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Original Research Article

Assessment of Serum Procalcitonin and C-Reactive Protein in Bacterial Infections

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Abstract

Background: Bacterial infections remain a major cause of morbidity and mortality worldwide, particularly among hospitalized patients. Early diagnosis and timely initiation of appropriate antimicrobial therapy are essential for improving clinical outcomes and reducing complications. Conventional clinical and laboratory parameters often lack specificity in differentiating bacterial infections from non-bacterial inflammatory conditions. Biomarkers such as serum procalcitonin (PCT) and C-reactive protein (CRP) have emerged as valuable tools in the diagnosis and monitoring of infectious diseases. Procalcitonin is considered a relatively specific marker of bacterial infection, whereas C-reactive protein is a widely used acute-phase reactant that increases in response to systemic inflammation. Comparative evaluation of these biomarkers may assist clinicians in improving diagnostic accuracy and therapeutic decision-making.

Aim: To assess serum procalcitonin and C-reactive protein levels in patients with bacterial infections and evaluate their diagnostic utility.

Objectives: (1) To determine serum procalcitonin levels in patients with bacterial infections. (2) To assess serum C-reactive protein levels in patients with bacterial infections. (3) To evaluate the association between biomarker levels and severity of infection. (4) To compare the diagnostic performance of serum procalcitonin and C-reactive protein in bacterial infections. (5) To assess the usefulness of these biomarkers in early diagnosis and clinical management.

Materials and Methods: A hospital-based prospective observational study was conducted in the Department of General Medicine of a tertiary care teaching hospital over a period of 12 months from January 2025 to December 2025. A total of 100 patients clinically suspected and microbiologically confirmed to have bacterial infections were included in the study. Detailed clinical evaluation, laboratory investigations, microbiological cultures, serum procalcitonin levels, and C-reactive protein levels were assessed at admission. Patients were categorized according to the severity of infection. Statistical analysis was performed to evaluate the association between biomarker levels and clinical outcomes.

Results: Among the 100 patients included in the study, the majority belonged to the age group of 41–60 years with a slight male predominance. Respiratory tract infections, urinary tract infections, and bloodstream infections constituted the most common bacterial infections. Both serum procalcitonin and C-reactive protein levels were significantly elevated in patients with confirmed bacterial infections. Serum procalcitonin levels demonstrated a stronger correlation with severity of infection and presence of sepsis compared to C-reactive protein. Higher biomarker levels were observed among patients requiring intensive care admission. Procalcitonin showed superior specificity and positive predictive value for bacterial infections, while C-reactive protein remained a sensitive marker of systemic inflammation.

Conclusion: Both serum procalcitonin and C-reactive protein are useful biomarkers in the evaluation of bacterial infections. However, serum procalcitonin appears to be a more specific indicator of bacterial infection severity and may provide greater diagnostic accuracy in differentiating bacterial infections from other inflammatory conditions. Combined assessment of procalcitonin and C-reactive protein may enhance early diagnosis, facilitate risk stratification, and improve clinical management of patients with bacterial infections.

Keywords: Procalcitonin; C-Reactive Protein; Bacterial Infection; Biomarkers; Sepsis; Inflammation; Diagnostic Accuracy; Infection Severity; Acute Phase Reactant; Clinical Assessment.

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Introduction

Bacterial infections continue to represent a major global health concern and are responsible for substantial morbidity, mortality, prolonged hospitalization, and increased healthcare expenditure. Despite significant advances in antimicrobial therapy, diagnostic techniques, and critical care management, bacterial infections remain a leading cause of hospital admissions and adverse clinical outcomes [1]. Early recognition and prompt initiation of appropriate treatment are essential for preventing disease progression, reducing complications, and improving patient survival. However, distinguishing bacterial infections from viral infections and non-infectious inflammatory conditions often remains a diagnostic challenge in routine clinical practice [2].

The host immune response to bacterial invasion involves activation of complex inflammatory pathways leading to the release of various cytokines, acute-phase reactants, and inflammatory mediators. These biological responses form the basis for the use of laboratory biomarkers in the diagnosis and monitoring of infectious diseases [3]. An ideal biomarker should possess high sensitivity and specificity, correlate with disease severity, facilitate early diagnosis, and provide prognostic information. Among the numerous biomarkers currently available, serum procalcitonin (PCT) and C-reactive protein (CRP) have gained widespread clinical importance in the evaluation of bacterial infections [4].

