



Original Article

Significance of CRP and PCT in Identifying Bacteremia among ICU Patients with Positive Blood Cultures at a Tertiary Care Hospital

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ABSTRACT

Background: Early identification of bacteremia among intensive care unit patients is critical for timely management of sepsis. Blood culture remains the diagnostic gold standard; however, delays in reporting necessitate reliable biomarkers for early detection. Serum procalcitonin and C-reactive protein are widely used inflammatory markers with potential diagnostic and prognostic value.

Methods: This retrospective study was conducted over six months in a tertiary care hospital and included 100 patients with positive blood cultures who had simultaneous serum procalcitonin and C-reactive protein testing. Microbial isolates were classified as Gram-negative bacteria, Gram-positive bacteria, or fungi. Serum marker levels were analyzed and correlated with blood culture results. Statistical analysis was performed using SPSS version 20.0.

Results: Gram-negative bacteremia predominated (83%), with *Escherichia coli* as the most common isolate. Elevated serum procalcitonin levels were observed in 91% of cases, while C-reactive protein was elevated in 83%. Procalcitonin demonstrated superior diagnostic performance for bacteremia with an area under the receiver operating characteristic curve of 0.73, compared to 0.52 for C-reactive protein. Higher procalcitonin levels were particularly associated with Gram-negative infections.

Conclusion: Serum procalcitonin is a more reliable biomarker than C-reactive protein for identifying bacteremia in intensive care unit patients. Its integration into routine clinical practice may enhance early diagnosis, guide antimicrobial therapy, and improve patient outcomes.

Keywords: Procalcitonin, Bacteremia, Sepsis, Blood culture

INTRODUCTION

The significance of sepsis markers among patients with positive blood cultures is paramount in enhancing early diagnosis and treatment within the ICU setting. Sepsis is the main reason for mortality in such settings, thus calling for fast and accurate diagnostic methods to improve the outcome of the patient. Of all the studied biomarkers, C-reactive protein (CRP) and serum procalcitonin (PCT) are the markers most important to diagnose bacterial sepsis in the early stage of the process than the methods applied traditionally. Procalcitonin minimizes the risk of death, antibiotic consumption, and antibiotic-related side effects when it is used to guide the initiation and duration of antibiotic treatment. [1,2]. ICU patients with trauma and sepsis have considerably higher PCT levels, which could possibly distinguish sepsis from SIRS in critical illness. [3] The study thus assesses their efficacy, keeping in mind both the suspected and confirmed cases of sepsis. The research aims to unearth insights into their roles in facilitating timely and proper therapeutic interventions, ultimately reducing the high mortality rates that characterize sepsis in ICU patients by analyzing the potential of PCT and CRP. Blood culture remains the gold standard for diagnosing bacterial sepsis and provides direct proof of microbial infection in the bloodstream. However, the limitations of this method regarding time to result have prompted interest in biomarkers such as serum procalcitonin (PCT) and C-reactive protein (CRP) for earlier detection of bacteremia-related sepsis. Biomarkers can offer critical insights into the inflammatory response, thereby improving the timeliness of

diagnosis and intervention [4]. This study specifically examines the effectiveness of PCT and CRP in patients with suspected and confirmed sepsis, aiming to determine their potential utility in clinical practice. Through such markers, this research seeks to improve diagnostic precision and predictive assessment for potential effective management in patients with sepsis.

METHODOLOGY

A retrospective study was conducted over a six-month period within the Microbiology department of a tertiary care hospital, focusing on patients with positive blood cultures. A total of 100 patient records were meticulously analyzed to assess the levels of inflammatory markers, specifically serum procalcitonin (PCT) and C-reactive protein (CRP).

Inclusion Criteria: Patient with both PCT and CRP requests along with blood culture

Exclusion Criteria: Patients with single marker request.

Assay method:

AGAPPE Mispa i3 nephelometry was used to determine the levels of serum PCT and serum CRP; a level of less than 6 mg/L for the latter and less than 0.3 ng/ml for the former was considered normal.

Data collection: Institutional HIMS (Hospital Information Management System) software was used to procure data regarding the patients included in the study.

Statistical analysis: MS Excel was used for data compilation. The statistical software of SPSS 20.0 was used for data analysis. The measurements were expressed by mean and frequency distribution and the count data were expressed by rate of prevalence (%) among the different groups studied (Gram positive bacteria, Gram negative bacteria and fungi).

RESULTS

Prevalence of Gram Positive & Gram-Negative septicemia:

The study shows the prevalence of Gram-negative bacteremia to be 83% and Gram-positive bacteremia to be 17%, with *Escherichia coli* being the predominant pathogen isolated accounting to 50.6% followed by multidrug-resistant *Klebsiella pneumoniae* (22.8%), (19 cases) and *Acinetobacter baumannii* (9 cases). Other pathogens include *Burkholderia pseudomallei* (4 cases) and *Enterobacter cloacae* (6 cases), while *Salmonella Typhi* and *Serratia marcescens* each account for 2 and 1 case respectively. The data shows the prevalence of Gram-positive bacteraemia, with *Staphylococcus aureus* being the most common cause (9 cases), followed by *Enterococcus faecalis* (5 cases). *Enterococcus faecium* and *Streptococcus pneumoniae* are less prevalent, with 2 cases and 1 case respectively.

