ORIGINAL ARTICLE

Role of Blood Urea Nitrogen to Serum Albumin Ratio (BAR) in the Prediction of Acute Kidney Injury in Intensive Care Units

Atef A. Ibrahim [a], Hazem S. A. Ayub [a], Medhat A. S. Abd Elghaffar [b], Mohamed S. A. Abdel- Aaty [a,*]

[a] Department of Internal Medicine, Faculty of Medicine for Boys, Al-Azhar University, Cairo, Egypt
[b] Department of Clinical Pathology, Faculty of Medicine for Boys, Al-Azhar University, Cairo, Egypt

Abstract

Background: ***The incidence of acute kidney injury (AKI) is higher than previously thought, with over 50% of ICU cases developing stage 1 AKI, while stages 2 and 3 are less frequent, and about 10% require RRT.***

Aim: ***To assess the role of the BUN to serum albumin ratio in the prediction of AKI in cases admitted to the ICU.***

Patients and methods: ***100 ICU patients (47 high BAR, 53 low BAR) from two hospitals were included. Adults (≥18 years) were included, excluding those with ESRD, repeat ICU admissions, or short stays. Baseline data, kidney function, and AKI incidence (KDIGO criteria) were assessed at admission and 48 hours.***

Results: ***Insignificant variance in creatinine levels among groups at admission, but patients with a low blood urea nitrogen to serum albumin ratio (BAR) had significantly lower BUN and BAR, along with higher albumin levels compared to those with a high BAR. At 48 hours of admission, patients with a high BAR showed significantly higher (BUN), creatinine, and BAR, but lower albumin concentrations than those with a low BAR. Additionally, cases with a high BAR had a significantly greater incidence of AKI. BAR additionally demonstrated a significant positive correlation with age, BUN, and sodium, but a significant negative correlation with albumin and hemoglobin (HB). At a cutoff value of 5.2, BAR demonstrated 93% sensitivity and 80% specificity for predicting acute kidney injury.***

Conclusion: ***High BAR individuals have a higher risk of AKI, with positive correlations between age, BUN, Na, and BAR, and a 93% sensitivity and 80% specificity.***

Keywords: AKI; BUN; BAR

1. Introduction

Acute kidney injury is acquiring significant recognition as an important factor affecting the final results of critically ill cases in the past decade. The frequency of AKI has been shown to be significantly greater than previously thought, with more than fifty percent of cases in the intensive care units developing stage 1 acute kidney injury at some point throughout the course. Stages 2 and 3 acute kidney injury are considerably less common, and the RRT requirement is around ten percent .[1]

There is a growing awareness that cases may either present to the intensive care units with acute kidney injury (community-acquired) or develop it throughout their hospitalization (hospital-acquired). The latter is frequently iatrogenic and correlated with an adverse outcome .[2]

Risk factors have involved the presence of heart failure, CKD, and liver failure, as well as anemia and exposures to nephrotoxic agents such as NSAIDS, contrast, and antibiotics. Other risk factors involve advancing age. The progression of acute kidney injury is well-established in high-risk settings, including sepsis, infections, shock, the necessity for mechanical ventilation, and operations .[3]

Accepted 15 April 2025.
Available online 30 June 2025

* Corresponding author at: Internal Medicine, Faculty of Medicine for Boys, Al-Azhar University, Cairo, Egypt.
E-mail address: Shomanabdo@gmail.com (M. S. A. Abdel- Aaty).

https://doi.org/10.21608/aimj.2025.446603

The prognosis of critically ill cases with acute kidney injury requiring RRT is inadequate, considering the significant advancements in kidney replacement methods and intensive care medicine.

In the past five decades, there has been an insignificant improvement in the in-hospital death and morbidity rates correlated with acute kidney injury, which remain dismally high (forty to sixty percent). Additionally, the development of chronic kidney illness or the progression of pre-existing chronic renal failure to ESRD, in addition to excessive long-term morbidity and death, are all consequences of incomplete recovery of kidney function from AKIs .[4]

An abrupt and sustained decline in kidney function is the classical definition of acute kidney injury. Nevertheless, there is no consensus regarding the best approach of evaluating kidney function or the precise cutoffs for the diagnosis. The absence of a standardized definition led to significant variations in the reporting of this condition, and contributed to an absence of comparative data.

The condition was called AKI and staging criteria and standardized diagnostic were established that are based on alterations in urine output (UO) and serum creatinine (SCr) for identifying acute kidney injury. This has occurred over the past fifteen years .[5]

The goal of research was to assess the role of BUN to serum albumin ratio in prediction of AKI in cases admitted to the ICU.

