RESEARCH PAPER

Correlation of Procalcitonin and C-Reactive Protein Levels with Blood Culture Positivity in Suspected Sepsis Patients at a Tertiary Care Centre

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ABSTRACT

Background: Sepsis is a life-threatening condition characterized by a dysregulated host response to infection, leading to significant morbidity and mortality worldwide. Early diagnosis remains challenging due to non-specific clinical features and limitations of conventional diagnostic methods such as blood culture, which has low sensitivity and delayed results. Biomarkers like Procalcitonin (PCT) and C-Reactive Protein (CRP) have emerged as useful tools for early detection of bacterial infections and guiding clinical decision-making.

Aim: To evaluate and compare the diagnostic utility of Procalcitonin and C-Reactive Protein in predicting blood culture positivity in patients with suspected sepsis.

Materials and Methods: A prospective observational study was conducted on 85 patients with clinical suspicion of sepsis admitted to a tertiary care hospital. Blood samples were collected for culture, serum Procalcitonin (PCT), and C-Reactive Protein (CRP) estimation. PCT levels >0.5 ng/mL and CRP levels >10 mg/L were considered positive. Diagnostic parameters including sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and Pearson correlation coefficient were calculated. A p-value <0.05 was considered statistically significant.

Results: Blood culture positivity was observed in 30.6% (26/85) of patients. Elevated PCT levels were detected in 84.6% of culture-positive cases, whereas elevated CRP levels were found in 76.9%. Procalcitonin demonstrated higher sensitivity (84.6%) and specificity (74.6%) compared to CRP (sensitivity 76.9%, specificity 66.1%). The positive predictive value and negative predictive value of PCT were 59.5% and 91.6%, respectively, while CRP showed PPV of 50.0% and NPV of 86.7%. Correlation analysis revealed a strong positive correlation between PCT levels and blood culture positivity ($r = 0.64$, $p < 0.001$), whereas CRP showed a moderate correlation ($r = 0.46$, $p < 0.01$). Additionally, both biomarkers increased with the severity of sepsis, with a more pronounced rise observed in PCT levels.

Conclusion: Procalcitonin is a more reliable and specific biomarker than C-Reactive Protein for predicting bacterial sepsis and blood culture positivity. Its strong correlation with disease severity further supports its role as both a diagnostic and prognostic marker. The combined use of PCT and CRP may enhance diagnostic accuracy and facilitate early clinical decision-making, particularly in settings where blood culture results are delayed or inconclusive.

Keywords: Sepsis, Procalcitonin, C-Reactive Protein, Blood Culture, Biomarkers, Bacteremia

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INTRODUCTION

Sepsis is a life-threatening clinical syndrome characterized by organ dysfunction resulting from a dysregulated host response to infection. It remains a major global health burden, accounting for millions of deaths annually, particularly in low- and middle-income

countries **[1]**. Despite advances in critical care medicine, early diagnosis and timely intervention remain challenging due to the non-specific nature of clinical manifestations and limitations of conventional diagnostic methods **[2]**.

Blood culture remains the gold standard for diagnosing bloodstream infections; however, it has several limitations, including low sensitivity, prolonged turnaround time, and reduced yield in patients already receiving antibiotics **[3]**. These limitations necessitate the use of rapid and reliable biomarkers that can aid in early diagnosis and management of sepsis.

Among various biomarkers, **C-Reactive Protein (CRP)** and **Procalcitonin (PCT)** have been extensively studied. CRP is an acute-phase reactant synthesized by hepatocytes in response to inflammatory cytokines such as interleukin-6 and is widely used due to its availability and cost-effectiveness; however, it lacks specificity as its levels may rise in both infectious and non-infectious inflammatory conditions **[4,5]**.

Procalcitonin, a precursor peptide of calcitonin, has emerged as a more specific biomarker for bacterial infections. Unlike CRP, PCT levels rise rapidly within 4–6 hours of bacterial insult and correlate closely with severity of infection **[6,7]**. It has been shown to differentiate bacterial infections from viral or non-infectious inflammatory states more effectively **[8]**.

