Original article

Study on severe prognostic factors in patients with sepsis at Hue Central Hospital

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Abstract

Background: Sepsis remains a leading cause of hospital mortality worldwide, placing significant pressure on healthcare systems. Therefore, investigating severe prognostic factors in patients with sepsis is crucial for improving prevention and treatment outcomes. **Objective**: To describe clinical and laboratory characteristics and evaluate severe prognostic factors for severity and mortality in patients with sepsis. **Methods**: A cross-sectional descriptive study was conducted on 107 patients admitted to the Intensive Care Unit (ICU) at Hue Central Hospital from September 2024 to November 2024. Data were collected from medical records and patient/relative interviews. Statistical analysis included Receiver Operating Characteristic (ROC) curves to determine the Area Under the Curve (AUC) for prognostic factors. **Results**: The mean age was 64.44 ± 15.75 years. The incidence of septic shock was 60.7% (65/107), and the mortality rate was 48.6% (52/107). Regarding prognostic factors for severity: Procalcitonin (PCT) at a cutoff of 7.012 ng/mL had a sensitivity of 89.2% and specificity of 78.2%; Lactate at a cutoff of 2.395 mmol/L had a sensitivity of 93.8% and specificity of 78.6%. Regarding mortality prediction: The SOFA and APACHE II scores showed significant predictive value, with SOFA (AUC 0.907) demonstrating high specificity (98.2%) for mortality risk. **Conclusion**: PCT and blood lactate levels are valuable for predicting severe outcomes in sepsis patients. Furthermore, the SOFA and APACHE II scoring systems are useful in predicting progression to septic shock and mortality in the study population.

***Keywords**: Sepsis, septic shock, severe prognostic factors, mortality.*

1. INTRODUCTION

In Vietnam, sepsis remains a pressing medical issue, exerting significant pressure on the healthcare system, with mortality rates remaining consistently high in recent years. The progression from sepsis to septic shock, multiple organ failure, and death is complex and difficult to predict. Once patients enter the late stages of septic shock or multi-organ failure, treatment efficacy significantly decreases. Thus, early diagnosis and accurate assessment of disease progression are crucial. Timely intervention during the "golden window" can reduce mortality and optimize hospital treatment duration.

Accurate prognostic assessment helps stratify patients, guide treatment, and evaluate intervention effectiveness. Scoring systems and biomarkers continue to be refined to enhance predictive accuracy and improve sepsis management. Additionally, research into factors that exacerbate sepsis severity is increasingly essential for monitoring, treatment, and preventing complications.

Given the urgency of the issue and the need for updated local data, we conducted this study with two main objectives:

1. To describe the clinical and laboratory characteristics of patients with sepsis.

2. To evaluate the value of prognostic factors (PCT, Lactate, SOFA, APACHE II) in predicting severity and mortality in patients with sepsis.

2. MATERIALS AND METHODS

2.1. Study Design and Setting

This was a cross-sectional descriptive study conducted in the Intensive Care Unit (ICU) of Hue Central Hospital, a tertiary referral hospital in central Vietnam. The study was carried out over a three-month period, from September 1st to November 30th, 2024.

2.2. Study Population

A total of 107 consecutive adult patients (≥18 years old) who were admitted to the ICU with a diagnosis of sepsis or septic shock were included. All patients met the diagnostic criteria of Sepsis-3 (2016), defined as life-threatening organ dysfunction caused by a dysregulated host response to infection, with an increase in SOFA score ≥ 2 points.

- Inclusion Criteria:
  - Adult patients (≥ 18 years old).

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○ Diagnosed with sepsis or septic shock according to Sepsis-3 (2016).

○ Admitted to the ICU for at least 24 hours.

○ Complete clinical and laboratory data available for analysis.

- Exclusion Criteria:

○ Patients <18 years old.

○ ICU stay <24 hours.

○ Missing essential laboratory measurements (PCT, lactate, arterial blood gas, SOFA/APACHE II scores).

○ Terminal diseases unrelated to sepsis (e.g., end-stage cancer receiving palliative care).

○ Patients or family declined participation (if applicable).

- Sample Size: All eligible patients admitted during the study period were included using total sampling technique. The final study sample consisted of 107 patients with complete datasets.

2.3. Data Collection and Variables

Data were collected from medical records (demographics, comorbidities, vital signs, laboratory results, culture results) and direct interviews with patients or their relatives.

- Variables Measured:

○ *Demographics:* Age, sex.

○ *Comorbidities:* Hypertension, diabetes, chronic lung disease, chronic kidney disease, etc.

○ *Infection characteristics:* Suspected or confirmed infection site, blood culture results.

○ *Laboratory parameters:* WBC, platelets, hematocrit, creatinine, BUN, bilirubin, PCT, lactate, arterial pH.

○ *Severity scores:* SOFA and APACHE II, calculated within the first 24 hours of ICU admission.