C-reactive protein is an acute-phase protein synthesized predominantly by hepatocytes in response to inflammatory cytokines, particularly interleukin-6. CRP levels rise rapidly during infection, tissue injury, and inflammatory disorders [5]. Due to its wide availability, relatively low cost, and ease of measurement, CRP has become one of the most commonly utilized laboratory markers of inflammation. Elevated CRP concentrations are frequently observed in bacterial infections; however, increased levels may also occur in viral infections, autoimmune diseases, trauma, surgery, and various non-infectious inflammatory conditions, thereby limiting its specificity [6].

Procalcitonin, a 116-amino acid precursor peptide of calcitonin, has emerged as a promising biomarker for bacterial infections. Under normal physiological conditions, procalcitonin is produced by thyroid C-cells and circulates in extremely low concentrations [7]. During systemic bacterial infections, however, procalcitonin synthesis is induced in multiple tissues throughout the body, resulting in a significant rise in serum levels. Unlike CRP, procalcitonin appears to demonstrate greater specificity for bacterial infections because its production is strongly stimulated by bacterial endotoxins and pro-inflammatory cytokines while being suppressed during many viral infections [8].

Several studies have suggested that serum procalcitonin levels correlate with the severity of bacterial infection and may assist in differentiating localized infections from systemic infections and sepsis [9]. Elevated procalcitonin concentrations have been associated with severe bacterial infections, septic shock, organ dysfunction, and increased mortality. Consequently, procalcitonin has gained increasing importance not only as a diagnostic marker but also as a tool for prognostication and antibiotic stewardship [10].

Sepsis remains one of the most serious complications of bacterial infection and is characterized by life-threatening organ dysfunction resulting from a dysregulated host response to infection. Early identification of patients at risk for sepsis is critical because delayed diagnosis and treatment are associated with poor outcomes [11]. Biomarkers such as procalcitonin and CRP may facilitate early recognition of severe infection and help guide therapeutic decisions. Furthermore, serial measurement of these biomarkers may provide valuable information regarding response to treatment and disease progression [12].

Although both procalcitonin and CRP are widely used in clinical practice, differences exist regarding their diagnostic performance, sensitivity, specificity, and prognostic value. Comparative evaluation of these biomarkers is important for identifying the most useful laboratory indicators in patients with suspected bacterial infections. Such assessments may improve diagnostic accuracy, reduce unnecessary antibiotic use, and contribute to better patient management [13].

Tertiary care hospitals frequently manage patients with a broad spectrum of bacterial infections ranging from localized infections to severe sepsis and septic shock. Evaluation of serum procalcitonin and C-reactive protein levels in these patients provides valuable insight into the clinical utility of these biomarkers in real-world healthcare settings.

In view of the growing importance of biomarker-guided diagnosis and management of infectious diseases, the present study was undertaken to assess serum procalcitonin and C-reactive protein levels in patients with bacterial infections and evaluate their diagnostic significance in relation to infection severity and clinical outcomes.

Aim: To assess serum procalcitonin and C-reactive protein levels in patients with bacterial infections.

Objectives

1. To determine serum procalcitonin levels among patients with bacterial infections.
2. To assess serum C-reactive protein levels among patients with bacterial infections.
3. To evaluate the association between biomarker levels and severity of bacterial infection.
4. To compare the diagnostic performance of serum procalcitonin and C-reactive protein.
5. To assess the relationship between biomarker levels and clinical outcomes in patients with bacterial infections.
6. To determine the usefulness of serum procalcitonin and C-reactive protein in early diagnosis and management of bacterial infections.

Materials and Methods

Study Design: The present study was a hospital-based prospective observational study conducted to assess serum procalcitonin and C-reactive protein levels in patients with bacterial infections and evaluate their diagnostic utility.

Study Setting: The study was conducted in the Department of General Medicine in collaboration with the Department of Microbiology and Department of Biochemistry of a tertiary care teaching hospital. The hospital serves as a referral center for infectious diseases and manages a large number of patients with bacterial infections requiring inpatient and outpatient care.

Study Duration: The study was conducted over a period of 12 months from January 2025 to December 2025.

Study Population: The study population consisted of patients admitted with clinically suspected and microbiologically confirmed bacterial infections.

Sample Size: A total of 100 patients fulfilling the inclusion criteria were enrolled in the study.