2. Patients and methods

The study recruited patients from the intensive care units at Al-Hussein University Hospital and Al-Amerya General Hospital. Patients were classified into two groups based on BAR levels: Group I (high BAR) and Group II (low BAR). The study assessed AKI prevalence and its association with high BAR levels.

Inclusion criteria: Adult cases (aged eighteen years and above) of both sexes, who are admitted to the hospital and intensive care unit for the 1st time, will be involved in the study.

Exclusion criteria: Age below 18 years, repeated hospital or intensive care unit admissions, hospital stays of below forty-eight hours, a history of end-stage renal disease, or absent blood urea nitrogen or serum albumin data.

Methodology

According to the KDIGO criteria, acute kidney injury is diagnosed when any of the following conditions is present: a serum creatinine elevated by 0.3 milligrams per deciliter or more (26.5 micromoles/L or more) in forty-eight hours, a serum creatinine increase of 1.5 times or more above baseline in the previous 7 days, or a urine volume of less than 0.5 milliliter per kilogram per hour for a minimum of six hours. All patients underwent a detailed medical history review, including age, sex, anthropometric measurements (weight, height, BMI), medical disorders such as diabetes, hypertension, cardiac conditions, and hepatic conditions, drug history including maintenance treatments and hospital medications, previous episodes of AKI, history of renal diseases, and any history of renal biopsy. A thorough clinical examination was conducted, with specific attention to interventions such as vasopressors, mechanical ventilation, and hemodialysis. The Sequential Organ Failure Assessment (SOFA) score was used to evaluate cases' status during their ICU stay, assessing the extent of organ function or failure across six systems: cardiovascular, respiratory, hepatic, renal, coagulation, and neurological. The SOFA scoring system is a valuable tool for predicting clinical results in critically ill cases. The death rate is a minimum of fifty percent if the SOFA score rises in the first ninety-six hours of admission, twenty-seven percent to thirty-five percent when the score continues unaltered, and less than twenty-seven percent when the score declines, according to an observational study. The SOFA score ranges from zero (best) to twenty-four (worst), providing a clear indicator of patient prognosis. Comprehensive laboratory investigations were performed, including a serum creatinine, complete blood count (CBC), blood urea nitrogen (BUN), estimated glomerular filtration rate (eGFR) using the CKD-EPI formula, electrolytes such as sodium, potassium, calcium, and phosphorus, serum chloride, serum sodium bicarbonate, anion gap, serum albumin, lipid profile including triglycerides (TGs), serum cholesterol (TC), very low-density lipoprotein (VLDL), low-density lipoprotein (LDL), and high-density lipoprotein (HDL), urinalysis, liver function tests involving total bilirubin, AST, direct bilirubin and ALT, albumin-to-creatinine ratio, and the BUN-to-serum albumin ratio (BAR). These tests provided a complete assessment of kidney function, nutritional status, and overall health, ensuring a thorough evaluation of each patient's condition.

Ethical consideration

Written informed consent has been attained from cases or their caregivers prior to their enrollment in the study. Approval from the Research Ethics Committee at Al-Azhar Faculty of Medicine was secured, and a detailed statement describing the research procedures was provided to all participants to ensure transparency and understanding of the study's objectives and processes.

Statistical analysis

All data will be tabulated in SPSS sheet version 29. Categorical data is going to be expressed as a

number and a percent. Continuous data is going to be expressed as either mean and standard deviation in the case of normally distributed data or as median and range in the case of abnormally distributed data. A chi-square test will be used to compare categorical data. Student t-test will be utilized to compare normally distributed continuous data, and the Mann-Whitney test will be utilized to compare abnormally distributed continuous data. A level of significance below 0.05 is considered statistically significant using a 95% confidence interval.

3. Results

Table 1 demonstrates that, A statistically insignificant variance was discovered among studied groups according to baseline characteristic.

Table 1. Baseline characteristic of examined groups.

	GROUP A (HIGH BAR) N=47	GROUP B (LOW BAR) N=53	TEST	P-VALUE
AGE (YEARS) MEAN± SD	65.4±11.5	62.5±14.9	t = 1.0792	0.28
SEX				
MALE	24 (51.1%)	24 (45.3%)	X^2=0.334	0.56
FEMALE	23 (48.9%)	29 (54.7%)		

SD: standard deviation, t: T test, x2: qui square test. P-value <0.05 is statistically significant, P-value >0.05: Insignificant, p-value <0.001 is highly significant.

Table 2 demonstrates that, A statistically insignificant variance was discovered among studied groups according to comorbidities.

Table 2. Comorbidities of studied groups.

