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Original Research Article

# Significance of Serum Procalcitonin and C-Reactive Protein in Septic Shock Patients

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**Abstract:**

**Aim:** The aim of this study was to investigate and evaluate the clinical significance of C-reactive protein (CRP) and serum procalcitonin (PCT) in patients with septic shock.

**Method:** Seventy-two patients with septic shock were divided two groups based on treatment outcomes- mortality (n = 42) and survival (n = 102) groups. As a control group, 40 sepsis patients without septic shock were selected. PCT, CRP, and SOFA scores were evaluated within twenty-four hours of admission.

**Results:** The mortality group had highest PCT, CRP, and SOFA scores, followed by survival and control groups. In determining the prognosis of patients with septic shock, the sensitivity and specificity of PCT were 67.9% and 46.5%, while those of CRP were 83.3% and 81%.

**Conclusion:** CRP and PCT levels may indicate a patient's prognosis.

**Keywords:** PCT, CRP, septic shock, SOFA.



## Introduction

Sepsis has been defined as a potentially fatal illness of the human body caused by inappropriate host immune system responses in a variety of infectious circumstances. Statistics show that around 18 million novel cases are reported worldwide each year, with an annual increase of 8% [1, 2]. Sepsis is distinguished by its sudden onset and critical stage. Its mortality rate has been estimated up to about 20-30 percent high, accounting for 30-50 percent of total hospital mortality, significantly outnumbering patients with myocardial infarction [2, 3].

During the initial few hours of triage, prompt diagnosis and treatment of septic conditions with particular antibiotics is critical [2]. The indiscriminate and nonspecific use of antibiotics leads to an increase in infection and resistance, elevating odds of healthcare expenses and mortality [3, 4]. More efficient and prompt diagnosis of the causal pathogen, as well as appropriate antibiotic therapy, have a promising future in resolving this issue [5].

Sepsis is a pathological condition known as Systemic Inflammatory Response Syndrome (SIRS), which manifests as a widespread inflammatory response impacting several organ systems. Scientific progress in the field of molecular biology has facilitated the identification of pertinent biomarkers for the timely detection of sepsis [8]. White blood cell count (WBC), Interleukin-1 (IL-1), and C-Reactive Protein (CRP) are the established biomarkers employed in the diagnostic process of sepsis. In comparison to CRP, PCT has superior prognostic and diagnostic efficacy, effectively discerning between bacterial and viral meningitis [9, 10]. The gold standard for confirming bacteraemia presence and responsible pathogen identification is blood culture. However, due to the time delay associated with this method, the rapid testing of a biomarker is highly valuable in facilitating the early identification of sepsis [11].

The objective of this study was to examine the expression and clinical relevance of C-reactive protein (CRP) and Procalcitonin (PCT) in individuals diagnosed with septic shock, with the intention of offering more precise and sensitive clinical markers.

## Materials and Methods

This descriptive observational study was conducted on 144 patients for two years at the Medical Intensive Care Unit of Apollo Hospital, Bhubaneswar, India.

The patients were divided into two groups- survival group (SG) (n = 102) and mortality group (MG) (n = 42), with a control group (CG) consisting of 40 sepsis patients without shock, treated during the same time period.

### Inclusion and exclusion criteria

This study included patients who met the diagnostic criteria for septic shock, had complete medical records, were ≥ 18 years old, were expected to spend more than 72 hours in the intensive care unit, and provided written consent.

This study excluded patients with irreversible illness during ICU admittance, psychiatric disorders, cardiopulmonary resuscitation, pregnancy or immune system diseases, haematological diseases, the need for long-term glucocorticoid therapy, long-term immunosuppressant use, and refusal to sign an informed consent form.

**Study procedure**

All study participants' demographic information, clinical examinations, details of fundamental investigations, and medical history were recorded on a standard form. Using an immunochromatographic assay and a commercially available test reagent, serum procalcitonin was measured and interpreted according to the manufacturer's instructions.