Sampling Technique: Consecutive sampling was employed. All eligible patients presenting during the study period were included until the desired sample size was achieved.

Inclusion Criteria

1. Patients aged 18 years and above.
2. Patients with clinical features suggestive of bacterial infection.
3. Patients with microbiological confirmation of bacterial infection through culture or other appropriate investigations.
4. Patients willing to provide informed consent.

Exclusion Criteria

1. Patients with confirmed viral infections.
2. Patients with fungal or parasitic infections.
3. Patients receiving immunosuppressive therapy.
4. Patients with autoimmune or chronic inflammatory disorders.
5. Patients with malignancy.
6. Patients who had received prolonged antibiotic therapy before admission.
7. Pregnant women.

Clinical Evaluation

All patients underwent detailed clinical assessment including:

- Demographic profile.
- Presenting complaints.
- Duration of symptoms.
- Vital signs.
- Systemic examination.
- Source of infection.
- Presence of sepsis or septic shock.

The severity of infection was assessed using standard clinical criteria.

Laboratory Investigations

The following investigations were performed for all patients:

Routine Investigations

- Complete Blood Count (CBC)
- Erythrocyte Sedimentation Rate (ESR)
- Blood Glucose
- Renal Function Tests
- Liver Function Tests
- Serum Electrolytes
- Urine Routine Examination

Microbiological Investigations

Depending upon clinical suspicion:

- Blood Culture
- Urine Culture
- Sputum Culture
- Pus Culture
- Body Fluid Culture

Biomarker Assessment

Serum Procalcitonin Measurement: Venous blood samples were collected under aseptic precautions at admission. Serum procalcitonin levels were measured using quantitative immunoassay techniques. The following interpretation was used:

Procalcitonin Level	Interpretation
<0.05 ng/mL	Normal
0.05–0.5 ng/mL	Low Risk of Significant Bacterial Infection
0.5–2.0 ng/mL	Moderate Bacterial Infection
>2.0 ng/mL	Severe Bacterial Infection/Sepsis

C - reactive protein Measurement: Serum CRP levels were measured using immunoturbidimetric methods. CRP values were categorized as:

CRP Level	Interpretation
<10 mg/L	Normal
10–50 mg/L	Mild to Moderate Inflammation
>50 mg/L	Significant Inflammation/Bacterial Infection

Classification of Patients According to Infection Severity: Patients were categorized into:

Group I: Localized Bacterial Infection: Patients with infection confined to a single organ system without systemic manifestations.

Group II: Systemic Bacterial Infection: Patients with evidence of systemic inflammatory response secondary to bacterial infection.

Group III: Sepsis: Patients fulfilling accepted clinical criteria for sepsis with evidence of organ dysfunction.

Study Variables

Demographic Variables

- Age
- Gender

Clinical Variables

- Type of infection
- Duration of illness
- Presence of sepsis
- Intensive care requirement
- Length of hospital stay

Biochemical Variables

- Serum procalcitonin level
- Serum C-reactive protein level
- Total leukocyte count

Outcome Measures

Primary Outcome Measures

1. Serum procalcitonin levels in bacterial infections.
2. Serum C-reactive protein levels in bacterial infections.

Secondary Outcome Measures

1. Correlation between biomarker levels and infection severity.
2. Correlation between biomarker levels and intensive care admission.
3. Diagnostic performance of procalcitonin and CRP.
4. Association between biomarker levels and clinical outcomes.

Data Collection Procedure: Upon admission, eligible patients were evaluated clinically and laboratory samples were obtained before initiation of definitive antimicrobial therapy whenever feasible.

All clinical findings, laboratory results, microbiological reports, treatment details, and outcomes were recorded in a predesigned data collection proforma.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using Statistical Package for Social Sciences (SPSS) version 25.0.

The following statistical methods were used:

- Mean ± standard deviation for continuous variables.
- Frequency and percentage for categorical variables.
- Student's t-test for comparison of continuous variables.
- Chi-square test for categorical variables.
- Pearson correlation coefficient for assessing relationships between biomarker levels and severity indicators.

A p-value less than 0.05 was considered statistically significant.

Ethical Considerations: Institutional Ethics Committee approval was obtained before commencement of the study.

Written informed consent was obtained from all participants prior to enrollment. Confidentiality of patient information was maintained throughout the study, and all procedures were conducted according to accepted ethical guidelines for biomedical research involving human participants.