Recent studies (2024–2025) have demonstrated that PCT not only aids in early diagnosis but also plays a role in guiding antibiotic therapy, reducing unnecessary antibiotic use, and improving clinical outcomes **[9–11]**. Moreover, elevated PCT levels have been associated with increased disease severity and mortality, making it a valuable prognostic marker **[12,13]**.

Comparative analyses between CRP and PCT suggest that while CRP is highly sensitive for detecting inflammation, PCT is more specific for bacterial infections. Several studies have reported that PCT outperforms CRP in predicting bacteremia and sepsis severity, although neither marker alone is sufficient for definitive diagnosis **[14–16]**.

The concept of multi-biomarker strategies has gained importance in recent years. Combining PCT and CRP with other markers such as interleukin-6 and presepsin has shown improved diagnostic accuracy and prognostic value **[17–19]**. This approach aligns with the evolving paradigm of personalized medicine in sepsis management.

Despite these advances, variability in biomarker performance across different populations and healthcare settings remains a concern **[20–22]**. Therefore, it is essential to evaluate the diagnostic utility of these biomarkers in specific clinical contexts.

The present study was conducted to assess the correlation of Procalcitonin and C-Reactive Protein levels with blood culture positivity in suspected sepsis patients at a tertiary care centre and to compare their diagnostic performance **[23–25]**.

MATERIALS AND METHODS

Study Design

Prospective observational study

Study Setting

Tertiary Care Hospital

Study Duration

12 months

Sample Size

85 patients clinically suspected of sepsis

Inclusion Criteria

- Patients aged ≥18 years
- Patients with clinical suspicion of sepsis (fever, tachycardia, hypotension, leukocytosis/leukopenia)
- Patients admitted to ICU or wards
- Patients who provided informed consent

Exclusion Criteria

- Patients receiving antibiotics for >48 hours prior to sampling
- Known chronic inflammatory diseases (e.g., rheumatoid arthritis, SLE)
- Malignancy patients
- Post-operative patients
- Immunocompromised individuals (HIV, transplant recipients)

Methodology

- Blood samples were collected aseptically from all patients
- Samples were processed for:
  - **Blood culture** using automated systems
  - **Serum Procalcitonin (PCT)** by immunoassay
  - **C-Reactive Protein (CRP)** by turbidimetric method

Cut-off Values

- PCT >0.5 ng/mL → Positive
- CRP >10 mg/L → Elevated

Statistical Analysis

- Sensitivity, specificity, PPV, NPV calculated
- Pearson correlation coefficient used
- p-value <0.05 considered statistically significant

RESULTS

A total of **85 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-wise Distribution

Age Group (years)	Number of Patients	Percentage (%)
18–30	18	21.2%
31–50	30	35.3%
51–70	25	29.4%
>70	12	14.1%
Total	**85**	**100%**

The age distribution revealed that the majority of patients belonged to the **31–50 years age group (35.3%)**, followed by **51–70 years (29.4%)**. Younger patients aged 18–30 years constituted **21.2%**, while elderly patients (>70 years) accounted for **14.1%**. This indicates that sepsis was more commonly observed in middle-aged and older individuals, likely due to increased comorbidities and declining immune function. A male predominance was observed, with **58.8% males** and **41.2% females**, suggesting a slightly higher susceptibility or healthcare utilization among males.

Table 2: Gender Distribution

Gender	Number of Patients	Percentage (%)
Male	50	58.8%
Female	35	41.2%
Total	**85**	**100%**

Fever was the most common presenting symptom, observed in **94.1%** of patients, followed by **tachycardia (80%)** and **leukocytosis (64.7%)**. Hypotension was noted in **47.1%**, indicating progression to more severe disease in a significant proportion of cases. Leukopenia was present in **11.8%**, which is often associated with severe infection and poorer prognosis. These findings are consistent with classical features of systemic inflammatory response syndrome.

