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SERUM PROCALCITONIN VERSUS C-REACTIVE PROTEIN FOR EARLY DIAGNOSIS OF SEPSIS IN THE EMERGENCY DEPARTMENT

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ABSTRACT

Background: Sepsis is a life-threatening condition that needs prompt diagnosis, and timely intervention, particularly in the emergency department where clinical features are often non-specific. The use of biomarkers like serum procalcitonin and C-reactive protein (CRP) is common for early recognition of infection and systemic inflammation.
Objective: To compare the diagnostic performance of serum procalcitonin and C-reactive protein for early diagnosis of sepsis among patients presenting to the emergency department.
Methods: The comparative diagnostic study was carried out at Kabir Medical College, Peshawar, from January 2025 to June 2025. There were 82 patients with suspected infection. Demographic data, clinical features, and suspected source of infection, serum procalcitonin, C-reactive protein, total leukocyte count, serum lactate, blood culture results, ICU admission, requirement of vasopressors, and mortality were documented. Patients were included in sepsis and non-sepsis groups. The performance of the two markers, serum procalcitonin and CRP was evaluated using sensitivity, specificity, positive predictive value, negative predictive value and overall accuracy.
Results: Out of 82 patients, 50 (61.0%) were diagnosed with sepsis and 32 (39.0%) were classified as non-sepsis cases. Mean serum procalcitonin was significantly higher in the sepsis group compared with the non-sepsis group (5.82 ± 3.41 ng/mL vs 0.91 ± 0.58 ng/mL; $p < 0.001$). Mean C-reactive protein was also significantly increased in sepsis patients (96.4 ± 41.8 mg/L vs 48.7 ± 26.5 mg/L; $p < 0.001$). Procalcitonin showed sensitivity, specificity, positive predictive value, negative predictive value, and accuracy of 88.0%, 75.0%, 84.6%, 80.0%, and 82.9%, respectively. Corresponding values for C-reactive protein were 82.0%, 59.4%, 75.9%, 67.9%, and 73.2%.
Conclusion: Serum procalcitonin demonstrated better diagnostic accuracy than C-reactive protein for early diagnosis of sepsis in emergency department patients. Although both biomarkers were significantly elevated in sepsis, procalcitonin showed higher specificity and overall accuracy, making it a more reliable supportive marker for early sepsis identification.

KEYWORDS: Sepsis, procalcitonin, C-reactive protein, emergency department, diagnostic accuracy, biomarkers

INTRODUCTION

Sepsis is serious medical emergency in which the body mounts an out-of-control response to infection that can result in organ dysfunction and a higher likelihood of death. Sepsis can quickly deteriorate the patient's condition, and early diagnosis and treatment are extremely important. Highly important in the ED setting as this may be the first place of contact for patients with acute infection, shock, fever, altered mental status or respiratory distress [1-3].
In the early stages, clinical signs and symptoms are not specific and diagnosing sepsis can be difficult. Tachycardia, tachycardia, fever, hypotension, and alterations in mental status can be associated with sepsis but are also seen in a variety of non-infectious inflammatory diseases. Likewise, routine blood tests like total leukocyte count can be altered during infection, stress, and trauma, if taking steroids or having a chronic inflammatory condition. Thus, there is a need for supplementing clinical judgment with other biomarkers to enhance diagnostic precision in the early stage of diagnosis[4-6].
C-reactive protein is one of the most widely used markers of inflammation clinically. It is readily available, is cheap, and can be easily measured. CRP will rise with inflammation and infection but not specific to bacterial sepsis. Inflammatory conditions such as auto-immune disorders, trauma, malignancy and post-operative states may also lead

