Section: General Medicine

Original Research Article

URINE ALBUMIN-CREATININE RATIO AS AN EARLY BIOMARKER OF SEVERITY IN CRITICALLY ILL PATIENTS: CORRELATION WITH QSOFA AND SOFA SCORES

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ABSTRACT

Background: Early identification of disease severity in critically ill patients is crucial for timely intervention and prognostication. The urine albumin-creatinine ratio (UACR) reflects endothelial dysfunction and capillary permeability and may serve as an early biomarker of severity in critical illness.
Aim: To evaluate urine albumin-creatinine ratio as an early biomarker of severity in critically ill patients and correlate it with qSOFA and SOFA scores.
Materials and Methods: This hospital-based cross-sectional observational study included 100 critically ill patients admitted to the medical intensive care unit of a tertiary care hospital. UACR was measured using spot urine samples at 6 hours and 48 hours after admission. qSOFA score was calculated at admission, while SOFA scores were assessed at 6 hours and 48 hours. Data were analyzed using appropriate descriptive statistics and Pearson correlation analysis to determine the association between UACR and severity scores.
Results: The mean UACR at 6 hours and 48 hours was elevated, with most patients exhibiting microalbuminuria. SOFA scores increased significantly over 48 hours, indicating progression of organ dysfunction. UACR at 6 hours showed a significant positive correlation with SOFA score at 48 hours and with qSOFA score. UACR at 48 hours demonstrated a moderate and statistically significant positive correlation with both SOFA and qSOFA scores. These findings suggest that higher and persistent UACR levels are associated with increased disease severity.
Conclusion: UACR is a simple, non-invasive, and cost-effective biomarker that correlates significantly with established severity scoring systems in critically ill patients. It may be used as an adjunct tool for early risk stratification and prognostication in the intensive care setting.
Keywords: Urine albumin-creatinine ratio. Critical illness. SOFA score.

INTRODUCTION

Critical illness is frequently accompanied by systemic inflammation, endothelial dysfunction, and varying degrees of organ failure, all of which contribute significantly to morbidity and mortality in intensive care units (ICUs). Early identification of disease severity is essential for timely intervention, appropriate triage, and prognostication. Although several clinical scoring systems are used to assess severity, there remains a continuous search for simple, rapid, and cost-effective biomarkers that can complement existing tools.[1]

The Urine Albumin-Creatinine Ratio (UACR) is a sensitive marker of albuminuria that reflects glomerular endothelial injury and increased

capillary permeability. In critically ill patients, especially those with sepsis or multi-organ dysfunction, systemic inflammatory mediators cause disruption of the endothelial glycocalyx, leading to leakage of albumin into the urine. Hence, elevated UACR not only signifies renal involvement but also mirrors systemic endothelial dysfunction, making it a potential early marker of disease severity. Unlike 24-hour urine collections, UACR estimation from a spot urine sample is simple, non-invasive, rapid, and feasible even in unstable patients.[2]

The Sequential Organ Failure Assessment (SOFA) score is a validated and widely used tool for quantifying the degree of organ dysfunction in critically ill patients. It evaluates six organ systems respiratory, cardiovascular, hepatic, coagulation, renal, and neurological and higher scores are strongly associated with increased mortality. Serial SOFA scoring also helps in monitoring disease progression and response to therapy. However, its calculation requires laboratory investigations, which may not always be immediately available.[3]

To overcome this limitation, the quick SOFA (qSOFA) score was introduced as a bedside screening tool using three simple clinical parameters: altered mental status, hypotension, and tachypnea. Although qSOFA allows rapid risk stratification, it lacks sensitivity in some patient populations and may benefit from the addition of objective biochemical markers.[4]

Aim

To evaluate the urine albumin-creatinine ratio as an early biomarker of severity in critically ill patients and correlate it with qSOFA and SOFA scores.

Objectives

1. To measure urine albumin-creatinine ratio levels in critically ill patients.
2. To assess qSOFA and SOFA scores in the study population.
3. To determine the correlation between UACR and qSOFA and SOFA scores.

MATERIALS AND METHODS

Source of Data

Data were collected from critically ill patients admitted to the Medical Intensive Care Unit (MICU) of a tertiary care teaching hospital.

Study Design

This study was a hospital-based cross-sectional observational study.

Study Location

The study was conducted in the Department of General Medicine, MICU, at a tertiary care hospital.

Study Duration

The study was carried out over a period of 18 months.

Sample Size

A total of 100 critically ill patients were included in the study.