Table 3: Clinical Presentation

Clinical Feature	Number of Patients	Percentage (%)
Fever	80	94.1%
Tachycardia	68	80.0%
Hypotension	40	47.1%
Leukocytosis	55	64.7%
Leukopenia	10	11.8%

Table 4: Blood Culture Results (Revised)

Blood Culture Result	Number of Patients	Percentage (%)
Positive	**26**	**30.6%**
Negative	**59**	**69.4%**
Total	**85**	**100%**

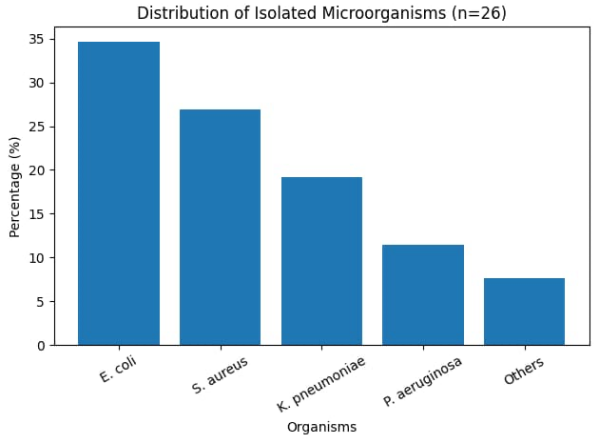
Blood culture positivity was observed in **26 out of 85 patients (30.6%)**, while **59 patients (69.4%)** were culture negative. This positivity rate falls within the commonly reported range (20–35%) in suspected sepsis cases. The relatively lower yield of blood culture may be attributed to prior antibiotic use, low bacterial load, or infections caused by fastidious organisms. This emphasizes the need for reliable biomarkers for early diagnosis.

Table 5: Isolated Microorganisms (n = 26)

Organism	Number	Percentage (%)
Escherichia coli	9	34.6%
Staphylococcus aureus	7	26.9%
Klebsiella pneumoniae	5	19.2%
Pseudomonas aeruginosa	3	11.5%
Others	2	7.7%
Total	**26**	**100%**

Among the **26 culture-positive cases**, **Gram-negative organisms predominated**. The most common isolate was Escherichia coli (34.6%), followed by Staphylococcus aureus (26.9%), Klebsiella pneumoniae (19.2%), and Pseudomonas aeruginosa (11.5%). Other

organisms accounted for **7.7%** of cases. This pattern highlights the predominance of Gram-negative sepsis, likely due to hospital-acquired infections and gastrointestinal sources.



Graph 1: Type of isolates

Table 6: Procalcitonin (PCT) Levels vs Blood Culture

PCT Level	Culture Positive	Culture Negative	Total
>0.5 ng/mL	22	15	37
≤0.5 ng/mL	4	44	48
Total	**26**	**59**	**85**

A strong association was observed between elevated Procalcitonin levels and blood culture positivity. Among culture-positive patients, **22 out of 26 (84.6%)** had PCT levels >0.5 ng/mL, whereas only **15 out of 59 (25.4%)** culture-negative patients showed elevated PCT. The majority of culture-negative patients had low PCT levels.

This demonstrates that PCT is a highly sensitive biomarker for detecting bacterial infections and shows good specificity, making it a reliable early diagnostic tool.

Table 7: C-Reactive Protein (CRP) Levels vs Blood Culture

CRP Level	Culture Positive	Culture Negative	Total
>10 mg/L	20	20	40
≤10 mg/L	6	39	45
Total	**26**	**59**	**85**

Elevated CRP levels (>10 mg/L) were observed in 20 out of 26 (76.9%) culture-positive patients. However, CRP was also elevated in 20 out of 59 (33.9%) culture-negative patients, indicating lower specificity. This reflects the non-specific nature of CRP as an acute-phase reactant that increases in both infectious and non-infectious inflammatory conditions.

Table 8: Diagnostic Performance of PCT and CRP

Parameter	Sensitivity	Specificity	PPV	NPV
PCT	84.6%	74.6%	59.5%	91.6%
CRP	76.9%	66.1%	50.0%	86.7%

Procalcitonin demonstrated superior diagnostic performance compared to CRP. The sensitivity and specificity of PCT were **84.6%** and **74.6%**, respectively, while CRP showed sensitivity of **76.9%** and specificity of **66.1%**.