to raised levels of CRP. This restricts its use to distinguish sepsis from non-septic inflammation, particularly those of the emergency setting who are acutely ill [7-9].
Procalcitonin has been the focus of interest as a more specific marker for bacterial infection and for sepsis. It typically increases when bacterial infection is present in the body and can help differentiate bacterial septicemia from viral or non-infectious inflammatory diseases. Procalcitonin may increase earlier than CRP, and may have a more significant relationship to the severity of infection. Because of this, it is becoming more common to be used as an auxiliary tool for the early diagnosis of sepsis, risk stratification, and antibiotic prescription [10-12].
Although these biomarkers are useful, no single test is 100% accurate in diagnosis of sepsis. Diagnosis of sepsis is based on clinical assessment, vital signs, assessment of organ dysfunction, laboratory data and response to therapy, in addition to microbiological results. Use of biomarkers should therefore be considered complementary, not supplanting clinical judgment. Procalcitonin versus CRP in emergency department patients may assist to determine which markers are more useful in the diagnosis of early sepsis [13, 14].
The present study was conducted to compare serum procalcitonin and C-reactive protein for early diagnosis of sepsis among patients presenting to the emergency department. The study aimed to assess and compare the sensitivity, specificity, positive predictive value, negative predictive value, and overall diagnostic accuracy of both biomarkers, using final clinical diagnosis of sepsis as the reference standard.

METHODOLOGY

This study was conducted as a comparative diagnostic study at Kabir Medical College, Peshawar**,** from January 2025 to June 2025. The study was designed to compare the diagnostic value of serum procalcitonin and C-reactive protein for the early diagnosis of sepsis among patients presenting to the emergency department. A total of 82 patients with suspected infection were included during the study period. Patients were enrolled after clinical evaluation in the emergency department, and all relevant demographic, clinical, and laboratory data were recorded on a structured proforma.
Eligible patients were all adults with clinical suspicion of infection. Patients were chosen because they presented to the Emergency Department with signs and symptoms of systemic infection (fever, tachycardia, tachypnea, hypotension, altered mental status). To minimise the likelihood of confounding in biomarker interpretation, patients were excluded if they had received long courses of antibiotics prior to presentation; had undergone recent major surgery or trauma; had known autoimmune or chronic inflammatory disease; or had incomplete laboratory records.
All patients were then carefully clinically evaluated after enrollment. Demographic data (age, gender) was obtained. At the time of presentation, clinical parameters recorded include body temperature, pulse rate, respiratory rate, blood pressure, oxygen saturation, and mental status. Clinical diagnosis was used to determine the suspected source of infection which was classified as respiratory tract infection, urinary tract infection, abdominal infection, skin and soft tissue infection, or unknown source. Patients were subsequently dichotomized into a sepsis group and a non-sepsis group according to physical examination and laboratory studies and using traditional criteria for the diagnosis of sepsis.
Wherever possible, blood samples were taken on emergency presentation before starting or increasing antibiotic therapy. Standard laboratory methods were used to measure the concentrations of procalcitonin and C-reactive protein (CRP) in the serum. Further laboratory tests such as total leucocyte count, differential leucocyte count, platelet count, lactate measurement, renal function tests and blood culture were ordered as clinically appropriate. Blood cultures were taken aseptically before giving antibiotics if possible.
The primary outcome measure was the final diagnosis of sepsis. The serum procalcitonin level and C-reactive protein level were the primary independent variables. Other variables were: age, sex, clinical characteristics, suspected source of infection, total leukocyte count, serum lactate, blood cultures positive, admission to the intensive care unit (ICU), use of vasopressors, and mortality after hospitalization. The levels of the biomarkers were compared between the sepsis and non-sepsis patients to see how useful they were in the emergency setting.
Evaluation of diagnostic performance was performed independently for the two serum markers: procalcitonin and C-reactive protein. True-positive, false-positive, true-negative and false-negative values were determined for both markers with the reference standard being the final clinical diagnosis of sepsis. The sensitivity, specificity, positive and negative predictive values, and overall diagnostic accuracy were determined by standard formulas for diagnostic accuracy. The performance of the procalcitonin test was then evaluated versus the C-reactive protein test.
Data were entered and analysed with the statistical software. For quantitative variables, like age, procalcitonin, CRP, total leucocyte count and serum lactate, the mean and standard deviation were calculated. Qualitative variables including gender, clinical features, source of infection, whether sepsis or not, whether the culture was positive, whether the patient was admitted to the Intensive Care Unit, requirement for vasopressors, and mortality were summarized as frequencies and percentages. An independent sample t-test for continuous variables and a chi-square test for

categorical variables were used for comparing the two groups (sepsis and non-sepsis). P value of <0.05 was considered statistically significant.

RESULTS

Total, 82 patients who attended the ED with suspected infection were studied. The average age of the patients was 49.8 ± 16.7 years. There were slightly more males than females. For each patient, the sepsis diagnosis was made (50 patients) or not (32 patients) according to clinical assessment and sepsis criteria. The most common clinical parameters in the examined population were fever, tachycardia and tachypnea.