**Statistical Analysis**

The obtained data was entered into a Microsoft Excel spreadsheet and evaluated with Statistical Package for the Social Sciences (SPSS) version 24.0 International Business Management USA. In terms of percentages, qualitative data was conveyed. The Mean and Standard Deviation were utilised to convey quantitative data. Using the Chi-square/Fisher's exact test, an association between two qualitative variables was observed. Using the Pearson correlation test, correlations between qualitative variables were determined.

**Results**

The baseline characteristics of the three groups, including age, sex, weight, and disease history, were comparable (Table 1).

**Table 1. Baseline data**

| | Death group | Survival group | Control group | P value |
|---|---|---|---|---|
| Male | 22 | 50 | 20 | 0.3 |
| Female | 20 | 52 | 20 | |
| Age | 52.2 | 52.4 | 53.7 | 0.3 |
| Weight | 61.5 | 60.1 | 61.2 | 0.9 |
| BMI | 21.4 | 21.5 | 21.9 | 0.8 |
| **Infections** | | | | |
| Urinary system | 16 | 24 | 14 | 0.2 |
| Respiratory system | 10 | 24 | 8 | |
| Digestive system | 8 | 28 | 10 | |
| Other | 8 | 26 | 8 | |
| Hypertension | 12 | 16 | 10 | 0.7 |
| Diabetes | 10 | 10 | 6 | 0.8 |

The MG demonstrated high SOFA scores as compared to the SG, whereas the SG demonstrated high SOFA scores as compared to the CG. Patients with septic shock exhibited a positive correlation between SOFA and PCT scores (r = 0.33, r = 0.34), whereas CRP scores exhibited a negative correlation (r = -0.10). PCT had sensitivity of 66.8%, specificity of 45.4% and an AUC of 0.81%, while CRP had a sensitivity of 82.2%, specificity of 80.3% and AUC of 0.52.

**Discussion**

Sepsis is a critical medical condition characterised by the presence of several organ dysfunctions [13]. It arises when the body's innate immune regulatory system is activated by a pathogen, resulting in widespread inflammatory responses throughout the body. The aforementioned process frequently entails an exaggerated response to pathogens, disrupting the equilibrium between anti-inflammatory and pro-inflammatory substances, resulting in significant death of T cells and ultimately leading to dysregulation of the body's immune response [14]. The available data indicate that the global yearly occurrence of sepsis in adults is around 300 cases per 100,000 individuals, with a corresponding fatality rate ranging from 19.3% to 47.2%. Research in clinical practice has indicated that individuals diagnosed with sepsis frequently encounter exorbitant healthcare expenses, with an estimated daily expenditure of 11,000 RMB per person. This financial burden places significant strain on both patients' families and society as a whole [15, 16]. The implementation of timely diagnosis and intervention is crucial in mitigating patient mortality rates and enhancing patient prognosis [17].

Sinha et al. [15] included forty patients between the ages of 18 and 84, with a male: female ratio of 2.33:1. Similarly, Todi S et al. and Martin GS et al. reported that sepsis is more common in men [16, 17]. Khan AA et al.'s study found that 53.34% of the total 60 patients were male, while 46.66% were female. 30% of male patients and 23.33% of female patients were younger than 50 years old [13]. The results of this study demonstrated that CRP and PCT levels in the MG were higher as compared to those in the SG. The levels of the SG were higher as compared to

those in the CG. This indicated that CRP and PCT levels increased substantially with sepsis progression.

A retrospective study conducted on 201 sepsis patients revealed that the mean CRP and PCT levels of the patient with clinically fatal outcomes were 110.94 mg/L and 11.03 μg/L, respectively. The mean CRP and PCT levels of the SG were 56.93 mg/L and 1.39 μg/L, respectively [21].