2.4. Follow-up and Outcome Assessment

Each patient was monitored from ICU admission until discharge or death. The primary outcome variable was in-hospital mortality (survival vs. death). The secondary outcome was disease severity, defined as progression to septic shock or multiple organ failure during the ICU stay.

2.5. Statistical Analysis

Data were analyzed using standard medical statistics software.

- Continuous variables were presented as mean ± SD or median (IQR).
- Categorical variables were presented as frequencies and percentages.
- Receiver Operating Characteristic (ROC) curves were constructed to determine cut-off values, sensitivity, and specificity for prognostic factors.
- Univariate regression analysis was used to evaluate predictors of severe progression and mortality.
- The DeLong test was used to compare the Area Under the Curve (AUC) of different prognostic models.
- A significance level of p < 0.05 was considered statistically significant.

2.6. Ethical Considerations

The study protocol was approved by the Ethics Committee of Hue Central Hospital. All procedures were conducted in accordance with the Declaration of Helsinki. Written informed consent was obtained from all patients or their legal surrogates prior to enrollment. Patient data were anonymized and used solely for research purposes.

3. RESULTS

Table 1. Baseline Characteristics and Microbiology of the Study Population

Characteristics	Total (n = 107)	Sepsis (n = 42)	Septic Shock (n = 65)	p-value
Age (Mean ± SD)	64.44 ± 15.75	64.0	65.0	0.760
Male, n (%)	65 (60.7%)	27 (64.3%)	38 (58.5%)	0.547
Comorbidities, n (%)	89 (83%)	-	-	0.279
Hypertension	29 (27.1%)	-	-	-
Diabetes Mellitus	20 (22.6%)	-	-	-
Infection Site, n (%)				
Respiratory	59 (55%)	-	-	-
Gastrointestinal	22 (21%)	-	-	-
Pathogens, n (%)				
Escherichia coli	16 (15.0%)	7 (43.8%)	9 (56.3%)	-
Klebsiella pneumoniae	5 (4.7%)	0 (0%)	5 (100%)	-

Streptococcus suis	7 (6.5%)	3 (42.9%)	4 (57.1%)	-
Staphylococcus aureus	6 (5.6%)	3 (50%)	3 (50%)	-
Acinetobacter baumannii	2 (1.9%)	1 (50%)	1 (50%)	-
Other Bacteria	71 (66.4%)	28 (39.4%)	43 (60.6%)	-

As shown in Table 1, the study population consisted of 107 patients with a mean age of 64.44 ± 15.75 years, predominantly male (60.7%). Comorbidities were prevalent, affecting 83% of patients, with hypertension (27.1%) and diabetes mellitus (22.6%) being the most common. There were no statistically significant differences in age, gender distribution, or the prevalence of comorbidities between the sepsis and septic shock groups ($p > 0.05$), indicating a homogeneous baseline demographic. Regarding infection characteristics, the respiratory tract was the most frequent site of infection (55%), followed by the gastrointestinal tract (21%). Among the identified pathogens, *Escherichia coli* was the most common (15.0%). Notably, all cases of *Klebsiella pneumoniae* (n = 5) were observed exclusively in the septic shock group.

Table 2. Comparison of Laboratory Parameters and Severity Scores

Parameter	Sepsis (n = 42)	Septic Shock (n = 65)	p-value
PCT (ng/mL)	4.56 (2.14 - 6.79)	10.52 (8.16 - 12.52)	< 0.001
Lactate (mmol/L)	1.79 (1.05 - 2.30)	4.50 (3.49 - 5.48)	< 0.001
SOFA Score	5 (3.75 - 7)	8 (6 - 10)	< 0.001
APACHE II Score	14.0	20.0	0.013

Table 2 compares the inflammatory markers and severity scores between the sepsis and septic shock groups. There were statistically significant differences in all investigated parameters ($p < 0.05$). Specifically, patients with septic shock exhibited markedly higher levels of Procalcitonin (median 10.52 ng/mL vs. 4.56 ng/mL, $p < 0.001$) and Lactate (median 4.50 mmol/L vs. 1.79 mmol/L, $p < 0.001$) compared to those with sepsis alone. Furthermore, the severity of organ dysfunction, as assessed by SOFA and APACHE II scores, was significantly greater in the septic shock group (median SOFA: 8 vs. 5, $p < 0.001$$; mean APACHE II: 20.0 vs. 14.0, $p = 0.013$).

