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Original Article

To Study the Procalcitonin (PCT) as an Early and Sensitive Biomarker for Sepsis, Particularly Bacterial Infections, Reflecting Severity and Progression of the Disease in Patients

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ABSTRACT

Background: Sepsis is a life-threatening condition caused by a dysregulated host response to infection and is associated with high morbidity and mortality worldwide. Early diagnosis and prompt initiation of treatment are critical for improving patient outcomes. Conventional diagnostic methods such as blood cultures often require prolonged time and may yield false-negative results. Procalcitonin (PCT), a precursor of the hormone calcitonin, has emerged as a promising biomarker for early detection of bacterial infections and sepsis.
Objective: To evaluate the role of procalcitonin as an early and sensitive biomarker for the diagnosis of sepsis and to assess its association with disease severity and progression in patients.
Materials and Methods: This prospective observational study included **100 patients with suspected sepsis** admitted to a tertiary care hospital. Demographic details, clinical presentation, microbiological investigations, and serum procalcitonin levels were analyzed. Blood cultures were performed using standard microbiological techniques. PCT levels were measured using immunoassay methods and correlated with culture positivity and clinical severity.
Results: Among the 100 patients included in the study, the majority belonged to the **>60 years age group (24%)**, and **58% were males**. Blood cultures were positive in **62% of cases**, with *Escherichia coli* being the most common isolate (29%). Elevated procalcitonin levels (>2 ng/mL) were observed in **58% of patients** and were significantly associated with culture-positive sepsis. Higher PCT levels were also correlated with severe sepsis and septic shock.
Conclusion: Procalcitonin is a valuable biomarker for the early diagnosis of bacterial sepsis and correlates well with disease severity. Measurement of PCT levels may aid clinicians in early detection, risk stratification, and timely management of septic patients.

Keywords*: Sepsis, Procalcitonin, Biomarker, Bacterial infection, Blood culture.*

INTRODUCTION

Sepsis is a major global health problem characterized by life-threatening organ dysfunction resulting from a dysregulated host response to infection. Despite advances in medical care, sepsis remains a leading cause of morbidity and mortality in hospitalized patients worldwide. According to recent global estimates, millions of cases of sepsis occur annually, leading to a significant burden on healthcare systems and contributing substantially to intensive care unit admissions and deaths [1].

Early recognition and timely management of sepsis are critical in improving patient survival. However, the diagnosis of sepsis is often challenging due to its nonspecific clinical manifestations and overlap with other inflammatory conditions. Traditional diagnostic methods such as blood cultures remain the gold standard for identifying causative pathogens, but they have several limitations, including prolonged turnaround time and reduced sensitivity, especially in patients who have already received antibiotic therapy [2].

In recent years, there has been increasing interest in identifying reliable biomarkers that can facilitate the early diagnosis of sepsis and guide therapeutic decisions. Among these, procalcitonin has emerged as a promising biomarker for bacterial infections. Procalcitonin is a peptide precursor of the hormone calcitonin, normally produced in the thyroid gland. Under physiological conditions, circulating levels of procalcitonin are extremely low. However, during systemic bacterial infections, procalcitonin production is markedly increased and released into the bloodstream [3].

The elevation of procalcitonin levels in bacterial infections is thought to occur due to stimulation by bacterial endotoxins and inflammatory cytokines such as tumor necrosis factor-alpha and interleukin-6. Unlike other inflammatory markers such as C-reactive protein (CRP), procalcitonin levels rise rapidly within a few hours of infection and correlate with the severity of the disease [4].

Several studies have demonstrated that procalcitonin can be used not only for early diagnosis of sepsis but also for differentiating bacterial infections from viral or non-infectious inflammatory conditions. This makes PCT a valuable tool in clinical practice for guiding antibiotic therapy and reducing unnecessary antibiotic use [5].
Moreover, monitoring serial procalcitonin levels may help assess the response to treatment and predict disease prognosis. Elevated PCT levels have been associated with severe sepsis, septic shock, and increased mortality rates in critically ill patients [6].