In this study, it is hypothesised that CRP and PCT are commonly used clinical laboratory indicators that reflect the body's inflammatory response. An abnormal elevated level indicates an inflammation state in the subjects. PCT is produced by kidneys, lungs, and other organs during an inflammatory response and then enters the bloodstream. It will be detected in blood samples within 2-4 hours of infection onset and will reach its apogee within 6 to 24 hours [22, 23]. CRP is an acutely sensitive and highly sensitive phase protein. It is sensitive to the body's inflammatory response. Consequently, CRP and PCT levels will vary in blood samples of septic shock patients with varying clinical outcomes [24].

This study also analysed the differences in SOFA scale scores between patients with septic shock. The difference in scores between the three patient groups in the study confirms the validity of the disparities in PCT and CRP levels between the three patient groups.

## Conclusion

In conclusion, the expression of PCT and CRP has a significant correlation with the prognosis and diagnosis of patients and can be used as essential indicators to reflect patients' prognoses. The novel aspect of this investigation is the correlation between CRP and PCT and the SOFA scores, confirming the viability of PCT and CRP as prognostic indicators for septic shock patients. As a consequence of the limited sample size, the results are insufficiently exhaustive. In addition, there was no long-term monitoring. In future, we will conduct clinical studies with larger samples, a longer follow-up period, and more indicators in order to provide better benchmarks for enhancing the clinical outcome of septic shock patients.

## References


1. Coopersmith CM, De Backer D, Deutschman CS, Ferrer R, Lat I, Machado FR, Martin GS, Martin-Loeches I, Nunnally ME, Antonelli M, Evans LE, Hellman J, Jog S, Kesecioglu J, Levy MM and Rhodes A. Surviving sepsis campaign: research priorities for sepsis and septic shock. Crit Care Med. 2018; 46: 1334-1356.
2. Sepsis: recognition, diagnosis and early management: © NICE (2017) Sepsis: recognition, diagnosis and early management. BJU Int. 2018; 121: 497-514.
3. Danielski LG, Giustina AD, Badawy M, Barichello T, Quevedo J, Dal-Pizzol F and Petronilho F. Brain barrier breakdown as a cause and consequence of neuroinflammation in sepsis. Mol Neurobiol. 2018; 55: 1045-1053.
4. Prescott HC and Angus DC. Enhancing recovery from sepsis: a review. JAMA. 2018; 319: 62- 75.
5. Ranjeva SL, Warf BC and Schiff SJ. Economic burden of neonatal sepsis in sub-Saharan Africa. BMJ Glob Health. 2018; 3: e000347.
6. Brenner T, Decker SO, Grumaz S, Stevens P, Bruckner T, Schmoch T, Pletz MW, Bracht H, Hofer S, Marx G, Weigand MA and Sohn K. Next-generation sequencing diagnostics of bacteremia in sepsis (Next GeneSiS-Trial): study protocol of a prospective, observational, noninterventional, multicenter, clinical trial. Medicine (Baltimore). 2018; 97: e9868.
7. Meyer N, Harhay MO, Small DS, Prescott HC, Bowles KH, Gaieski DF and Mikkelsen ME. Temporal trends in incidence, sepsis-related mortality, and hospital-based acute care after sepsis. Crit Care Med. 2018; 46: 354-360.
8. Omran A, Maaroof A, Saleh MH and Abdelwahab A. Salivary C-reactive protein, mean platelet volume and neutrophil lymphocyte ratio as diagnostic markers for neonatal sepsis. J Pediatr (Rio J). 2018; 94: 82-87.
9. Cockrell RC and An G. Examining the controllability of sepsis using genetic algorithms on an agent-based model of systemic inflammation. PLoS Comput Biol. 2018; 14: e1005876.
10. Vallabhajosyula S, Sakhuja A, Geske JB, Kumar M, Kashyap R, Kashani K and Jentzer JC. Clinical profile and outcomes of acute cardiorenal syndrome type-5 in sepsis: an eight-year cohort study. PLoS One. 2018; 13: e0190965.
11. Jensen IJ, Sjaastad FV, Griffith TS and Badovinac VP. Sepsis-induced t cell immunoparalysis: the ins and outs of impaired t cell immunity. J Immunol. 2018; 200: 1543-1553.
12. Olijve L, Jennings L and Walls T. Human parechovirus: an increasingly recognized cause of sepsis-like illness in young infants. Clin Microbiol Rev. 2017; 31: e00047-17.
13. Khan AA, Singh R, Singh PK. Diagnostic and prognostic significance of procalcitonin in septicemia. Int J Adv Med. 2017;4(3):630-34.
14. Gruda MC, Ruggeberg KG, O'Sullivan P, Guliashvili T, Scheirer AR, Golobish TD, Capponi VJ and Chan PP. Broad adsorption of sepsisrelated PAMP and DAMP molecules, mycotoxins, and cytokines from whole blood using CytoSorb® sorbent porous polymer beads. PLoS One. 2018; 13: e0191676.
15. Sinha M, Desai S, Mantri S, Kulkarni A. Procalcitonin as an adjunctive biomarker in sepsis. Indian J Anaesth. 2011;55(3):266-70.
16. Martin GS, Mannino DM, Eaton S, Moss M. The epidemiology of sepsis in the United States