Table 1. Baseline demographic and clinical characteristics of patients

Variable	Frequency / Mean
Total patients	82
Mean age	49.8 ± 16.7 years
Male	47 (57.3%)
Female	35 (42.7%)
Sepsis cases	50 (61.0%)
Non-sepsis cases	32 (39.0%)
Fever	63 (76.8%)
Tachycardia	58 (70.7%)
Tachypnea	49 (59.8%)
Hypotension	34 (41.5%)
Altered mental status	21 (25.6%)

Infections of the respiratory tract, urinary tract and abdominal infection were identified as the top three suspected source of infections. There was a smaller proportion of patients with skin and soft tissue infection and some patients were unable to identify the source of infection at presentation.

Table 2. Distribution of suspected source of infection

Source of infection	Frequency	Percentage
Respiratory tract infection	27	32.9%
Urinary tract infection	21	25.6%
Abdominal infection	15	18.3%
Skin and soft tissue infection	10	12.2%
Unknown source	9	11.0%
Total	**82**	**100.0%**

Serum procalcitonin and C-reactive protein levels were both higher among patients diagnosed with sepsis compared with non-sepsis patients. But this difference became more apparent for serum procalcitonin between the sepsis and non-sepsis groups. The mean procalcitonin level was 5.82±3.41 ng/mL in sepsis patients and 0.91±0.58 ng/mL in non-sepsis patients. Mean CRP level was also higher in the sepsis group than in the non-sepsis group (96.4 ± 41.8 mg/L versus 48.7 ± 26.5 mg/L, respectively). The difference in both was significant at $p<0.05$.

Table 3. Comparison of laboratory parameters between sepsis and non-sepsis groups

Laboratory parameter	Sepsis group n=50	Non-sepsis group n=32	p-value
Procalcitonin, ng/mL	5.82 ± 3.41	0.91 ± 0.58	<0.001
C-reactive protein, mg/L	96.4 ± 41.8	48.7 ± 26.5	<0.001
Total leukocyte count, ×10⁹/L	15.8 ± 5.4	10.9 ± 3.7	<0.001
Serum lactate, mmol/L	3.4 ± 1.6	1.8 ± 0.9	<0.001

Sepsis was seen in 44/50 (88%) patients with raised procalcitonin and 8/32 (25%) patients with normal procalcitonin. A total of 41 of 50 (82%) sepsis patients and 13 of 32 (41%) non-sepsis patients had raised CRP. The results indicate that procalcitonin did not have as many false positive results as CRP, indicating that it may be more effective at distinguishing a septic from a non-septic inflammatory condition.

Table 4. Cross-tabulation of raised biomarkers with final diagnosis

Biomarker status	Sepsis n=50	Non-sepsis n=32	Total
Raised procalcitonin	44	8	52
Normal procalcitonin	6	24	30
Raised CRP	41	13	54

Normal CRP	9	19	28

The level of serum procalcitonin had better diagnostic performance than that of C-reactive protein. The sensitivity of procalcitonin was 88.0% with a specificity of 75.0%. Contrastively, CRP had a sensitivity of 82.0%, and a specificity of 59.4%. Overall, the accuracy of procalcitonin was higher (82.9%) than that of CRP (73.2%).

Table 5. Diagnostic performance of serum procalcitonin and C-reactive protein

Diagnostic parameter	Procalcitonin	C-reactive protein
True positive	44	41
False positive	8	13
True negative	24	19
False negative	6	9
Sensitivity	88.0%	82.0%
Specificity	75.0%	59.4%
Positive predictive value	84.6%	75.9%
Negative predictive value	80.0%	67.9%
Diagnostic accuracy	82.9%	73.2%

Clinical results were complicated by 26 patients requiring admission to the ICU, 18 patients requiring vasopressor support, and 11 patients dying in hospital. Twenty-eight patients had blood cultures that were positive. Patients with raised procalcitonin were more likely to have a positive blood culture, to require intensive care, to need vasopressors and to die than patients with normal or mildly raised procalcitonin levels.