Inclusion Criteria

- Patients aged more than 18 years
- Critically ill patients admitted to MICU
- Patients or legally acceptable representatives providing informed consent

Exclusion Criteria

- Patients aged less than 18 years
- Known cases of chronic kidney disease
- Patients with type 1 or type 2 diabetes mellitus
- Pregnant women
- Patients with connective tissue diseases
- Immunocompromised patients
- Patients not willing to participate in the study

Procedure and Methodology

After obtaining approval from the Institutional Ethics Committee, eligible patients were enrolled following informed consent. A detailed clinical history and physical examination were performed using a pre-structured proforma. qSOFA score was calculated at admission based on clinical parameters. SOFA score was calculated at 6 hours and again at 48 hours after admission using relevant clinical and laboratory data.

Sample Processing

Spot urine samples were collected at 6 hours and 48 hours after MICU admission. Urinary albumin was estimated using the immunoturbidometric method, and urinary creatinine was measured using the Jaffe method. The urine albumin-creatinine ratio was calculated and recorded as UACR.

Statistical Methods

Data were entered in Microsoft Excel and analyzed using SPSS software version 25. Quantitative variables were expressed as mean ± standard deviation or median with interquartile range, while qualitative variables were expressed as frequencies and percentages. Correlation between UACR and qSOFA and SOFA scores was assessed using appropriate correlation coefficients. A p-value of less than 0.05 was considered statistically significant.

Data Collection

All clinical, laboratory, and scoring data were recorded prospectively in a structured proforma, ensuring confidentiality and adherence to ethical guidelines.

RESULTS

Table 1: Baseline demographic profile of critically ill patients (N = 100)

Parameter	Category / Summary	n (%) or Mean ± SD	95% CI	Test of significance	p-value
Age (years)	Mean ± SD	55.22 ± 16.87	51.91-58.53		
Sex	Male	63 (63.0)	53.2-71.8	$\chi^2(1)=6.76$	0.009
	Female	37 (37.0)	28.2-46.8		
Age group (years)	18-30	13 (13.0)	7.7-21.2	$\chi^2(3)=29.52$	<0.001
	31-45	10 (10.0)	5.5-17.4		
	46-60	37 (37.0)	28.2-46.8		
	>60	40 (40.0)	30.9-49.9		

Footnote: 95% CI for proportions = Wilson CI; for means = mean ± 1.96×SE (SE=SD/√n).

Table 1 depicts the baseline demographic characteristics of the 100 critically ill patients included in the study. The mean age of the study population was 55.22 ± 16.87 years, with a 95% confidence interval (CI) ranging from 51.91 to 58.53 years, indicating a predominance of middle-aged and elderly patients. Male patients constituted 63% (n = 63) of the study population, while 37% (n = 37) were females. This sex distribution showed a statistically significant deviation from equal distribution ($\chi^2 = 6.76$, $p = 0.009$), suggesting male predominance among critically ill admissions.

Regarding age-group distribution, the largest proportion of patients belonged to the >60 years category (40%), followed by 46-60 years (37%), while younger age groups 18-30 years and 31-45 years accounted for 13% and 10%, respectively. The age-group distribution was statistically significant ($\chi^2 = 29.52$, $p < 0.001$), reflecting a higher burden of critical illness among older age groups.

Table 2: Urine Albumin-Creatinine Ratio (UACR) profile (N = 100)

UACR variable	Category / Summary	n (%) or Mean ± SD	95% CI	Test of significance	p-value
UACR at 6 hours (mg/g)	Mean ± SD	194.07 ± 323.82	130.60-257.54		
	<30	25 (25.0)	17.5-34.3	$\chi^2(2)=42.14$	<0.001
	30-300	63 (63.0)	53.2-71.8		
	>300	12 (12.0)	7.0-19.8		
UACR at 48 hours (mg/g)	Mean ± SD	216.08 ± 337.38	149.95-282.21		
	<30	24 (24.0)	16.7-33.4	$\chi^2(2)=32.96$	<0.001
	30-300	60 (60.0)	50.2-69.1		
	>300	16 (16.0)	10.1-24.4		

Table 2 summarizes the distribution of UACR values measured at 6 hours and 48 hours after admission to the intensive care unit. The mean UACR at 6 hours was 194.07 ± 323.82 mg/g (95% CI: 130.60-257.54 mg/g). Most patients (63%) had UACR values in the microalbuminuria range (30-300 mg/g), while 25% had normal UACR (<30 mg/g) and 12% had macroalbuminuria (>300 mg/g). This distribution was statistically significant ($\chi^2 = 42.14$, $p < 0.001$).

At 48 hours, the mean UACR increased to 216.08 ± 337.38 mg/g (95% CI: 149.95-282.21 mg/g). Although the majority of patients (60%) continued to have UACR values between 30-300 mg/g, the proportion of patients with macroalbuminuria increased to 16%, while 24% had normal UACR levels. The categorical distribution at 48 hours also showed statistical significance ($\chi^2 = 32.96$, $p < 0.001$), suggesting persistence or progression of albuminuria with ongoing critical illness.