	GROUP A (HIGH BAR) N=47	GROUP B (LOW BAR) N=53	TEST	P-VALUE
DM	28 (59.6%)	27 (50.9%)	X^2= 0.75	0.38
HTN	28 (59.6%)	35 (66%)	X^2= 0.446	0.5
IHD	28 (59.6%)	27 (50.9%)	X^2= 0.75	0.38

DM: Diabetes mellitus, HTN: hypertension, IHD: ischemic heart disease.

Table 3 demonstrates that, A statistically insignificant variance was discovered among studied groups according to creatinine, while there was significant decrease in cases with low BAR if than patients with high BAR regarding BUN and BAR and significant increase in albumin.

Table 3. Kidney function tests at the time of admission of studied groups.

	GROUP A (HIGH BAR) N=47	GROUP B (LOW BAR) N=53	TEST	P-VALUE
BUN (MG/DL) MEAN± SD	18.7±4.71	14.34±3.10	t=5.511	<0.001
CREATININE (MILLIGRAM PER DECILITERS) MEAN± SD	0.77±0.18	0.74±0.23	t=0.792	0.43
ALBUMIN (GRAM PER DECILITERS) MEAN± SD	2.66±0.52	3.6±0.53	t=8.832	<0.001
BAR MEAN± SD	7.15±2.16	3.94±0.73	t=10.17	<0.001

BUN: blood urea nitrogen, t: T test, BAR: BUN to serum albumin ratio.

Table 4 shows that, statistically significant rise was discovered in cases with high BAR when compared to patients with low BAR regarding BUN, creatinine and BAR while there was statistically significant decrease in cases with high BAR when compared to patients with low BAR regarding albumin at 48 hours of admission.

Table (4): Kidney function tests at 48 hours of admission of studied groups.

	GROUP A (HIGH BAR) N=47	GROUP B (LOW BAR) N=53	TEST	P-VALUE
BUN (MG/DL) MEAN± SD	40.9±15.1	16.5±6.2	t=10.816	<0.001
CREATININE (MILLIGRAM PER DECILITERS) MEAN± SD	1.6±0.7	0.79±0.3	t= 7.704	<0.001
ALBUMIN (GRAM PER DECILITERS) MEAN± SD	2.9±0.6	3.6±0.6	t= 6.118	<0.001
BAR MEAN± SD	14.9±6.6	4.7±1.7	t= 10.892	<0.001

Table 5 shows that, statistically significant rise was discovered in cases with high BAR when comparing with cases with low BAR regarding AKI.

Table 5. AKI of examined groups.

	GROUP A (HIGH BAR) NUMBER=47	GROUP B (LOW BAR) NUMBER=53	TEST	P-VALUE
AKI				
YES	37 (78.7%)	4 (7.5%)	X^2=52.168	<0.001
NO	10 (21.3%)	49 (92.5%)		

Table 6 shows that, significant positive correlation was observed among BAR, age, BUN and Na, while significant negative connection was observed among BAR, albumin and HB.

Table 6. Correlation between BAR and patient characteristics.

	BAR	
	r	p
AGE	0.282	0.004
DM	0.038	0.704
HTN	-.038	0.710
IHD	0.178	0.077
BUN	0.756	<0.001
CR	0.158	0.117
ALBUMIN	-.667	<0.001
NA	0.263	0.008
K	-.081	0.422
HB	-.268	0.007
WBC	0.057	0.575
PLT	-.037	0.717
CRP	0.151	0.134
SGOT	-.008	0.939
SGPT	-.061	0.548
PH	-.004	0.970
PCO2	.022	0.824
HCO3	-.027	0.793

r: Pearson Correlation

Table 7 demonstrated that, at cutoff value 5.2, BAR has 93% sensitivity and 80% specificity for predicting of AKI.

Table 7. Roc curve for predicting of AKI using BAR.

	AUC	SIG.	CUTOFF VALUE.	SENSITIVITY	SPECIFICITY
BAR	0.869	<0.001	5.2	93%	80%

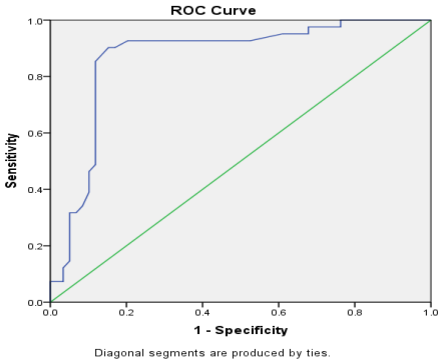

Figure 1. ROC curve for BAR as a predictor for AKI.

