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Serial Procalcitonin Predicts Mortality In Severe Sepsis Patients: Results From A Single-Center Study In A Tertiary Care Hospital In Central India

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Abstract

Severe sepsis is a critical condition associated with high mortality rates in intensive care units (ICUs) globally. Procalcitonin (PCT), a peptide precursor of calcitonin, has emerged as a promising biomarker for assessing infection severity and predicting outcomes in sepsis. This study aimed to evaluate the prognostic value of serial PCT measurements in predicting mortality among severe sepsis patients in a tertiary care hospital in Central India. Our findings reveal that serial PCT levels, especially on days 3 and 7, are significant predictors of mortality. This provides clinicians with a valuable tool for risk stratification and management of sepsis, potentially improving patient outcomes through timely interventions.

Introduction

Sepsis is defined as a life-threatening organ dysfunction caused by a dysregulated host response to infection. Severe sepsis, marked by acute organ dysfunction, drastically increases the risk of mortality. Despite advancements in medical treatments, the mortality rate for severe sepsis remains alarmingly high. Early detection and prompt intervention are crucial to improving patient outcomes.

Procalcitonin (PCT) is a biomarker that rises in response to bacterial infections and sepsis. Unlike other inflammatory markers, PCT levels correlate more closely with bacterial infections and sepsis severity. This study explores the utility of serial PCT measurements—taken on days 1, 3, and 7—in predicting mortality in severe sepsis patients, aiming to provide evidence for incorporating PCT monitoring into clinical practice.

Methods

Study Design and Population

This prospective observational study was conducted in the ICU of a tertiary care hospital in Central India from June 2022 to May 2024. We included patients diagnosed with severe sepsis according to the Sepsis-3 criteria, which define sepsis as a life-threatening organ dysfunction caused by a dysregulated host response to infection. Patients with chronic infections, recent major surgery, or those on immunosuppressive therapy were excluded.

Data Collection

We collected clinical and demographic data, including age, gender, comorbidities, source of infection, and initial severity of sepsis, assessed using the Sequential Organ Failure Assessment (SOFA) score. PCT levels were measured on days 1, 3, and 7 using an immunoassay technique, specifically an enzyme-linked immunosorbent assay (ELISA) that quantifies PCT levels with high sensitivity and specificity. Patients were followed for 28 days to record mortality outcomes.

Statistical Analysis

Descriptive statistics summarized the data. Continuous variables were analyzed using the Student's t-test, and categorical variables were analyzed with the chi-square test. Multivariate logistic regression identified independent predictors of mortality. The predictive value of serial PCT measurements was assessed using receiver operating characteristic (ROC) curves, with the area under the curve (AUC) indicating the test's ability to discriminate between survivors and non-survivors.

Results

Demographics and Clinical Characteristics

We included 200 patients in the study, with a mean age of 58 years (range 18–85). The majority were male (60%). The most common infection sources were the respiratory tract (45%) and gastrointestinal tract (30%). The median initial SOFA score, reflecting the severity of organ dysfunction, was 9.

Table 1: Demographic and Clinical Characteristics of Patients

Characteristic	Total Patients (n=200)
Mean Age (years)	58
Gender (Male)	120 (60%)
Respiratory Tract Infection	90 (45%)
Gastrointestinal Tract Infection	60 (30%)
Median SOFA Score	9

Procalcitonin Levels and Mortality

PCT levels were significantly higher in non-survivors compared to survivors at all measurement points. Non-survivors had median PCT levels of 10.2 ng/mL, 8.5 ng/mL, and 7.0 ng/mL on days 1, 3, and 7, respectively, compared to 5.1 ng/mL, 3.5 ng/mL, and 1.2 ng/mL in survivors.

Table 2: Procalcitonin Levels in Survivors and Non-Survivors

Day	Survivors (n=140)	Non-Survivors (n=60)
Day 1	5.1 ng/mL	10.2 ng/mL
Day 3	3.5 ng/mL	8.5 ng/mL
Day 7	1.2 ng/mL	7.0 ng/mL

Predictive Value of Serial PCT Measurements

ROC curve analysis showed that PCT levels on day 3 had the highest predictive value for mortality (AUC 0.82), followed by day 7 (AUC 0.78) and day 1 (AUC 0.75). Multivariate logistic regression identified high PCT levels on days 3 and 7, along with higher initial SOFA scores, as independent predictors of mortality ($p < 0.001$).

Table 3: ROC Curve Analysis for Predictive Value of PCT Levels

Day	Area Under Curve (AUC)
Day 1	0.75
Day 3	0.82
Day 7	0.78

Length of ICU Stay

Non-survivors had a significantly longer ICU stay compared to survivors. The median ICU stay for non-survivors was 18 days, whereas for survivors, it was 10 days.

Table 4: Length of ICU Stay in Survivors and Non-Survivors

Group	Median ICU Stay (days)
Survivors	10
Non-Survivors	18

Antibiotic Use

Broad-spectrum antibiotic use was more prevalent among non-survivors. Approximately 70% of non-survivors received broad-spectrum antibiotics compared to 50% of survivors.

Table 5: Broad-Spectrum Antibiotic Use in Survivors and Non-Survivors

Group	Broad-Spectrum Antibiotic Use (%)
Survivors	50
Non-Survivors	70

Comorbidities and Mortality

Patients with comorbidities such as diabetes, chronic kidney disease, and cardiovascular diseases had higher mortality rates.

Table 6: Comorbidities in Survivors and Non-Survivors

Comorbidity	Survivors (n=140)	Non-Survivors (n=60)
Diabetes	40 (28.6%)	30 (50%)
Chronic Kidney Disease	20 (14.3%)	25 (41.7%)
Cardiovascular Diseases	25 (17.9%)	20 (33.3%)

Discussion

Our study underscores the prognostic significance of serial PCT measurements in severe sepsis patients. Elevated PCT levels on days 3 and 7 are strong indicators of mortality risk. This finding is consistent with previous studies indicating that persistent high PCT levels correlate with adverse

outcomes in sepsis. Serial PCT monitoring provides a more reliable assessment of patient status than single measurements, facilitating better risk stratification and therapeutic decision-making. The utility of PCT in sepsis has been explored in various studies, with some reporting its effectiveness in predicting mortality. Schuetz et al. demonstrated the utility of serial PCT measurements in predicting sepsis outcomes, aligning with our findings. Our study adds to the existing literature by providing specific data from a Central Indian population, highlighting regional variations and the importance of localized research.

Incorporating serial PCT measurements into sepsis management protocols could enhance early detection of high-risk patients, allowing for more timely interventions and resource allocation. This approach may improve outcomes in ICU settings by guiding therapeutic decisions based on more dynamic and reliable biomarkers.

Conclusion

Serial PCT measurements are valuable for predicting mortality in severe sepsis patients. Elevated PCT levels, particularly on days 3 and 7, are strong indicators of poor prognosis. Integrating PCT monitoring into clinical practice could significantly improve sepsis management and patient outcomes in tertiary care settings.

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