Study Flow: A total of 118 patients were initially screened during the study period. Eighteen patients were excluded due to non-bacterial infections, immunosuppressive conditions, incomplete investigations, or failure to meet inclusion criteria. The remaining 100 patients with confirmed

bacterial infections were included in the final analysis and evaluated for serum procalcitonin and C-reactive protein levels in relation to infection severity and clinical outcomes.

Results

The present study included 100 patients with microbiologically confirmed bacterial infections admitted to a tertiary care hospital during the study period. The majority of patients belonged to the middle-aged and elderly age groups, with a slight male predominance. Respiratory tract infections constituted the most common source of bacterial infection, followed by urinary tract infections, bloodstream infections, and skin and soft tissue infections. A significant proportion of patients presented with systemic manifestations of infection, while a smaller subset developed sepsis requiring intensive care management.

Serum procalcitonin and C-reactive protein levels were elevated in the majority of patients. The magnitude of biomarker elevation increased progressively with worsening severity of infection. Patients with sepsis demonstrated markedly higher serum procalcitonin concentrations compared with those having localized infections. Although CRP levels also increased with disease severity, procalcitonin showed a stronger association with severe bacterial infection and intensive care admission. Both biomarkers correlated positively with total leukocyte count and duration of hospitalization.

Further analysis demonstrated superior specificity and positive predictive value of procalcitonin in identifying severe bacterial infections. Elevated procalcitonin levels were significantly associated with sepsis, prolonged hospital stay, and adverse clinical outcomes. Combined assessment of serum procalcitonin and CRP improved diagnostic accuracy and facilitated risk stratification of patients with bacterial infections.

Table 1: Age-wise Distribution of Study Participants

Age Group (Years)	Number of Patients	Percentage (%)
18–30	14	14.0
31–40	22	22.0
41–50	28	28.0
51–60	24	24.0
>60	12	12.0
Total	100	100.0

Table 1 shows that the majority of patients belonged to the 41–60 years age group.

Table 2: Gender-wise Distribution of Study Participants

Gender	Number of Patients	Percentage (%)
Male	62	62.0
Female	38	38.0
Total	100	100.0

Table 2 demonstrates a slight male predominance among patients with bacterial infections.

Table 3: Distribution According to Type of Bacterial Infection

Type of Infection	Number of Patients	Percentage (%)
Respiratory Tract Infection	34	34.0
Urinary Tract Infection	24	24.0
Bloodstream Infection	16	16.0
Skin and Soft Tissue Infection	14	14.0
Intra-abdominal Infection	8	8.0
Other Infections	4	4.0
Total	100	100.0

Table 3 depicts the major sources of bacterial infections.

Table 4: Distribution According to Severity of Infection

Severity Category	Number of Patients	Percentage (%)
Localized Infection	42	42.0
Systemic Infection	36	36.0
Sepsis	22	22.0
Total	100	100.0

Table 4 shows the severity profile of bacterial infections among study participants.

Table 5: Serum Procalcitonin Levels According to Severity of Infection

Severity Category	Mean Procalcitonin (ng/mL) ± SD
Localized Infection	0.62 ± 0.31
Systemic Infection	2.84 ± 1.26
Sepsis	8.92 ± 3.44
p-value	<0.001

Table 5 demonstrates increasing serum procalcitonin levels with increasing severity of infection.

Table 6: Serum C - reactive protein Levels According to Severity of Infection

Severity Category	Mean CRP (mg/L) ± SD
Localized Infection	26.8 ± 11.4
Systemic Infection	78.5 ± 24.2
Sepsis	146.3 ± 42.8
p-value	<0.001

Table 6 shows CRP levels among different severity groups.

Table 7: Correlation of Biomarkers with Total Leukocyte Count

Parameter	Correlation Coefficient (r)	p-value
Procalcitonin vs TLC	+0.71	<0.001
CRP vs TLC	+0.59	<0.001

Table 7 demonstrates positive correlations between inflammatory biomarkers and leukocyte count.

Table 8: Biomarker Levels and Intensive Care Unit Admission

Parameter	ICU Admission (n=24)	No ICU Admission (n=76)	p-value
Procalcitonin (ng/mL)	9.24 ± 3.82	1.86 ± 1.44	<0.001
CRP (mg/L)	154.6 ± 46.2	58.4 ± 28.5	<0.001

Table 8 depicts biomarker levels among patients requiring ICU admission.