4. Discussion

AKI is a medical condition and is prevalent among critically ill cases hospitalized in intensive care units (ICUs), and is defined by an abrupt decline in kidney functions .[6]

Our studies showed that there was a statistically insignificant difference among the examined groups according to sex and age.

Our outcomes agreed with He et al.,[7] he studied whether the BAR might function as an independent indicator of AKI in the ICUs, the research stated that insignificant variant among high BAR and low BAR regarding age and sex.

In our studies demonstrated that statistically insignificant variance among examined groups according to diabetes mellitus, HTN, and IHD.

On the other hand, Zhao et al.[8] stated that significant variance among was discovered high and low BAR groups regarding DM and HTN.

In contrast Shi et al.[9] stated that statistically significant was discovered among the examined groups according to DM and HTN.

In our studies showed that, our kidney function test results at the time of admission demonstrated that statistically insignificant variance was discovered among examined groups according to creatinine, while significant decrease was discovered in cases with low BAR when compared to patients with high BAR regarding BUN and BAR and significant increase in albumin.

Our outcomes agreed with He et al.,[7] he reported that statistically insignificant variance was discovered among examined groups according to creatinine at the time of admission in the matched cohort and the weighted cohort.

Also, Peng et al.[10] stated that statistically insignificant variance among examined groups according to creatinine at the time of admission in matched cohort.

In addition, Zhao et al.[8] stated that significant decrease was discovered in cases with low BAR if comparing with patients with high BAR regarding BUN and BAR and significant increase in albumin, although they reported there was significant decrease in creatinine in low BAR group than high BAR at the time of admission.

In our studies showed that, our kidney function test results at 48 hours of admission demonstrated that statistically significant increase was discovered in cases with high BAR when comparing with patients with low BAR regarding BUN, creatinine and BAR while there was statistically significant decrease in patients with high BAR when compared to patients with low BAR regarding albumin at 48 hours of admission. A statistically insignificant variance was discovered among examined groups according to electrolytes at 48 hours of admission.

Our outcomes agreed with Wang et al.[11] he reported that statistically significant variance was discovered among examined groups according to BUN, creatinine, and albumin after 48 hours of admission. However, they stated that significant variance was discovered among examined groups according to electrolytes at 48 hours of admission.

In our studies demonstrated that statistically significant increase was discovered in cases with high BAR when comparing with patients with low BAR regarding AKI.

Our outcomes agreed with He et al.,[7] who stated that the high serum albumin ratio group had a significantly elevated incidence of acute kidney injury than patients with low BAR ($p<0.001$).

Also, Yang et al.[12] stated that cases in the high-BAR group were more likely to develop acute kidney injury in the original cohort and the matched cohort compared with those in the low-BAR group, indicating that the blood urea nitrogen to serum albumin ratio has a prognostic value for acute kidney injury in the intensive care unit.

In our studies demonstrated that significant positive correlation was discovered among BAR, age, BUN and Na, while significant negative correlation was discovered among BAR, albumin and HB.

Our results agreed with Lin et al.[13] who investigated the correlation among the BUN to serum albumin ratio and the outcome of cases with CHF who are admitted to the intensive care unit, the study reported that significant negative correlation was discovered among BAR and HB,

while insignificant association was discovered among BAR and Na.

In our studies showed that at cutoff value 5.2, BAR has 93% sensitivity and 80% specificity for predicting of AKI.

Our research agreement with He et al.,[7] who stated that optimal the cutoff value for serum albumin ratio was 5.26 depend on ROC curve. Also reported that BAR was superior in predicting AKI.

Also, Yang et al.[12] reported that a high BAR continued an independent indicator of acute kidney injury in all cohort investigations.

Conversely, Shi et al.[9] had stated that a cutoff of 8.07 BAR can detect 28-day mortality as the end outcome of AKI patients with a sensitivity of 65% and specificity of 62%.

LIST OF ABBREVIATIONS

AKI – Acute Kidney Injury

BAR – Blood Urea Nitrogen to Serum Albumin Ratio

BUN – Blood Urea Nitrogen

HB – Hemoglobin

ICU – Intensive Care Unit

KDIGO – kidney disease: Improving Global Outcomes

Na – Sodium

RRT – Renal Replacement Therapy

ESRD – End-Stage Renal Disease

4. Conclusion

Our results demonstrated that statistically significant increase was discovered in people with high BAR compared to low BAR regarding AKI, moreover there was positive significant correlation between age, BUN, Na, and BAR, while there was negative significant correlation between albumin, hemoglobin and BAR. Furthermore, we evaluated that at cut off 5.2, BAR can predict AKI with sensitivity of 93% and specificity of 80%.

