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Blood Urea Nitrogen-to-Albumin Ratio: A Marker of Disease Severity in Critically Ill Patients

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Abstract

Background: *Simple, readily available biomarkers that reflect disease severity in critically ill patients are of significant clinical interest. The blood urea nitrogen-to-albumin (BUN/ALB) ratio has emerged as a potential marker integrating renal function, nutritional status, and systemic illness.*

Objectives: *To evaluate the association between the BUN/ALB ratio and in-hospital mortality, hospital length of stay (LOS), intensive care unit (ICU) LOS, and vasopressor requirements among ICU patients.*

Methods: *We conducted a retrospective cohort study of adult ICU admissions. The primary outcome was in-hospital mortality. Secondary outcomes included hospital LOS, ICU LOS, and number of vasopressors administered. Multivariable logistic regression was used to evaluate associations with mortality, while negative binomial regression models were used for count outcomes. Models were sequentially adjusted for demographic variables, laboratory values, and comorbidities.*

Results: *A total of 1,879 unique ICU admissions were included. The median BUN/ALB ratio was 6.7 (Q1–Q3: 4.3–12.4). Higher BUN/ALB ratios were associated with increased odds of in-hospital mortality in adjusted models without comorbidities (OR 1.03 per unit increase; 95% CI 1.01–1.04), but this association was attenuated after adjustment for comorbidities. The BUN/ALB ratio remained independently associated with hospital LOS after full adjustment (IRR 1.011; 95% CI 1.005–1.016). Associations with ICU LOS and vasopressor use were no longer significant after accounting for comorbidities.*

Conclusions: *The BUN/ALB ratio is associated with markers of disease severity, particularly hospital LOS, among critically ill patients. However, comorbid conditions appear to drive much of the observed association with mortality and ICU-level outcomes. The BUN/ALB ratio may serve as a useful adjunctive marker of illness burden rather than an independent predictor of mortality.*

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Introduction

Critically ill patients frequently present with complex physiologic derangements involving renal dysfunction, inflammation, and altered nutritional status [1-3]. Identifying simple, inexpensive biomarkers that reflect overall disease severity and prognosis remains a priority in intensive care medicine. Even though scoring systems such as APACHE II and SOFA already provide risk stratification for critically ill patients, they require the accurate documentation and integration of physiologic variables and patient data [4-6]. Having a simpler laboratory-based marker for disease risk-stratification, as such, remains attractive for early assessment.

Blood urea nitrogen (BUN) and serum albumin are routinely measured laboratory values that individually have been associated with adverse outcomes in hospitalized and critically ill populations. Elevated BUN reflects renal hypoperfusion, neurohormonal activation, intravascular volume depletion, or increased protein catabolism [7-9]. Hypoalbuminemia is also recognized as a marker of systemic inflammation, capillary leak, hepatic dysfunction, and poor nutritional reserve, and has repeatedly shown association with increased morbidity and mortality [10-13].

The BUN and albumin ratio (BUN/ALB) has been proposed as a composite marker integrating these overlapping pathophysiologic processes. There have been prior studies demonstrating associations between elevated BUN/ALB ratios and mortality in patients with sepsis, pneumonia, gastrointestinal bleeding, and heart failure [14-17,18-20]. However, data examining its performance in a broad, heterogeneous ICU population and its independence from underlying comorbid disease burden remain limited.

Our study aims to evaluate the association between the BUN/ALB ratio with clinically relevant outcomes in ICU patients, including in-hospital mortality, hospital length of stay, ICU length of stay, and vasopressor requirements, while accounting for demographic factors, laboratory values, and comorbid conditions.

Methods

Study Design and Population

We conducted a retrospective observational cohort study of adult patients admitted to the ICU during the study period. The study site is a 668-bed Level 1 trauma center located in an urban setting. The original dataset consisted of 2,055 ICU admissions. Patients with multiple admissions (approximately 8%) were restricted to their first ICU admission to avoid correlated observations, resulting in a final analytic cohort of 1,879 unique patients.

Outcomes

The primary outcome was in-hospital mortality (yes/no). Secondary outcomes included hospital length of stay (LOS), ICU LOS, and the number of vasopressors administered during the ICU stay.

Variables

The primary exposure variable was the BUN/ALB ratio, calculated using laboratory values obtained during hospitalization. Additional covariates included age, sex, race, ethnicity, and laboratory values (creatinine, hematocrit, chloride, and white blood cell count). Comorbid conditions were included in fully adjusted models to account for underlying disease burden.