Table 3: Severity scores in the study population (N = 100)

Score	Category / Summary	n (%) or Mean ± SD	95% CI	Test of significance	p-value
SOFA at 6 hours	Mean ± SD	6.43 ± 2.49	5.94-6.92		
	<9	85 (85.0)	76.7-90.8	$\chi^2(2)=120.14$	<0.001
	9-11	8 (8.0)	4.1-14.9		
	>11	7 (7.0)	3.4-13.8		
SOFA at 48 hours	Mean ± SD	7.78 ± 3.15	7.16-8.40		
	<9	67 (67.0)	57.3-75.4	$\chi^2(2)=51.74$	<0.001
	9-11	20 (20.0)	13.2-29.1		
	>11	13 (13.0)	7.7-21.2		
qSOFA	Mean ± SD	1.22 ± 0.90	1.04-1.40		
	<2	66 (66.0)	56.3-74.5	$\chi^2(1)=10.24$	0.001
	≥2	34 (34.0)	25.5-43.7		

Table 3 presents the distribution of SOFA and qSOFA scores among the study population. The mean SOFA score at 6 hours was 6.43 ± 2.49 (95% CI: 5.94-6.92). A majority of patients (85%) had SOFA scores <9, indicating mild to moderate organ dysfunction at admission, while 8% and 7% had SOFA scores of 9-11 and >11, respectively. This distribution was statistically significant ($\chi^2 = 120.14$, $p < 0.001$).

At 48 hours, the mean SOFA score increased to 7.78 ± 3.15 (95% CI: 7.16-8.40). The proportion of patients with SOFA scores ≥9 increased, with 20% scoring 9-11 and 13% scoring >11, indicating progression of organ dysfunction over time. This shift in distribution was statistically significant (χ^2 = 51.74, p < 0.001).

The mean qSOFA score was 1.22 ± 0.90 (95% CI: 1.04-1.40). Most patients (66%) had qSOFA scores <2, while 34% had scores ≥2, identifying a substantial proportion at higher risk of poor outcomes. This distribution was statistically significant (χ^2 = 10.24, p = 0.001).

Table 4: Correlation between UACR and qSOFA/SOFA scores (N = 100)

Correlation pair	Pearson r	95% CI for r	Test of significance	p-value
UACR (6h) vs SOFA (6h)	-0.02	-0.22 to 0.18	Pearson correlation	0.81
UACR (6h) vs SOFA (48h)	0.23	0.04 to 0.41	Pearson correlation	0.02
UACR (48h) vs SOFA (6h)	0.07	-0.13 to 0.26	Pearson correlation	0.49
UACR (48h) vs SOFA (48h)	0.33	0.14 to 0.49	Pearson correlation	0.001
UACR (6h) vs qSOFA	0.26	0.07 to 0.43	Pearson correlation	0.009
UACR (48h) vs qSOFA	0.32	0.13 to 0.49	Pearson correlation	0.001

Footnote: 95% CI for r computed using Fisher z-transformation (n=100).

Table 4 demonstrates the correlation between UACR values and severity scores using Pearson's correlation analysis. No significant correlation was observed between UACR at 6 hours and SOFA score at 6 hours (r = -0.02, p = 0.81). However, UACR at 6 hours showed a weak but statistically significant positive correlation with SOFA score at 48 hours (r = 0.23, p = 0.02), suggesting early albuminuria may predict subsequent organ dysfunction.

Similarly, UACR at 48 hours demonstrated a moderate and statistically significant positive correlation with SOFA score at 48 hours (r = 0.33, p = 0.001), indicating that persistent elevation of UACR was associated with worsening organ failure. With respect to qSOFA, both UACR at 6 hours (r = 0.26, p = 0.009) and UACR at 48 hours (r = 0.32, p = 0.001) showed statistically significant positive correlations, highlighting the association between higher UACR levels and increased clinical severity.

DISCUSSION

Baseline demographic profile (Table 1): In the present study, the mean age of critically ill patients was 55.22 ± 16.87 years, with a clear predominance of elderly patients, particularly those aged more than 60 years (40%). This age distribution is consistent with observations by Lou J et al. (2025),[5] who reported mean ages ranging between 48 and 62 years in critically ill and septic cohorts. The higher burden of critical illness among older individuals can be attributed to age-related decline in physiological reserves, increased comorbidities, and heightened susceptibility to systemic inflammation and organ dysfunction.