Despite these advantages, the clinical utility of procalcitonin in diagnosing sepsis and predicting outcomes varies among different populations and clinical settings. Therefore, further studies are needed to evaluate its diagnostic accuracy and clinical significance in diverse patient groups.

The present study was conducted to evaluate the role of procalcitonin as an early and sensitive biomarker for sepsis in patients admitted to a tertiary care hospital and to determine its association with bacterial infections and disease severity.

MATERIALS AND METHODS

This was a **prospective observational study** conducted in the Department of Biochemistry in collaboration with the Department of Medicine of a tertiary care hospital JLMCH Bhagalpur.

Study Duration

The study was conducted over a **period of one year**.

Study Population

A total of **100 patients clinically suspected of sepsis** were included in the study.

Sample Collection

Blood samples were collected under strict aseptic precautions from patients suspected of sepsis. Samples were processed for:

- Blood culture
- Procalcitonin estimation
- Routine laboratory investigations

Microbiological Analysis

Blood cultures were performed using standard microbiological techniques. Isolates were identified based on colony morphology, Gram staining, and biochemical tests.

Procalcitonin Estimation

Serum procalcitonin levels were measured using an **immunoassay-based automated analyzer**. The results were interpreted as:

PCT Level	Interpretation
<0.5 ng/mL	Low risk of bacterial infection
0.5–2 ng/mL	Possible infection
2–10 ng/mL	Likely bacterial sepsis
>10 ng/mL	Severe sepsis/septic shock

INCLUSION CRITERIA

1. Patients clinically suspected of sepsis
2. Patients admitted to ICU or medical wards
3. Patients aged **18 years and above**
4. Patients who provided informed consent

EXCLUSION CRITERIA

1. Patients receiving long-term antibiotic therapy
2. Patients with chronic inflammatory diseases
3. Patients with malignancy
4. Patients with incomplete clinical data

Statistical Analysis

Data were entered in Microsoft Excel and analyzed using statistical software. Results were expressed in percentages and frequencies.

RESULTS

A total of **100 patients with suspected sepsis** were included in the study. Various demographic, clinical, microbiological, and biochemical parameters including **procalcitonin (PCT) levels** were analyzed.

Table 1: Age Distribution of Study Participants (n=100)

Age Group (Years)	Number of Cases	Percentage (%)
18–30	22	22%
31–40	18	18%
41–50	20	20%
51–60	16	16%
>60	24	24%
Total	**100**	**100%**

The majority of patients belonged to the **>60 years age group (24%)**, followed by **18–30 years (22%)** and **41–50 years (20%)**. This indicates that sepsis was more common in elderly individuals.

The age distribution of the study population showed that sepsis occurred across a wide range of age groups. The highest number of patients belonged to the **>60 years age group (24%)**, followed by **18–30 years (22%)** and **41–50 years (20%)**. Patients in the **31–40 years age group accounted for 18%**, while **16% belonged to the 51–60 years age group**. The findings indicate that although sepsis affects individuals of all ages, it was relatively more common among elderly patients in the present study, which may be attributed to decreased immunity, presence of comorbidities, and increased susceptibility to infections in older individuals.

Table 2: Gender Distribution

Gender	Number of Cases	Percentage (%)
Male	58	58%
Female	42	42%
Total	**100**	**100%**

Among the study population, **58% were males** and **42% were females**, indicating a slight male predominance among patients with suspected sepsis.

Gender-wise distribution revealed that **58% of the patients were males and 42% were females**, showing a slight male predominance in the study population. This higher prevalence among males may be due to increased exposure to environmental risk factors, higher incidence of comorbid conditions, and differences in healthcare-seeking behavior. However, sepsis affected both genders significantly, emphasizing that it remains an important clinical concern across the entire population.