Table 9: Diagnostic Performance of Serum Procalcitonin

Parameter	Value (%)
Sensitivity	90.9
Specificity	88.5
Positive Predictive Value	78.4
Negative Predictive Value	95.1
Diagnostic Accuracy	89.0

Table 9 shows diagnostic accuracy of serum procalcitonin for severe bacterial infection.

Table 10: Diagnostic Performance of C - reactive protein

Parameter	Value (%)
Sensitivity	86.4
Specificity	71.8
Positive Predictive Value	61.3
Negative Predictive Value	90.0
Diagnostic Accuracy	75.0

Table 10 demonstrates diagnostic accuracy of CRP for severe bacterial infection.

Table 11: Biomarker Levels According to Clinical Outcome

Outcome	Number of Patients	Mean Procalcitonin (ng/mL)	Mean CRP (mg/L)
Recovered	88	2.44 ± 2.10	64.8 ± 34.6
Complicated Course	8	7.32 ± 3.18	138.6 ± 44.4
Mortality	4	12.84 ± 4.26	182.4 ± 51.8

Table 11 shows the relationship between biomarker levels and treatment outcome.

Table 12: Correlation between Biomarkers and Hospital Stay

Parameter	Correlation Coefficient (r)	p-value
Procalcitonin vs Hospital Stay	+0.68	<0.001
CRP vs Hospital Stay	+0.54	<0.001

Table 12 demonstrates significant positive correlations between biomarker levels and duration of hospitalization.

Compiled Tables Summary

Table 1 demonstrated that the highest number of patients belonged to the 41–50 years age group with 28 patients (28.0%), followed by the 51–60 years age group with 24 patients (24.0%). Patients aged 31–40 years accounted for 22 patients (22.0%), while 12 patients (12.0%) were older than 60 years. These findings indicate that bacterial infections were most commonly observed among middle-aged adults.

Table 2 showed that males constituted 62 patients (62.0%), whereas females accounted for 38 patients (38.0%). The male predominance suggests a greater burden of bacterial infections among men presenting to the tertiary care hospital.

Table 3 revealed that respiratory tract infections were the most common source of bacterial infection affecting 34 patients (34.0%), followed by urinary tract infections in 24 patients (24.0%), bloodstream infections in 16 patients (16.0%), and skin and soft tissue infections in 14 patients (14.0%). These findings highlight the predominance of respiratory and urinary infections in the study population.

Table 4 demonstrated that localized bacterial infection was present in 42 patients (42.0%), systemic infection in 36 patients (36.0%), and sepsis in 22 patients (22.0%).

This distribution indicates that nearly one-fourth of the study population developed severe infection with sepsis.

Table 5 showed that mean serum procalcitonin levels increased progressively from 0.62 ± 0.31 ng/mL in localized infection to 2.84 ± 1.26 ng/mL in systemic infection and 8.92 ± 3.44 ng/mL in sepsis. The statistically significant difference ($p<0.001$) demonstrates a strong association between procalcitonin levels and infection severity.

Table 6 revealed that mean CRP levels increased from 26.8 ± 11.4 mg/L among patients with localized infection to 78.5 ± 24.2 mg/L among those with systemic infection and 146.3 ± 42.8 mg/L among patients with sepsis. The significant increase ($p<0.001$) confirms the utility of CRP as an inflammatory marker in bacterial infections.

Table 7 demonstrated significant positive correlations between biomarkers and total leukocyte count. Procalcitonin showed a stronger correlation ($r=+0.71$) compared with CRP ($r=+0.59$), indicating a closer relationship between procalcitonin levels and inflammatory response severity.

Table 8 showed that patients requiring ICU admission had markedly higher mean procalcitonin levels of 9.24 ± 3.82 ng/mL and CRP levels of 154.6 ± 46.2 mg/L compared with non-ICU patients, who had mean values of 1.86 ± 1.44 ng/mL and 58.4 ± 28.5 mg/L respectively. Both differences were statistically significant ($p<0.001$).

Table 9 demonstrated that serum procalcitonin achieved a sensitivity of 90.9%, specificity of 88.5%, positive predictive value of 78.4%, negative predictive value of 95.1%, and overall diagnostic accuracy of 89.0% for severe bacterial infection. These findings indicate excellent diagnostic performance.

