)	Q1 (n = 527)	Q2 (n = 524)	Q3 (n = 526)	Q4 (n = 525)	p-value
Rheumatic disease						
No	2,026 (96.38)	506 (96.02)	500 (95.42)	515 (97.91)	505 (96.19)	0.160
Yes	76 (3.62)	21 (3.98)	24 (4.58)	11 (2.09)	20 (3.81)	
Peptic ulcer disease						
No	2,020 (96.10)	521 (98.86)	504 (96.18)	502 (95.44)	493 (93.90)	< 0.001
Yes	82 (3.90)	6 (1.14)	20 (3.82)	24 (4.56)	32 (6.10)	
Liver disease						
No	1,742 (82.87)	446 (84.63)	443 (84.54)	440 (83.65)	413 (78.67)	0.030
Yes	360 (17.13)	81 (15.37)	81 (15.46)	86 (16.35)	112 (21.33)	
Diabetes						
No	875 (41.63)	256 (48.58)	218 (41.60)	197 (37.45)	204 (38.86)	0.001
Yes	1,227 (58.37)	271 (51.42)	306 (58.40)	329 (62.55)	321 (61.14)	
Paraplegia						
No	2,034 (96.76)	510 (96.77)	508 (96.95)	512 (97.34)	504 (96.00)	0.662
Yes	68 (3.24)	17 (3.23)	16 (3.05)	14 (2.66)	21 (4.00)	
Tumor						
No	1,920 (91.34)	492 (93.36)	479 (91.41)	476 (90.49)	473 (90.10)	0.238
Yes	182 (8.66)	35 (6.64)	45 (8.59)	50 (9.51)	52 (9.90)	
Events						
60-day mortality, n (%)						
No	1,598 (76.02)	434 (82.35)	408 (77.86)	382 (72.62)	374 (71.24)	< 0.001
Yes	504 (23.98)	93 (17.65)	116 (22.14)	144 (27.38)	151 (28.76)	
365-day mortality, n (%)						
No	1,207 (57.42)	346 (65.65)	291 (55.53)	292 (55.51)	278 (52.95)	< 0.001
Yes	895 (42.58)	181 (34.35)	233 (44.47)	234 (44.49)	247 (47.05)	

BUN: blood urea nitrogen, DBP: diastolic blood pressure, INR: international rationalized ratio, SBP: systolic blood pressure, Scr: serum creatinine, WBC: white blood cell, MBP: mean blood pressure.