Table 3: Clinical Diagnosis of Patients

Clinical Condition	Number of Cases	Percentage (%)
Septicemia	40	40%
Pneumonia	22	22%
Urinary Tract Infection	18	18%
Intra-abdominal infection	12	12%
Others	8	8%
Total	**100**	**100%**

The most common clinical condition associated with sepsis was **septicemia (40%)**, followed by **pneumonia (22%)** and **urinary tract infection (18%)**.

The clinical diagnosis among the study participants showed that **septicemia was the most common presentation, accounting for 40% of cases**. This was followed by **pneumonia (22%)** and **urinary tract infections (18%)**, which are well-known sources of systemic infection leading to sepsis. **Intra-abdominal infections constituted 12%**, while **other infections accounted for 8% of cases**. These findings highlight that bloodstream infections and respiratory infections are major contributors to sepsis in hospitalized patients.

Blood culture analysis demonstrated that **62% of patients were culture positive**, whereas **38% were culture negative**. The relatively high culture positivity rate indicates a significant burden of bacterial infections among suspected sepsis patients. However, a considerable proportion of culture-negative cases was also observed, which may be due to prior antibiotic therapy, low bacterial load, or infections caused by fastidious organisms that are difficult to grow in conventional culture media.

Table 4: Blood Culture Results

Culture Result	**Number of Cases**	**Percentage (%)**
Culture Positive	62	62%
Culture Negative	38	38%
Total	**100**	**100%**

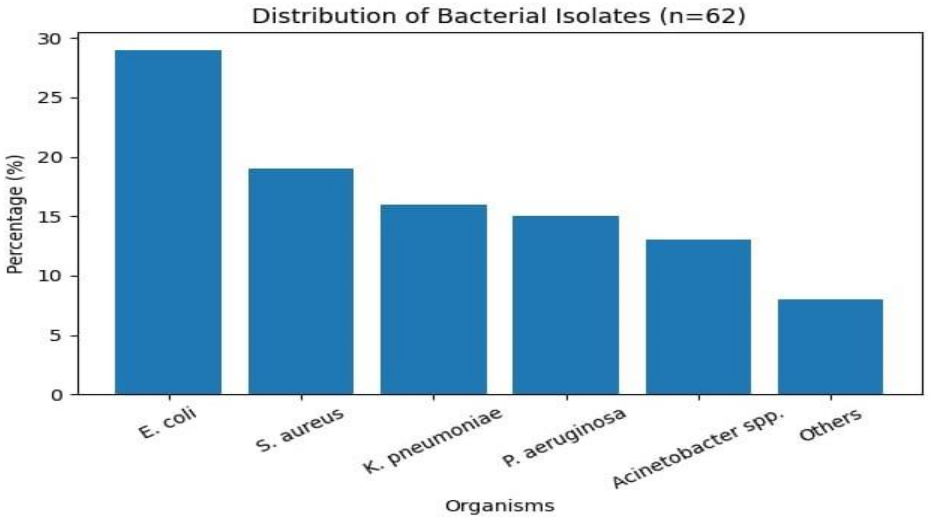
Out of 100 cases, **62% showed positive blood culture**, while **38% were culture negative**, suggesting possible prior antibiotic therapy or non-bacterial infections.

Among the **62 culture-positive cases**, the most commonly isolated organism was **Escherichia coli (29%)**, followed by **Staphylococcus aureus (19%)** and **Klebsiella pneumoniae (16%)**. Other organisms included **Pseudomonas aeruginosa (15%)**, **Acinetobacter species (13%)**, and **other bacterial isolates (8%)**. The predominance of gram-negative organisms in the present study indicates their major role in causing sepsis in hospitalized patients, although gram-positive pathogens also contributed significantly.