from 1979 through. 2000. N Engl J Med. 2003; 348(16):1546-54.
17. Todi S, Chatterjee S, Bhattacharyya M. Epidemiology of severe sepsis in India. Crit Care Med. 2007;11(suppl. 2):P65.
18. Liverani E, Mondrinos MJ, Sun S, Kunapuli SP and Kilpatrick LE. Role of protein kinase C-delta in regulating platelet activation and plateletleukocyte interaction during sepsis. PLoS One. 2018; 13: e0195379.
19. Kell DB and Pretorius E. To what extent are the terminal stages of sepsis, septic shock, systemic inflammatory response syndrome, and multiple organ dysfunction syndrome actually driven by a prion/amyloid form of fibrin? Semin Thromb Hemost. 2018; 44: 224-238.
20. Vallabhajosyula S, Pruthi S, Shah S, Wiley BM, Mankad SV and Jentzer JC. Basic and advanced echocardiographic evaluation of myocardial dysfunction in sepsis and septic shock. Anaesth Intensive Care. 2018; 46: 13-24.
21. Sunahara S, Watanabe E, Hatano M, Swanson PE, Oami T, Fujimura L, Teratake Y, Shimazui T, Lee C and Oda S. Influence of autophagy on acute kidney injury in a murine cecal ligation and puncture sepsis model. Sci Rep. 2018; 8: 1050.
22. Samuels JM, Moore HB and Moore EE. Coagulopathy in severe sepsis: interconnectivity of coagulation and the immune system. Surg Infect (Larchmt). 2018; 19: 208-215.
23. Lai D, Tang J, Chen L, Fan EK, Scott MJ, Li Y, Billiar TR, Wilson MA, Fang X, Shu Q and Fan J. Group 2 innate lymphoid cells protect lung endothelial cells from pyroptosis in sepsis. Cell Death Dis. 2018; 9: 369.
24. Hellman J, Bahrami S, Boros M, Chaudry IH, Fritsch G, Gozdzik W, Inoue S, Radermacher P, Singer M, Osuchowski MF and Huber-Lang M. Part III: minimum quality threshold in preclinical sepsis studies (mqtipss) for fluid resuscitation and antimicrobial therapy endpoints. Shock. 2019; 51: 33-43.
25. Geven C, Bergmann A, Kox M and Pickkers P. Vascular effects of adrenomedullin and the anti-adrenomedullin antibody adrecizumab in sepsis. Shock. 2018; 50: 132-140.
26. Hsu J, Donnelly JP, Chaudhary NS, Moore JX, Safford MM, Kim J and Wang HE. Aspirin use and long-term rates of sepsis: a populationbased cohort study. PLoS One. 2018; 13: e0194829.