Statistical Analysis

Descriptive statistics were calculated for all variables. Categorical variables were summarized as frequencies and proportions, and continuous variables were summarized as medians with interquartile ranges (IQR). Baseline characteristics were compared by mortality status using chi-square tests for categorical variables and Wilcoxon rank-sum or two-sample t-tests for continuous variables, as appropriate.

Multivariable logistic regression was used to assess

the association between the BUN/ALB ratio and in-hospital mortality. Odds ratios (ORs) with 95% confidence intervals (CIs) were reported.

Negative binomial regression models were used to evaluate associations with hospital LOS, ICU LOS, and number of vasopressors, given the count distribution of these outcomes. Incidence rate ratios (IRRs) with 95% CIs were reported. Models were sequentially adjusted for demographic variables, laboratory values, and comorbid conditions. Statistical significance was defined as a two-sided p-value <0.05.

All analyses were performed using SAS version 9.4 (SAS Institute Inc., Cary, NC).

Results

Baseline Characteristics

Among the 1,879 patients included in the analysis, 56% were male and the median age was 72 years (Q1–Q3: 61–81). The majority were White (75%) and non-Hispanic or Latino (89%). Overall, 19% of patients died during hospitalization.

The median hospital LOS was 7 days (Q1–Q3: 4–14), and the median ICU LOS was 3 days (Q1–Q3: 2–6). The median BUN/ALB ratio was 6.7 (Q1–Q3: 4.3–12.4).

In-Hospital Mortality

In multivariable logistic regression models adjusting for race, ethnicity, age, hematocrit, and creatinine, the BUN/ALB ratio was significantly associated with in-hospital mortality (OR 1.03 per unit increase; 95% CI 1.01–1.04; p=0.0006). This association was attenuated after further adjustment for comorbid conditions.

Hospital Length of Stay

Higher BUN/ALB ratios were consistently associated with longer hospital LOS. For every unit increase in the BUN/ALB ratio, hospital LOS increased by approximately 1.5% (IRR 1.015; 95% CI 1.01–1.02; p<0.0001). This association remained statistically significant after full adjustment, including comorbidities (IRR 1.011; 95% CI 1.005–1.016).

ICU Length of Stay

The BUN/ALB ratio was minimally associated with ICU LOS in adjusted models (IRR 1.004; 95% CI 1.0001–1.0007; p=0.04). This association was no longer statistically significant after accounting for comorbid conditions.

Vasopressor Use

In models adjusting for sex, creatinine, hematocrit, and white blood cell count, higher BUN/ALB ratios were associated with an increased number of vasopressors administered (IRR 1.02; 95% CI 1.01–1.03; p<0.0001). This association was attenuated after inclusion of comorbidities in the fully adjusted model.

Discussion

In this large cohort of critically ill patients, we found that the blood urea nitrogen-to-albumin (BUN/ALB) ratio was associated with multiple clinically meaningful indicators of disease severity. Higher BUN/ALB ratios were associated with increased in-hospital mortality in models adjusting for demographic and laboratory variables, although this association was attenuated after accounting for comorbid conditions. The ratio remained independently associated with hospital length of stay even after full adjustment. Associations with ICU length of stay and vasopressor requirements were present in partially adjusted analyses but were no longer statistically significant once comorbidities were included. Taken together, these findings suggest that the BUN/ALB ratio reflects overall illness burden, with its prognostic performance influenced by underlying chronic disease.

There are several physiologic mechanisms that support the observed associations. Elevated BUN is commonly seen in states of renal hypoperfusion, sympathetic and renin-angiotensin activation, and increased catabolic stress, features frequent in severe critical illness [7-9]. Acute kidney injury and impaired renal perfusion are strongly associated with adverse ICU outcomes [8]. At the same time, hypoalbuminemia reflects systemic inflammation, endothelial dysfunction, capillary leak, and diminished physiologic reserve [10-13]. Low serum albumin has consistently been linked to higher mortality and longer hospitalization across multiple samples of medical and surgical patient groups [10,11].

By integrating markers of renal function and systemic inflammation, the BUN/ALB ratio may capture both acute physiologic stress and baseline vulnerability. This integrative property may explain its persistent association with hospital length of stay, an outcome

that likely reflects not only acute severity but also recovery trajectory and underlying comorbidity burden. Length of stay is increasingly recognized as a meaningful marker of resource utilization and healthcare burden in critically ill populations [21].

While the most of the associations with mortality and ICU-level outcomes dissipated after adjustment for comorbidities, this information in and of itself is also clinically informative. Comorbidity burden is a well-established determinant of ICU outcomes and mortality risk [22,23]. Rather than an independent predictor of mortality, the BUN/ALB ratio may instead function partly as a surrogate for chronic disease severity and physiologic reserve for critically ill patients.