Table 5: Distribution of Bacterial Isolates (n=62)

Organism	**Number of Isolates**	**Percentage (%)**
Escherichia coli	18	29%
Staphylococcus aureus	12	19%
Klebsiella pneumoniae	10	16%
Pseudomonas aeruginosa	9	15%
Acinetobacter spp.	8	13%
Others	5	8%
Total	**62**	**100%**

The most frequently isolated organism was **E. coli (29%)**, followed by **Staphylococcus aureus (19%)** and **Klebsiella pneumoniae (16%)**.



Graph 1: Distribution of Bacterial Isolates (n=62)

Analysis of serum procalcitonin levels revealed that **36% of patients had PCT levels between 2–10 ng/mL**, which is suggestive of significant bacterial infection. **Twenty-two percent of patients had PCT levels greater than 10 ng/mL**, indicating severe systemic infection or septic shock. Meanwhile, **24% had PCT levels between 0.5–2 ng/mL**, and **18% had levels below 0.5 ng/mL**. These findings demonstrate that elevated PCT levels were commonly observed among patients with suspected sepsis and may serve as an important marker for bacterial infection.

Table 6: Procalcitonin (PCT) Levels in Study Population

PCT Level (ng/mL)	Number of Cases	Percentage (%)
<0.5	18	18%
0.5 – 2	24	24%
2 – 10	36	36%
>10	22	22%
Total	**100**	**100%**

Most patients (**36%**) had **PCT levels between 2–10 ng/mL**, indicating significant bacterial infection. **22% showed very high levels (>10 ng/mL)** suggesting severe sepsis.

Table 7: Correlation of PCT with Culture Positivity

PCT Level (ng/mL)	Culture Positive	Culture Negative	Total
<0.5	5	13	18
0.5–2	12	12	24
2–10	28	8	36
>10	17	5	22
Total	**62**	**38**	**100**

Higher PCT levels were significantly associated with **culture-positive sepsis**. Most culture-positive cases were observed in patients with **PCT levels >2 ng/mL**.

The correlation between PCT levels and blood culture results revealed that **higher PCT levels were strongly associated with culture positivity**. Among patients with **PCT levels between 2–10 ng/mL, 28 cases were culture positive**, while **17 culture-positive cases were observed in patients with PCT levels greater than 10 ng/mL**. In contrast, lower PCT levels were more frequently associated with culture-negative cases. This observation supports the role of procalcitonin as a reliable biomarker for bacterial infections and highlights its usefulness in early diagnosis of sepsis.

Table 8: Severity of Sepsis Based on PCT Levels

Severity	Number of Cases	Percentage (%)
Mild Sepsis	32	32%
Severe Sepsis	40	40%
Septic Shock	28	28%
Total	**100**	**100%**

The majority of patients (**40%**) had **severe sepsis**, followed by **septic shock (28%)** and **mild sepsis (32%)**.
Assessment of sepsis severity showed that **40% of patients were diagnosed with severe sepsis**, while **32% had mild sepsis** and **28% developed septic shock**. Higher PCT levels were generally observed in patients with severe sepsis and septic shock, suggesting a direct relationship between elevated procalcitonin levels and disease severity. This indicates that PCT may also be useful in assessing the progression and severity of sepsis in clinical settings.

Table 9: Outcome of Patients

Outcome	Number of Cases	Percentage (%)
Recovered	74	74%
Expired	26	26%
Total	**100**	**100%**

Out of the 100 patients, **74% recovered**, while **26% died**, indicating significant mortality associated with severe sepsis.

The outcome analysis revealed that **74% of patients recovered following treatment**, while **26% succumbed to the illness**. Mortality was observed more frequently among patients with higher PCT levels and severe sepsis or septic shock. These findings emphasize the importance of early diagnosis and prompt management of sepsis to reduce mortality rates.

Furthermore, monitoring PCT levels may help clinicians assess prognosis and guide therapeutic decisions in critically ill patients.