Disclosure

The authors have no financial interest to declare in relation to the content of this article.

Authorship

All authors have a substantial contribution to the article

Funding

No Funds : Yes

Conflicts of interest

There are no conflicts of interest.

References

1. Kuo G, Chen JJ, Yen CL, Fan PC, Lee CC, Chang CH. Association between early, small creatinine elevation and severe acute kidney injury in critically ill adult patients. J Crit Care. 2022;72:154142. doi:10.1016/j.jcrc.2022.154142
2. Singh, S., Patel, P. S., Doley, P. K., Sharma, S. S., Iqbal, M., Agarwal, A., et al. Outcomes of hospital-acquired acute kidney injury in elderly patients: a single-centre study. Int Urol Nephrol. 2019;51(5):875-883. doi:10.1007/s11255-019-02130-4
3. LASZCZYŃSKA, Olga; AZEVEDO, Ana; SEVERO, Milton. Incidence, clinical characteristics and outcomes of acute kidney injury in hospitalised patients--the relevance of presence on admission versus post-admission syndrome onset. Authorea Preprints, 2020. DOI: 10.22541/au.159050630.02057639
4. Woodward, C. W., Lambert, J., Ortiz-Soriano, V., Li, Y., Ruiz-Conejo, M., Bissell, B. D., et al. Fluid Overload Associates with Major Adverse Kidney Events in Critically Ill Patients With Acute Kidney Injury Requiring Continuous Renal Replacement Therapy. Crit Care Med. 2019;47(9):e753-e760. doi:10.1097/CCM.0000000000003862
5. Jiang W, Hu Y, Sun Y, Shen Y, Xun Y. Prevalence and short-term outcome of acute kidney injury in patients with acute-on-chronic liver failure: A meta-analysis. J Viral Hepat. 2020;27(8):810-817. doi:10.1111/jvh.13287
6. Gong K, Lee HK, Yu K, Xie X, Li J. A prediction and interpretation framework of acute kidney injury in critical care. J Biomed Inform. 2021;113:103653. doi:10.1016/j.jbi.2020.103653
7. He T, Li G, Xu S, Guo L, Tang B. Blood Urea Nitrogen to Serum Albumin Ratio in the Prediction of Acute Kidney Injury of Patients with Rib Fracture in Intensive Care Unit. Int J Gen Med. 2022;15:965-974. Published 2022 Jan 29. doi:10.2147/IJGM.S348383
8. Zhao, D., Liu, Y., Chen, S., Xu, Z., Yang, X., Shen, H., et al. . Predictive Value of Blood Urea Nitrogen to Albumin Ratio in Long-Term Mortality in Intensive Care Unit Patients with Acute Myocardial Infarction: A Propensity Score Matching Analysis. Int J Gen Med. 2022;15:2247-2259. Published 2022 Mar 1. doi:10.2147/IJGM.S349722
9. Shi, Y., Duan, H., Liu, J., Shi, X., Zhang, Y., Zhang, et al. Blood urea nitrogen to serum albumin ratio is associated with all-cause mortality in patients with AKI: a cohort study. Front Nutr. 2024;11:1353956. Published 2024 Feb 20. doi:10.3389/fnut.2024.1353956
10. Peng X, Huang Y, Fu H, Zhang Z, He A, Luo R. Prognostic Value of Blood Urea Nitrogen to Serum Albumin Ratio in Intensive Care Unit Patients with Lung Cancer. Int J Gen Med. 2021;14:7349-7359. Published 2021 Oct 28. doi:10.2147/IJGM.S337822
11. Wang, J., Zhao, K., Mao, X., Zhang, Y., Shao, J., Fan, W., et al. Relationship between CRP Albumin Ratio and the Mortality in Critically Ill Patients with AKI: A Retrospective Observational Study. Biomed Res Int. 2021;2021:9957563. Published 2021 Sep 30. doi:10.1155/2021/9957563
12. Yang F, Wang R, Lu W, Hu H, Li Z, Shui H. Prognostic value of blood urea nitrogen to serum albumin ratio for acute kidney injury and in-hospital mortality in intensive care unit patients with intracerebral haemorrhage: a retrospective cohort study using the MIMIC-IV database. BMJ Open. 2023;13(8):e069503. Published 2023 Aug 22. doi:10.1136/bmjopen-2022-069503
13. Lin Z, Zhao Y, Xiao L, Qi C, Chen Q, Li Y. Blood urea nitrogen to serum albumin ratio as a new prognostic indicator in critical patients with chronic heart failure. ESC Heart Fail. 2022;9(2):1360-1369. doi:10.1002/ehf2.13825