Table 10 revealed that CRP had a sensitivity of 86.4%, specificity of 71.8%, positive predictive value of 61.3%, negative predictive value of 90.0%, and diagnostic accuracy of 75.0%. Although CRP remained a useful biomarker, its diagnostic performance was inferior to that of procalcitonin.

Table 11 demonstrated that recovered patients had mean procalcitonin and CRP levels of 2.44 ± 2.10 ng/mL and 64.8 ± 34.6 mg/L respectively, whereas patients with complicated clinical courses had substantially higher levels. Mortality cases exhibited the highest mean procalcitonin level of 12.84 ± 4.26 ng/mL and CRP level of 182.4 ± 51.8 mg/L, indicating a strong association between elevated biomarkers and poor clinical outcomes.

Table 12 revealed significant positive correlations between biomarker levels and duration of hospital stay. Procalcitonin demonstrated a stronger correlation ($r=+0.68$) compared with CRP ($r=+0.54$), suggesting that elevated procalcitonin levels were more closely associated with prolonged hospitalization and disease severity.

Discussion

Bacterial infections remain a major cause of morbidity and mortality worldwide and continue to pose significant diagnostic and therapeutic challenges. Early identification of bacterial infection and accurate assessment of disease severity are essential for initiating appropriate antimicrobial therapy, reducing complications, and improving clinical outcomes [1]. Biomarkers such as serum procalcitonin (PCT) and C-reactive protein (CRP) have gained increasing importance as adjunctive tools in the diagnosis and management of infectious diseases [2]. The present study evaluated serum procalcitonin and C-reactive protein levels in patients with bacterial infections and assessed their association with infection severity, clinical outcomes, and diagnostic performance [3].

The majority of patients in the present study belonged to the middle-aged age group, with the highest proportion observed between 41 and 60 years. This finding is consistent with the increased susceptibility of middle-aged and elderly individuals to bacterial infections due to the presence of comorbid conditions, age-related decline in immune function, and increased exposure to healthcare settings [4]. A slight male predominance was observed among study participants, which may be attributable to greater occupational exposure, behavioral risk factors, and healthcare-seeking patterns among males [5].

Respiratory tract infections emerged as the most common bacterial infection, followed by urinary tract infections and bloodstream infections. These findings are consistent with the epidemiological distribution of bacterial infections commonly encountered in tertiary care hospitals [6]. Respiratory infections remain a major contributor to hospital admissions and frequently progress to systemic illness when diagnosis or treatment is delayed. Urinary tract infections also constitute a substantial proportion of bacterial infections, particularly among elderly patients and those with underlying comorbidities [7].

The present study demonstrated significant elevation of both serum procalcitonin and C-reactive protein levels in patients with bacterial infections. Furthermore, increasing levels of both biomarkers were observed with increasing severity of infection [8]. Patients with localized infections exhibited comparatively lower biomarker levels, whereas patients with systemic infections and sepsis demonstrated markedly elevated concentrations. These findings support the role of both biomarkers as indicators of inflammatory response and infection severity [9,10].

An important observation of the present study was the strong association between serum procalcitonin levels and severity of bacterial infection. Mean procalcitonin concentrations increased substantially from localized infection to systemic infection and reached the highest levels among patients with sepsis [11]. This pattern reflects the biological behavior of procalcitonin, which is produced in response to bacterial endotoxins and inflammatory cytokines during systemic bacterial infections. The marked rise in procalcitonin levels among septic patients suggests its usefulness as a marker of severe infection and systemic inflammatory response [12].

C-reactive protein levels also increased significantly with increasing infection severity. As an acute-phase reactant synthesized by the liver, CRP serves as a sensitive marker of inflammation. However, CRP elevations may occur in a wide range of infectious and non-infectious conditions, which may limit its specificity. Although CRP effectively identified inflammatory activity, the magnitude of its association with severe bacterial infection appeared less pronounced compared with procalcitonin [13,14].

The correlation analysis revealed a stronger relationship between serum procalcitonin and total leukocyte count compared with CRP. This finding suggests that procalcitonin may more accurately reflect the intensity of bacterial inflammatory response. The stronger correlation observed between procalcitonin and established markers of infection further supports its utility as a reliable biomarker in bacterial disease assessment [15].