Prior studies in more narrowly defined populations such as patients with sepsis, pneumonia, and cardiovascular disease have demonstrated similar associations between elevated BUN/ALB ratios and adverse outcomes [4-6,18-20]. Our findings extend these observations to a heterogeneous ICU cohort and underscore the importance of accounting for comorbid disease burden when interpreting laboratory-based prognostic markers.

Given its accessibility, low cost, and ease of calculation, the BUN/ALB ratio could complement existing clinical assessments and established severity scoring systems such as APACHE II and SOFA [4-6]. While it should not replace validated tools, it may provide rapid contextual information regarding overall illness burden at the time of ICU admission. Future prospective studies are needed to evaluate whether dynamic changes in the BUN/ALB ratio over time offer additional prognostic value and whether incorporation into clinical risk models improves discrimination or calibration [24].

As a retrospective observational study, our study is inherently vulnerable to residual confounding despite multivariable adjustment. Observational designs cannot establish causality, and unmeasured variables such as illness severity at presentation, fluid balance, or therapeutic interventions may have influenced both the BUN/ALB ratio and outcomes. Additionally, laboratory measurements were obtained as part of routine clinical care, and the BUN/albumin ratio collection time was not standardized. Thus, the calculated ratio may not uniformly represent the same phase of illness across patients.

Given that our study was conducted at a large diverse urban tertiary care hospital, its generalizability to other ICU settings may be inappropriate due to different patient populations or practice patterns. Additionally, we did not directly compare the predictive performance of the BUN/ALB ratio with already established ICU severity scores like the APACHE II or SOFA. Therefore, we cannot determine the BUN/albumin ratio's incremental prognostic value relative to these validated instruments.

Table 1

Demographic and Clinical Characteristics

	Variable	N (%)*
Sex	Female	826 (43.96)
	Male	1053 (56.04)
Race	White	1416 (75.36)
	African American	145 (7.72)
	Asian	59 (3.14)
	Other/Multiracial	242 (12.88)
	Unknown	17 (0.90)
Race	Not Hispanic or Latino	1676 (89.20)
	Hispanic or Latino	164 (8.73)
	Unknown/Declined	39 (2.08)
Disposition	Home	472 (25.12)
	Expired	364 (19.37)

	Nursing Home	325 (17.30)
	Routine Discharge	285 (15.17)
	Other	433 (23.04)
Mortality	No	1515 (80.63)
	Yes	364 (19.37)

*Percentages may not add upto 100% due to rounding calculations

Table 2

Association of BUN/Albumin Ratio With Clinical Outcomes

Outcome	Model	Effect	95% CI	P-Value
In-Hospital Mortality	Adjusted	OR 1.03	1.01–1.04	0.0006
	Fully Adjusted	Not significant	—	0.29
Hospital Length of Stay	Adjusted	IRR 1.015	1.01–1.02	<0.0001
	Fully Adjusted	IRR 1.011 1	005–1.016	<0.0001
ICU Length of Stay	Adjusted	IRR 1.004	1.0001–1.0007	0.04
	Fully Adjusted	Not significant	—	0.88
Vasopressor Use (Number)	Adjusted*	IRR 1.02	1.01–1.03	<0.0001
	Fully Adjusted	Not significant	—	0.95

OR = Odds Ratio; IRR = Incidence Rate Ratio; CI = Confidence Interval
Adjusted: Model Adjusted for Age, Race, Ethnicity, Hematocrit, and Creatinine
Fully Adjusted: Includes Comorbid Conditions (Sepsis, Septic Shock, ARF, AKI, CHF, Stroke, Altered Mental Status)
*Vasopressor model additionally adjusted for sex and white blood cell count

Conclusion

In critically ill patients, higher BUN/albumin ratios were associated with increased markers of illness severity, including higher inpatient mortality in partially adjusted models and longer hospital length of stay even after full adjustment. Associations with ICU length of stay and vasopressor requirements were influenced by comorbid disease burden, highlighting the complex interplay between acute physiologic stress and chronic health conditions.

The BUN/ALB ratio is an inexpensive and readily available biomarker that integrates information regarding renal function, inflammatory burden, and nutritional reserve. Although it does not function as a fully independent predictor of all adverse outcomes, it may serve as a practical adjunctive measure of overall illness burden in the ICU. Future prospective, multicenter investigations are warranted to validate these findings, examine potential temporal changes in the ratio, and determine its optimal role alongside established risk stratification tools in critical care practice.