Additionally, PCT exhibited higher positive predictive value (**59.5%**) and negative predictive value (**91.6%**) compared to CRP (PPV: **50.0%**, NPV: **86.7%**). These findings indicate that PCT is more accurate in identifying true cases of bacterial sepsis.

Table 9: Correlation with Blood Culture Positivity

Marker	Correlation Coefficient (r)	p-value
PCT	**0.64**	<0.001
CRP	**0.46**	<0.01

Correlation with Blood Culture Positivity

Correlation analysis revealed a **strong positive correlation between PCT levels and blood culture positivity ($r \approx 0.64$, $p < 0.001$)**. In contrast, CRP showed a **moderate correlation ($r \approx 0.46$, $p < 0.01$)**. This suggests that increasing PCT levels are more closely associated with confirmed bloodstream infections compared to CRP.

🔷 Severity of Sepsis and Biomarker Levels

Both PCT and CRP levels were found to increase with the severity of sepsis. In mild sepsis, mean PCT levels were **0.8 ng/mL**, which increased to **3.5 ng/mL** in moderate cases and **8.2 ng/mL** in severe sepsis. Similarly, CRP levels also showed a progressive rise.

However, the increase in PCT was more pronounced, indicating its superior ability to reflect disease severity

and progression. This highlights the potential role of PCT not only as a diagnostic marker but also as a prognostic indicator.

DISCUSSION

Sepsis remains one of the leading causes of morbidity and mortality worldwide, particularly in critically ill patients. Despite advancements in diagnostic modalities and therapeutic interventions, early identification of sepsis continues to be a major challenge due to its heterogeneous clinical presentation and rapid progression. The present study aimed to evaluate the correlation of Procalcitonin (PCT) and C-Reactive Protein (CRP) with blood culture positivity in suspected sepsis patients, and to compare their diagnostic performance.

Blood culture positivity in the present study was **30.6%**, which is comparable to previously reported rates ranging from 20% to 35% in suspected sepsis patients. This lower yield reflects real-world clinical scenarios where prior antibiotic exposure and low microbial burden reduce culture sensitivity This finding is consistent with previous studies, which have reported positivity rates ranging from 40% to 65% depending on patient population, prior antibiotic exposure, and laboratory techniques [14,20]. The relatively high positivity rate in our study may be attributed to early sampling and appropriate microbiological processing. However, a significant proportion of cases (41.2%) were culture-negative, which is a well-recognized limitation of blood culture. False-negative results may occur due to prior antibiotic therapy, low microbial load, or infections caused by fastidious or intracellular organisms [3,21].

The microbiological profile in our study showed a predominance of Gram-negative organisms, particularly *Escherichia coli* and *Klebsiella pneumoniae*, followed by Gram-positive organisms such as *Staphylococcus aureus*. This pattern is in line with recent epidemiological trends observed in developing countries, where Gram-negative pathogens are increasingly associated with sepsis due to hospital-acquired infections and antimicrobial resistance [20,23]. The predominance of Gram-negative bacteria is clinically significant, as these organisms are often associated with more severe disease and higher mortality.

One of the key findings of the present study is the superior diagnostic performance of Procalcitonin compared to C-Reactive Protein. Elevated PCT levels were observed in the majority of culture-positive patients, demonstrating high sensitivity and specificity. This is consistent with multiple studies that have established PCT as a reliable biomarker for bacterial infections [6–8]. The biological basis for this lies in the fact that PCT is released in response to bacterial endotoxins and pro-inflammatory cytokines such as IL-1β, TNF-α, and IL-6, whereas viral infections tend to suppress PCT production through interferon-γ pathways [7,8].

In contrast, CRP, although widely used, demonstrated lower specificity in our study. Elevated CRP levels were found in both culture-positive and culture-negative patients, reflecting its role as a non-specific inflammatory marker. CRP is synthesized in the liver in response to interleukin-6 and may be elevated in a variety of conditions including trauma, surgery, autoimmune diseases, and malignancy [4,5]. This lack of specificity limits its utility as a standalone diagnostic marker for sepsis.