Table 3. Prognostic Value (AUC) and Risk Factors (OR) for Severity and Mortality

Outcome/Parameter	AUC (95% CI)	Cut-off	Sens. (%)	Spec. (%)	OR (95% CI)	p-value
Prediction of Severity						
PCT	0.911 (0.86 - 0.96)	7.012	89.2	78.2	1.99 (1.50 - 2.46)	< 0.001
Lactate	0.939 (0.90 - 0.98)	2.395	93.8	78.6	5.51 (2.95 - 10.28)	< 0.001
Combined (PCT+Lac+SOFA)	0.961 (0.93 - 0.99)	15.36	95.4	95.2	-	< 0.001
Prediction of Mortality						
SOFA Score	0.907 (0.85 - 0.96)	8.5	61.5	98.2	1.59 (1.30 - 1.95)	< 0.001
APACHE II Score	0.899 (0.84 - 0.96)	21.5	59.6	92.7	1.09 (1.02 - 1.16)	0.013

Table 3 summarizes the prognostic performance and risk association of the studied factors. Regarding severity prediction, lactate emerged as the strongest individual risk factor with an Odds Ratio (OR) of 5.51 (95% CI: 2.95–10.28, $p < 0.001$), followed by PCT (OR = 1.99). Notably, the combined model (PCT + Lactate + SOFA) demonstrated superior diagnostic accuracy, achieving an AUC of 0.961 (95% CI: 0.93–0.99) with both sensitivity and specificity exceeding 95%. In terms of mortality prediction, while the SOFA score had moderate sensitivity (61.5%), it showed exceptional specificity (98.2%) at a cutoff of 8.5

points. Similarly, the APACHE II score provided a high specificity of 92.7% for predicting fatal outcomes.

4. DISCUSSION

4.1. Clinical and Laboratory Characteristics of Patients with sepsis

In our study, the mean age was 64.44 ± 15.75 years, with a predominance of male patients (60.7%). This demographic profile aligns with global trends reported by Martin et al., where elderly patients account for the majority of sepsis cases due to "immunosenescence." However, a notable difference in our study is the extremely high rate of comorbidities (83%), which is higher than the 66% reported in European cohorts by Artero et al. This burden of chronic disease likely contributed to the high mortality rate observed in our population (48.6%).

Regarding microbiological characteristics, our findings reflect a distinct epidemiological pattern common in Southeast Asia but different from Western studies. While Staphylococcus aureus is often the leading pathogen in North America and Europe, our study found a predominance of Gram-negative bacteria, specifically *E. coli* and *K. pneumoniae.* Most notably, 100% of patients infected with *K. pneumoniae* in our study progressed to septic shock. This suggests a high prevalence of hyper-virulent or multidrug-resistant strains in our setting, a growing concern in developing countries that complicates empiric antibiotic selection compared to developed nations.

The incidence of septic shock (60.7%) in our study was also higher than the 40 - 50% typically reported in international multicenter trials. This discrepancy suggests that patients at Hue Central Hospital often present at a later stage of the disease, emphasizing the need for earlier community-level screening.

4.2. Prognostic Factors for Severity and Mortality

Risk Factors and Severity Prediction: Our univariate analysis identified Lactate (OR=5.5) and PCT (OR = 1.99) as significant risk factors for progression to septic shock. Lactate levels in our septic shock group (median 4.5 mmol/L) were significantly higher than in the sepsis group, consistent with the Surviving Sepsis Campaign guidelines which identify lactate as a marker of tissue hypoperfusion. However, our optimal cut-off for Lactate (2.395 mmol/L) was slightly higher than the standard 2.0 mmol/L used in Western definitions, suggesting that in our clinical context, a higher threshold might be more specific for predicting severe outcomes.

Prognostic Value and Novel Findings: While individual markers like PCT and SOFA are well-established, a key contribution of our study is demonstrating the superior value of a multi-modal approach. Using the DeLong test, we confirmed that the combination of PCT + Lactate + SOFA yielded an AUC of 0.961, which was statistically superior to using any single marker alone ($p < 0.05$). This finding differs from some previous domestic studies that relied on single biomarkers. It aligns with recent international trends (e.g., Jing Wang et al., 2024) advocating for combined scoring systems. This suggests that in resource-limited settings like Vietnam, integrating readily available biomarkers (Lactate, PCT) with clinical scores (SOFA) provides the most accurate risk stratification, allowing clinicians to prioritize ICU resources for the highest-risk patients.

4.3. Limitations of the Study

Our study has several limitations. First, it was a single-center study conducted at a tertiary referral hospital, which may lead to selection bias towards more severe cases, potentially overestimating the mortality rate compared to the general population. Second, due to the cross-sectional design, we could not evaluate long-term survival rates (e.g., 28-day or 90-day mortality) or the long-term sequelae of sepsis survivors. Finally, the sample size (n=107) was moderate, limiting the ability to perform subgroup analyses for specific pathogens. Future multicenter studies with larger sample sizes are needed to validate these prognostic models.

5. CONCLUSION

Clinical and Laboratory Characteristics: The study population was characterized by advanced age and a high burden of comorbidities (83%). Gram-negative bacteria were the predominant pathogens, particularly *E. coli* and *K. pneumoniae*. The study highlighted a severe clinical profile with a high incidence of septic shock (60.7%) and a hospital mortality rate of 48.6%. Prognostic Factors for Severity and Mortality: PCT and Lactate are effective early biomarkers for predicting disease severity and the progression to septic shock. Regarding mortality prediction, both SOFA and APACHE II scores calculated at admission demonstrated significant prognostic value. Specifically, the SOFA score showed high specificity, making it a reliable tool for identifying patients at high risk of death.

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