References

1. Angus DC, Vander Poll T (2013) Severe Sepsis and Septic Shock. N Engl J Med 369: 840-851.
2. Vincent JL, Sakr Y, Sprung CL, Ranieri VM, Reinhart K, et al. (2006) Sepsis in European Intensive Care Units: Results of the SOAP Study. JAMA 296: 2323-2329.
3. Singer M, Deutschman CS, Seymour CW, Shankar Hari M, Annane D, et al. (2016) The Third International Consensus Definitions for

Sepsis and Septic Shock (Sepsis-3). JAMA 315: 801-810.

4. Knaus WA, Draper EA, Wagner DP, Zimmerman JE (1985) APACHE II: A Severity of DISEASE Classification System. Crit Care Med 13: 818-829.
5. Vincent JL, Moreno R, Takala J, Willatts S, De Mendonça A, et al. (1996) The SOFA (Sepsis-related Organ Failure Assessment) Score to Describe Organ Dysfunction/Failure. Intensive Care Med 22: 707-710.
6. Raith EP, Udy AA, Bailey M, McGloughlin S, MacIsaac C, et al. (2017) Prognostic Accuracy of the SOFA Score, SIRS Criteria, and qSofa Score for In-Hospital Mortality Among Adults with Suspected Infection. JAMA 317: 290-300.
7. Schrier RW (2006) Blood Urea Nitrogen and Serum Creatinine: Not Married in Heart Failure. N Engl J Med 354: 191-193.
8. Bellomo R, Kellum JA, Ronco C (2012) Acute Kidney Injury. Lancet 380: 756-766.
9. Prowle JR, Molan MP, Hornsey E, Bellomo R (2012) Measurement of Renal Perfusion in Critically Ill Patients. Intensive Care Med 38: 1018-1028.
10. Vincent JL, Dubois MJ, Navickis RJ, Wilkes MM (2003) Hypoalbuminemia in Acute Illness: Is There a Rationale for Intervention? Crit Care Med 31: 1747-1752.
11. Lee JH, Kim J, Kim K (2010) Albumin and Mortality in Critically Ill Patients. Ann Surg 251: 447-453.
12. Nicholson JP, Wolmarans MR, Park GR (2000) The Role of Albumin in Critical Illness. Br J Anaesth 85: 599-610.
13. Don BR, Kaysen G (2004) Serum Albumin: Relationship to Inflammation and Nutrition. Kidney Int 65: 778-784.
14. Ryu S, Oh SK, Cho SU (2018) Blood Urea Nitrogen to Serum Albumin Ratio as a Predictor of Mortality in Patients with Sepsis. Am J Emerg Med 36: 989-993.
15. Kim HJ, Jo EJ, Eom JS (2015) The Blood Urea Nitrogen/Albumin Ratio as a Predictor of Mortality in Patients with Community-Acquired Pneumonia. Clin Chim Acta 450: 45-50.
16. Dundar ZD, Kocak S, Girisgin AS (2011) The Blood Urea Nitrogen/Albumin Ratio as a Predictor of Mortality in Patients with Upper Gastrointestinal Bleeding. Am J Emerg Med 29: 665-668.
17. Aronson D, Hammerman H, Beyar R, Yalonetsky S, Kapeliovich M, et al. (2004) Serum Albumin and Long-Term Survival in Patients with Heart Failure. Eur J Heart Fail 6: 493-498.
18. Feng DY, Zhou YQ, Zou XL, Zhou M, Yang HL (2019) Elevated Blood Urea Nitrogen-to-Albumin Ratio as a Predictor of Mortality in Patients with Pneumonia. Am J Med Sci 358: 386-392.
19. Chen XY, Li H, Li J (2020) Prognostic Value of Blood Urea Nitrogen to Albumin Ratio in Septic Shock Patients. Shock 53: 221-228.
20. Liu M, Chan CP, Yan BP (2012) Albumin Levels and Cardiovascular Outcomes. Int J Cardiol 155: 35-40.
21. Kahn JM, Rubenfeld GD, Rohrbach J, Fuchs BD (2008) Cost Savings Attributable to Reductions in Intensive Care Unit Length of Stay. Med Care 46: 1226-1233.
22. Esper AM, Martin GS (2011) The Impact of Comorbid [Corrected] Conditions on Critical Illness. Crit Care Med 39: 2728-2735.
23. Simpson A, Puxty K, McLoone P, Quasim T, Sloan B, et al. (2021) Comorbidity and Survival After Admission to the Intensive Care Unit: A Population-Based Study of 41,230 Patients. J Intensive Care Soc 22: 143-151.
24. Shankar Hari M, Phillips GS, Levy ML, Seymour CW, Liu VX, et al. (2016) Developing a New Definition and Assessing New Clinical Criteria for Septic Shock. Intensive Care Med 42: 783-794.