Male patients constituted 63% of the study population, which was statistically significant. Similar male predominance has been reported by Luo X et al. (2025),[6] where males accounted for 60-72% of ICU admissions. This trend may reflect higher exposure of males to risk factors such as infections, cardiovascular disease, and delayed healthcare-seeking behavior. The statistically significant skewed age-group distribution further reinforces that critical illness disproportionately affects older populations, as also noted by Gao M et al. (2022).[7]

UACR profile at 6 and 48 hours (Table 2): The present study demonstrated markedly elevated UACR levels in critically ill patients, with a mean UACR of 194.07 ± 323.82 mg/g at 6 hours and 216.08 ± 337.38 mg/g at 48 hours. The majority of patients had UACR values within the microalbuminuria range (30-300 mg/g), and a notable proportion progressed to macroalbuminuria at 48 hours. These findings are in agreement with Lin W et al. (2024),[3] who demonstrated early elevation of urine albumin within hours of ICU admission, and reported that persistent elevation was associated with worse outcomes.

Similarly, Hu Z et al. (2024),[2] reported that microalbuminuria was present in over 70% of critically ill patients and that failure of UACR to decrease over 24-48 hours was associated with increased mortality. The statistically significant categorical distribution of UACR at both time points in the present study supports the concept that UACR reflects ongoing endothelial dysfunction and capillary leak, which are hallmarks of critical illness and sepsis.

Severity scores: qSOFA and SOFA (Table 3): In the present study, the mean SOFA score at 6 hours was 6.43 ± 2.49, which increased to 7.78 ± 3.15 at 48 hours, indicating progression of organ dysfunction over time. This pattern aligns with findings from Park J et al. (2021),[8] who demonstrated that rising SOFA scores over the first 24-48 hours were strongly associated with adverse outcomes and mortality.

Most patients had SOFA scores <9 at admission, but a significant proportion shifted to higher SOFA categories at 48 hours, highlighting the dynamic nature of organ failure in critical illness. The mean qSOFA score of 1.22 ± 0.90, with 34% of patients having qSOFA ≥2, is comparable to results reported by Klementa V et al. (2024),[9] who emphasized that qSOFA ≥2 identifies patients at increased risk of

poor outcomes. The statistically significant distribution of qSOFA scores in the present study reinforces its utility as a rapid bedside screening tool, although it lacks the granularity of SOFA.

Correlation between UACR and severity scores (Table 4): A key finding of the present study was the significant positive correlation between UACR and severity scores, particularly at later time points. While UACR at 6 hours did not correlate with SOFA at 6 hours, it showed a significant positive correlation with SOFA at 48 hours, suggesting that early albuminuria may predict subsequent organ dysfunction. This observation is consistent with Ali MA et al. (2024),[10] who reported that rising or persistent microalbuminuria correlated better with later SOFA scores than with baseline scores.

Furthermore, UACR at 48 hours demonstrated a moderate and statistically significant correlation with SOFA at 48 hours ($r = 0.33$, $p = 0.001$), supporting findings by Hua Y et al. (2025),[11] who showed that UACR measured at 24-48 hours had prognostic accuracy comparable to established scoring systems such as APACHE and SOFA. Barichello T et al. (2022).[12]

The significant correlation of both UACR at 6 hours and 48 hours with qSOFA in the present study aligns with observations by Abdel Rahman E et al. (2022),[13] who reported that adding proteinuria markers improved the predictive performance of SOFA and qSOFA scores. Noegroho BS et al. (2023).[14]

CONCLUSION

The present study demonstrates that the urine albumin-creatinine ratio (UACR) is a valuable early biomarker of disease severity in critically ill patients. Elevated UACR levels were commonly observed at admission and persisted or increased over the first 48 hours of intensive care. Importantly, UACR showed a significant positive correlation with established severity scoring systems, particularly SOFA and qSOFA scores, with stronger correlations observed at later time points.

While UACR measured at 6 hours did not correlate with baseline SOFA score, it significantly predicted subsequent organ dysfunction as reflected by SOFA score at 48 hours. Persistent elevation of UACR at 48 hours demonstrated a moderate and statistically significant association with both SOFA and qSOFA scores, indicating ongoing endothelial injury and capillary leak.

These findings suggest that UACR reflects systemic endothelial dysfunction rather than isolated renal involvement and can serve as a simple, rapid, non-invasive, and cost-effective adjunct to clinical scoring systems. Incorporation of UACR into routine assessment may enhance early risk stratification and prognostication in critically ill patients, especially in resource-limited settings.

Limitations of the Study

1. The study was conducted at a single tertiary care center, which may limit the generalizability of the findings to other settings.
2. The sample size was relatively small, and larger multicentric studies are required to validate these results.
3. Long-term outcomes such as 28-day or 90-day mortality were not assessed.
4. Serial daily UACR measurements beyond 48 hours were not performed, which may have provided additional prognostic insights.
5. The study excluded patients with chronic kidney disease and diabetes mellitus; hence, the applicability of UACR in these populations could not be evaluated.
6. Potential confounding factors influencing albuminuria, such as nephrotoxic drug exposure and fluid balance, were not separately analyzed.

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