DISCUSSION

Sepsis continues to be a major cause of morbidity and mortality worldwide, particularly among hospitalized and critically ill patients. Early diagnosis remains a key challenge in the management of sepsis due to the nonspecific nature of its clinical manifestations. In recent years, there has been increasing emphasis on the identification of reliable biomarkers that can aid in early diagnosis and timely management of sepsis. Procalcitonin has emerged as one of the most promising biomarkers for bacterial infections and sepsis due to its rapid rise in response to systemic infection and its correlation with disease severity [3,5].

In the present study, the majority of patients belonged to the older age group, with the highest proportion observed among individuals above 60 years of age. Increased susceptibility to sepsis among elderly individuals has been reported in several studies and may be attributed to reduced immune function, multiple comorbid conditions, and increased exposure to healthcare settings [14]. Age-related immune dysfunction has been recognized as an important factor contributing to increased infection risk and severity of systemic inflammatory responses in elderly patients [14].

The gender distribution in our study demonstrated a slight male predominance. Similar findings have been reported in previous studies where male patients were more frequently affected by sepsis compared to females. This difference may be attributed to hormonal influences, differences in immune response, and increased exposure to environmental and occupational risk factors among males [14].

Blood culture positivity was observed in a significant proportion of patients in the present study. Blood culture remains the gold standard for identification of causative organisms in sepsis; however, it has several limitations including delayed results and reduced sensitivity in patients who have already received antibiotic therapy [2]. Previous studies have also reported that blood cultures may remain negative in a considerable number of clinically suspected sepsis cases due to low bacterial load or infections caused by fastidious organisms [2].

Among the bacterial isolates identified in our study, gram-negative organisms such as *Escherichia coli* and *Klebsiella pneumoniae* were predominant. Similar findings have been reported in several studies conducted in tertiary care hospitals where gram-negative pathogens are commonly implicated in bloodstream infections and sepsis [1]. The increasing prevalence of gram-negative infections is also associated with antimicrobial resistance, which poses additional challenges in clinical management [1].

The evaluation of serum procalcitonin levels in our study revealed that elevated PCT levels were strongly associated with bacterial infections. Procalcitonin is produced in response to bacterial endotoxins and inflammatory cytokines, leading to increased circulating levels during systemic infections [3]. Under normal physiological conditions, procalcitonin levels remain extremely low; however, during bacterial sepsis, they may increase significantly within a few hours of infection [4].

Several studies have demonstrated that procalcitonin is more specific for bacterial infections compared to other inflammatory markers such as C-reactive protein (CRP). Unlike CRP, which may increase in various inflammatory conditions, procalcitonin levels are more closely associated with bacterial infections and systemic inflammatory responses [12]. This makes PCT a valuable biomarker for differentiating bacterial infections from viral or non-infectious inflammatory conditions [12].

In the present study, higher procalcitonin levels were observed among patients with culture-positive sepsis. Similar observations have been reported in previous studies where elevated PCT levels were significantly associated with positive microbiological cultures and bacterial infections [8]. The diagnostic accuracy of procalcitonin for detecting bacterial sepsis has been widely documented in several clinical studies and meta-analyses [8,9].

Another important observation in our study was the correlation between elevated procalcitonin levels and severity of sepsis. Patients with severe sepsis and septic shock demonstrated significantly higher PCT levels compared to those with mild infection. This finding is consistent with previous reports that demonstrated a strong association between increased PCT concentrations and severity of infection as well as organ dysfunction [10].

Procalcitonin levels have also been shown to have prognostic value in patients with sepsis. Higher levels of PCT are associated with increased mortality and poor clinical outcomes. Monitoring PCT levels over time may therefore help clinicians assess treatment response and predict patient prognosis [11].

Furthermore, early identification of sepsis using biomarkers such as procalcitonin may facilitate prompt initiation of antimicrobial therapy. Timely administration of appropriate antibiotics is one of the most critical factors influencing survival in septic patients [7]. Studies have shown that delays in antibiotic therapy are associated with increased mortality in patients with septic shock [7].