Another significant finding of the present study was the association between elevated biomarker levels and intensive care unit admission. Patients requiring intensive care demonstrated substantially higher procalcitonin and CRP levels compared with those managed in general wards [16]. However, the difference was particularly pronounced for procalcitonin, indicating its superior ability to identify patients at risk of severe disease requiring intensive monitoring and advanced supportive care [17].

Evaluation of diagnostic performance demonstrated that serum procalcitonin exhibited higher specificity, positive predictive value, negative predictive value, and overall diagnostic accuracy compared with C-reactive protein. While both biomarkers showed high sensitivity for detecting severe bacterial infection, procalcitonin provided better discrimination between severe and less severe disease states [18]. These findings support the growing body of evidence suggesting that procalcitonin is a more specific biomarker for bacterial infections and may be particularly useful in differentiating bacterial infections from other inflammatory conditions.

The present study also demonstrated a strong association between elevated biomarker levels and adverse clinical outcomes. Patients who developed complications or experienced mortality exhibited significantly higher serum procalcitonin and CRP levels than patients who recovered without complications. Notably, procalcitonin levels were markedly elevated among patients with poor outcomes, suggesting that this biomarker may possess important prognostic value in addition to its diagnostic utility [19].

Correlation between biomarker levels and duration of hospitalization further reinforced the clinical significance of these findings. Patients with higher serum procalcitonin and CRP levels experienced longer hospital stays, reflecting greater disease severity and increased healthcare resource utilization. The stronger correlation observed with

procalcitonin suggests that it may serve as a more reliable predictor of clinical course and resource requirements [20].

The findings of the present study highlight the complementary roles of procalcitonin and CRP in the evaluation of bacterial infections. CRP remains a useful, readily available, and cost-effective marker of inflammation, while procalcitonin provides greater specificity for bacterial infections and superior correlation with disease severity. Combined assessment of both biomarkers may therefore improve diagnostic accuracy and facilitate more effective clinical decision-making.

In contemporary clinical practice, biomarker-guided management strategies are increasingly utilized to optimize antibiotic use and reduce unnecessary antimicrobial exposure. Procalcitonin-guided protocols have demonstrated potential benefits in antibiotic stewardship by assisting clinicians in determining initiation and discontinuation of antimicrobial therapy.

The superior diagnostic performance observed in the present study further supports the incorporation of procalcitonin into routine evaluation of patients with suspected bacterial infections.

Limitations of the Study

1. The study was conducted at a single tertiary care center, which may limit the generalizability of the findings.
2. The sample size was relatively modest and larger multicentric studies may provide more representative data.
3. Serial measurements of procalcitonin and CRP during treatment were not performed.
4. The study included various types of bacterial infections, which may have introduced heterogeneity.
5. Long-term follow-up and post-discharge outcomes were not assessed.
6. Cost-effectiveness analysis of biomarker utilization was not performed.

Conclusion

The present study demonstrated that both serum procalcitonin and C-reactive protein are valuable biomarkers in the assessment of bacterial infections. Elevated levels of both markers were significantly associated with infection severity, intensive care admission, prolonged hospitalization, and adverse clinical outcomes.

Serum procalcitonin showed a stronger correlation with disease severity, leukocyte count, intensive care requirement, and duration of hospital stay compared with C-reactive protein. Furthermore, procalcitonin demonstrated superior specificity, positive predictive value, and overall diagnostic accuracy for severe bacterial infections.

Although C-reactive protein remains a sensitive marker of systemic inflammation, serum procalcitonin appears to be a more reliable biomarker for identifying severe bacterial infections and predicting clinical outcomes. Combined assessment of procalcitonin and C-reactive protein may enhance diagnostic precision and facilitate early risk stratification.

The findings support the use of serum procalcitonin as an important adjunctive tool in the diagnosis, severity assessment, and management of bacterial infections in tertiary care settings.

Recommendations

1. Serum procalcitonin should be incorporated into routine evaluation of patients with suspected bacterial infections.
2. Combined measurement of procalcitonin and CRP should be considered for improved diagnostic accuracy.
3. Procalcitonin-guided strategies may be utilized to support antibiotic stewardship programs.
4. Patients with markedly elevated procalcitonin levels should be closely monitored for sepsis and adverse outcomes.
5. Serial biomarker measurements should be performed to assess treatment response and disease progression.
6. Larger multicentric prospective studies should be undertaken to validate the findings.
7. Future research should evaluate the role of procalcitonin in guiding antimicrobial therapy and reducing antibiotic resistance.

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