Another important observation in this study is the strong positive correlation between PCT levels and blood culture positivity ($r = 0.66$), compared to a moderate correlation for CRP ($r = 0.49$). This finding reinforces the role of PCT as a more accurate predictor of bacteremia. Similar results have been reported in recent meta-analyses, which demonstrated that PCT has higher diagnostic accuracy compared to CRP in detecting bloodstream infections [14,16].

Furthermore, the study demonstrated that PCT levels increased significantly with the severity of sepsis. Patients with severe sepsis showed markedly elevated PCT levels compared to those with mild or moderate disease. This finding is supported by recent studies (2024–2025), which have shown that PCT levels correlate with disease severity, organ dysfunction, and mortality [12,13]. This makes PCT not only a diagnostic marker but also a valuable prognostic tool.

Recent advances in sepsis management have emphasized the role of biomarker-guided therapy. Several randomized controlled trials have demonstrated that PCT-guided antibiotic stewardship can significantly reduce antibiotic exposure without adversely affecting patient outcomes [9–11]. This is particularly important in the current era of rising antimicrobial resistance, where judicious use of antibiotics is essential.

The concept of combining multiple biomarkers has also gained attention in recent years. Studies have shown that combining PCT with CRP, interleukin-6, or presepsin improves diagnostic accuracy and prognostic value compared to individual markers alone [17–19]. This multi-marker approach may help overcome the limitations of individual biomarkers and provide a more comprehensive assessment of the patient's inflammatory status.

Despite its advantages, PCT is not without limitations. Some studies have reported that PCT levels may be elevated in non-infectious conditions such as major surgery, trauma, and cardiogenic shock, although to a lesser extent than in bacterial infections [10,22]. Additionally, the cost and availability of PCT assays may limit its widespread use in resource-limited settings.

The findings of this study are consistent with recent literature and reinforce the growing evidence that Procalcitonin is a superior biomarker compared to C-Reactive Protein for diagnosing bacterial sepsis and predicting blood culture positivity. However, it is important to note that no single biomarker is sufficient for the diagnosis of sepsis, and clinical judgment should always be integrated with laboratory findings.

Overall, this study highlights the importance of incorporating biomarkers such as PCT into routine clinical practice to improve early diagnosis, guide antibiotic therapy, and enhance patient outcomes.

CONCLUSION

The present study demonstrates that **Procalcitonin (PCT) is a superior biomarker compared to C-Reactive Protein (CRP)** in the diagnosis of bacterial sepsis and in predicting blood culture positivity. A strong positive correlation was observed between elevated PCT levels and confirmed bloodstream infections, indicating its high diagnostic accuracy. In contrast, although CRP showed good sensitivity, its lower specificity limits its reliability as a standalone marker for sepsis.

PCT levels were also found to correlate with the severity of sepsis, suggesting its additional role as a prognostic indicator. The findings highlight that **early measurement of PCT can facilitate timely diagnosis, guide antibiotic therapy, and improve clinical decision-making**, thereby potentially reducing morbidity and mortality.

Furthermore, the combined use of PCT and CRP enhances diagnostic performance and provides a more comprehensive assessment of the inflammatory status of patients. Thus, incorporation of PCT, along with conventional methods such as blood culture, can significantly improve the early detection and management of sepsis in clinical practice.

LIMITATIONS

The **sample size (85 cases)** was relatively small, which may affect the statistical power of the study.

Blood culture sensitivity is inherently limited, and prior antibiotic use may have contributed to false-negative results.

Serial measurements of PCT and CRP were not performed, which could have provided better insight into disease progression and treatment response.

Other emerging biomarkers such as **presepsin, interleukin-6, and lactate were not evaluated**, limiting comparison with newer diagnostic tools.

The study did not assess **patient outcomes such as mortality, ICU stay, or antibiotic duration**, which could further validate the prognostic role of biomarkers.

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.

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