CRP and PCT: Of all the patients included, PCT was found to be positive in 91% cases, while CRP was 83% making PCT, a reliable marker for sepsis. The CRP and PCT values obtained were compared with the organisms isolated by blood culture. Fig 1 & Fig: 2 shows the frequency distribution of CRP and PCT among Gram Positive Bacteria, Gram Negative bacteria and Fungi isolated from clinical samples.

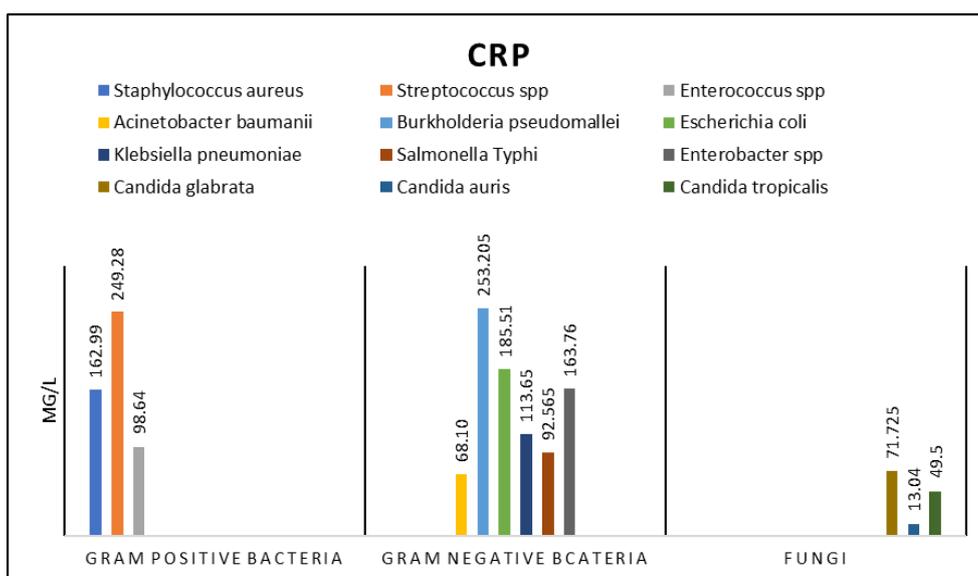


Fig:1 showing comparison of mean CRP levels (mg/L) among patients infected with Gram-positive bacteria, Gram-negative bacteria, and fungi.

Gram-positive bacteria (*Streptococcus* spp., *Staphylococcus aureus*) and Gram-negative bacteria (*Burkholderia pseudomallei*, *Escherichia coli*) tend to show high levels of CRP; this is compatible with the fact that they often cause more serious and invasive infections. Such infections would likely lead to significant inflammation, possibly as a result of factors such as bacterial virulence, the location of infection, or the nature of the immune response.

Fungal infections, such as *Candida glabrata*, *Candida auris*, show lower CRP values. It is possible that fungal infections, although serious (especially in immunocompromised patients), provoke a less pronounced inflammatory response compared to bacterial infections. Fungal infections, however, can be very debilitating and require prompt treatment.

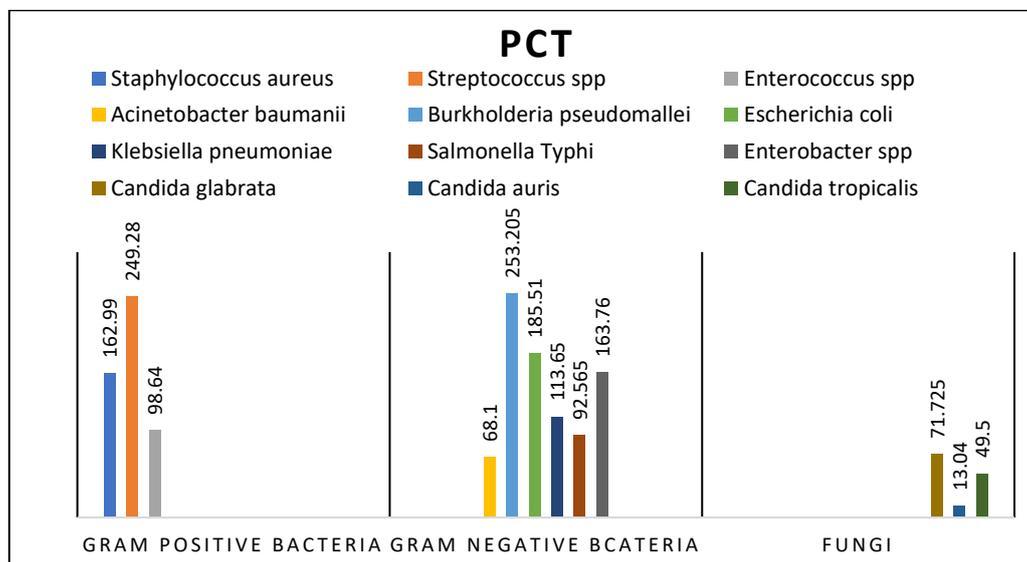


Fig 2: Comparative analysis of serum procalcitonin (PCT) levels (ng/mL) across different microbial pathogens.