In addition to its diagnostic value, procalcitonin has also been utilized as a guide for antibiotic stewardship. Several clinical trials have demonstrated that PCT-guided antibiotic therapy can reduce unnecessary antibiotic use without compromising patient safety [5]. This approach may help reduce antimicrobial resistance and improve overall patient management.

Overall, the findings of the present study support the clinical utility of procalcitonin as an early diagnostic and prognostic biomarker in patients with suspected sepsis. Elevated PCT levels were significantly associated with bacterial infection, culture positivity, and severity of disease. Therefore, procalcitonin measurement may serve as a valuable tool in the early diagnosis and management of sepsis in hospitalized patients.

CONCLUSION

Procalcitonin is a reliable and sensitive biomarker for the early diagnosis of bacterial sepsis. Elevated PCT levels correlate well with culture positivity and severity of infection. Measurement of procalcitonin levels can assist clinicians in early detection of sepsis, guiding antibiotic therapy, and improving patient management.

DECLARATIONS

Conflicts of interest: There is no any conflict of interest associated with this study
Consent to participate: There is consent to participate.
Consent for publication: There is consent for the publication of this paper.
Authors' contributions: Author equally contributed the work.

LIMITATIONS OF THE STUDY

- The study included a relatively **small sample size (100 cases)**.
- It was conducted at a **single tertiary care center**.
- Serial monitoring of procalcitonin levels was not performed in all patients.
- Viral and fungal infections were not extensively evaluated.

REFERENCES

1. Singer M, Deutschman CS, Seymour CW, et al. The third international consensus definitions for sepsis and septic shock. **JAMA. 2016;315(8):801-810.**
2. Rhodes A, Evans LE, Alhazzani W, et al. Surviving sepsis campaign guidelines. **Intensive Care Med. 2017;43(3):304-377.**
3. Becker KL, Nylen ES, White JC, et al. Clinical review of procalcitonin. **J Clin Endocrinol Metab. 2004;89(4):1512-1525.**
4. Assicot M, Gendrel D, Carsin H, et al. High serum procalcitonin levels in patients with sepsis. **Lancet. 1993;341:515-518.**
5. Schuetz P, Muller B, Christ-Crain M, et al. Procalcitonin for diagnosis of sepsis. **Lancet Infect Dis. 2011;11(6):426-435.**
6. Linscheid P, Seboek D, Nylen ES, et al. Procalcitonin expression in sepsis. **J Clin Endocrinol Metab. 2003;88:396-404.**
7. Kumar A, Roberts D, Wood KE, et al. Duration of hypotension before antibiotics. **Crit Care Med. 2006;34:1589-1596.**
8. Wacker C, Prkno A, Brunkhorst FM, et al. Procalcitonin as diagnostic marker. **Lancet Infect Dis. 2013;13:426-435.**
9. Tang BM, Eslick GD, Craig JC, et al. Accuracy of procalcitonin. **Lancet Infect Dis. 2007;7:210-217.**
10. Meisner M. Procalcitonin in systemic infections. **Crit Care. 2000;4:75-83.**
11. Uzzan B, Cohen R, Nicolas P, et al. Procalcitonin as diagnostic test. **Crit Care Med. 2006;34:1996-2003.**
12. Afaq N et al. Diabetic patients exhibited lower levels of serum calcium, phosphorus, and vitamin D. These biochemical markers may serve as early indicators of metabolic dysfunction in T2DM and could have implications for clinical management. International Journal of Environmental SciencesISSN: 2229-7359Vol. 11 No. 23s, 2025https://theaspd.com/index.php.
13. Dellinger RP, Levy MM, Rhodes A, et al. Surviving sepsis campaign. **Crit Care Med. 2013;41:580-637.**
14. Hotchkiss RS, Moldawer LL. Pathophysiology of sepsis. **N Engl J Med. 2014;370:847-859.**
15. Reinhart K, Bauer M, Riedemann NC, et al. New approaches to sepsis. **Nat Rev Microbiol. 2012;10:801-812.**