The elevated PCT values across these organisms suggest active and potentially severe infections, with Gram-negative bacteria such as *Escherichia coli* and *Burkholderia pseudomallei* posing the highest risk. Gram-positive bacteria, particularly *Streptococcus* spp. and *Staphylococcus aureus*, also show significantly elevated levels, indicating serious infections. Fungal infections, while generally showing lower PCT values, can still be significant, particularly when caused by invasive organisms like *Candida glabrata* or *C. auris*.

In our study, procalcitonin (PCT) showed a good diagnostic performance in identifying bacteraemia, with an AUC of 0.73 (95% CI: 0.65–0.81). At a cutoff value of 2.1 ng/mL, PCT achieved a positive predictive value of 72.5% and a negative predictive value of 67.9%, indicating its usefulness both in ruling in and ruling out bloodstream infection. In contrast, C-reactive protein (CRP) had a poor discriminatory value, with an AUC of 0.52 (95% CI: 0.43–0.62), which is close to random chance and statistically insignificant. These findings suggest that PCT is a more reliable biomarker than CRP for predicting bacteraemia among ICU patients with positive blood cultures.

DISCUSSION

Prevalence of Gram-Positive & Gram-Negative septicemia:

A larger proportion of Gram-negative organisms (87.3%) were isolated from culture-positive individuals, with *Escherichia coli* (27.3%) and *Klebsiella* (20%) being the most common. Gram-positive isolates accounted for 12.7% [5,6]. This finding is similar to our study. The study reveals that high levels of serum procalcitonin (PCT) are strongly linked to infections caused by extended-spectrum beta-lactamase (ESBL) producing and multidrug-resistant (MDR) bacteria. This suggests PCT could be a valuable tool for predicting sepsis outcomes, especially in infections involving resistant bacteria [7]. Since procalcitonin can indicate the early stages of multiple organ dysfunction syndrome (MODS), monitoring its levels daily could be beneficial for tracking the condition of critically ill patients. [8]. PCT concentrations of gram-negative (14.94 ng/mL, IQR 2.93 ~ 48.76) were significantly higher than gram-positive (4.74 ng/mL, IQR 1.22 ~ 17.5) and fungal (1.47 ng/mL, IQR 0.66 ~ 35.34). [9] C-reactive protein (CRP) is a sensitive parameter for diagnosing non-systemic infections, whereas procalcitonin (PCT) appears to be a useful parameter for improving the diagnosis and monitoring of therapy in patients with sepsis and septic shock [10,11,12,13]. In contrast, C-reactive protein (CRP), while elevated, did not exhibit the same level of specificity or prognostic value in these instances. The differential impact of these markers suggests that PCT may offer superior predictive capabilities in the early identification and management of sepsis, especially in complex cases involving resistance [14]. PCT levels were significantly higher in the GP group compared to the GN group, while CRP levels did not show any significant difference between the two groups [15]. Consequently, integrating PCT assessments into clinical protocols could significantly enhance the ability to stratify patients based on risk and tailor treatments more effectively, thereby improving the overall management of sepsis cases within intensive care settings.

The findings of this study underscore the critical role that serum procalcitonin (PCT) and C-reactive protein (CRP) play in the diagnostic and prognostic evaluation of sepsis. PCT has demonstrated substantial potential in identifying high-risk sepsis patients, allowing clinicians to make more informed decisions regarding treatment strategies. The accurate determination of PCT levels can significantly enhance patient outcomes by facilitating timely diagnoses and preventing unnecessary interventions. Moreover, the integration of CRP, despite its lower specificity compared to PCT, contributes to a more comprehensive understanding of the inflammatory response in sepsis cases [16]. Collectively, these biomarkers provide valuable tools for clinicians to improve the management of sepsis, ultimately reducing the associated morbidity and mortality rates.

CONCLUSION

In summary, the study reinforces the pivotal role that serum procalcitonin (PCT) and C-reactive protein (CRP) play in the diagnosis and management of sepsis, particularly among patients with positive blood cultures. Elevated levels of PCT, in particular, have been shown to correlate with a higher risk of severe sepsis, offering clinicians a reliable biomarker for identifying patients in need of urgent intervention. The ability of PCT to provide early prognostic insights surpasses that of CRP, making it a valuable tool for enhancing diagnostic accuracy and informing treatment strategies. As such, integrating PCT measurements into standard clinical protocols can significantly improve patient outcomes by ensuring timely diagnosis and reducing unnecessary treatments. These findings underscore the importance of adopting comprehensive biomarker analysis in sepsis management, ultimately advancing therapeutic approaches and reducing mortality rates in intensive care units.

These findings suggest that integrating PCT measurement in clinical practice could enhance the accuracy of sepsis diagnosis and improve patient management by facilitating timely interventions.

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