Table 6. Clinical outcomes among study participants

Outcome	Frequency	Percentage
Blood culture positive	28	34.1%
ICU admission	26	31.7%
Vasopressor requirement	18	22.0%
In-hospital mortality	11	13.4%

Overall, the results suggest that both procalcitonin and C-reactive protein could be useful biomarkers for early diagnosis of sepsis in patients in the emergency department. However, serum procalcitonin was more specific, had a higher negative predictive value and good overall diagnostic accuracy compared with C-reactive protein, which makes it a better marker for early discrimination of sepsis from non-septic inflammatory diseases.

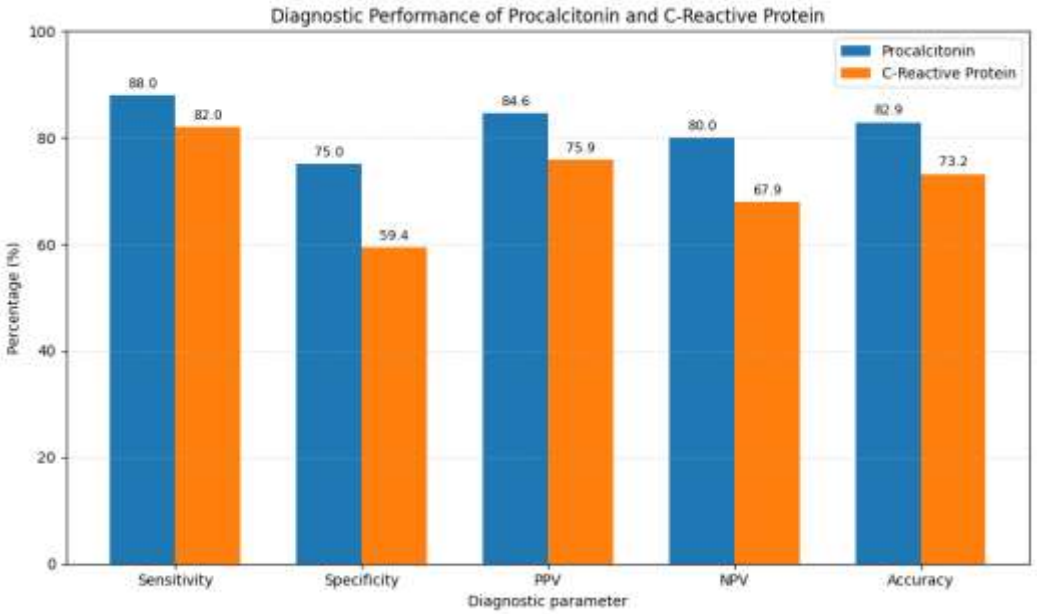

Figure 1. Diagnostic performance of serum procalcitonin and C-reactive protein for early diagnosis of sepsis in the emergency department. Procalcitonin showed higher sensitivity, specificity, PPV, NPV, and overall accuracy compared with C-reactive protein.

DISCUSSION

The present study compared serum procalcitonin and C-reactive protein for the early diagnosis of sepsis among patients presenting to the emergency department. Sepsis remains a time-sensitive clinical condition in which early recognition and prompt treatment strongly influence patient outcome. In emergency settings, clinical signs such as fever, tachycardia, tachypnea, hypotension, and altered mental status may raise suspicion of sepsis, but these findings are not always specific. Therefore, laboratory biomarkers are commonly used to support early clinical decision-making. In this study, both procalcitonin and CRP were significantly higher among sepsis patients compared with non-sepsis patients, but procalcitonin showed better diagnostic performance [15, 16].

The serum PCT level in the sepsis group was significantly elevated. Thus, the detection of procalcitonin appears to be more closely linked to septic inflammatory states rather than to non-septic inflammatory states. The sensitivity of procalcitonin was 88.0% and specificity was 75.0% indicating that this was not only useful in identifying patients with sepsis but also to exclude false-positive diagnosis. This is crucial in the emergency setting as there is a potential for inappropriate antibiotic use, unnecessary admission to the intensive care unit (ICU), and over investigation of non-septic inflammatory processes [17, 18].

Similarly, patients with sepsis had significantly elevated values of C-reactive protein, a strong indicator of inflammation. But CRP had less specificity than procalcitonin. Sensitivity of the CRP was 82.0 % and specificity was just 59.4 % in this study. This suggests that CRP was capable of identifying a significant number of cases of sepsis, but had limited usefulness in discriminating between sepsis and other inflammatory conditions. Trauma, autoimmune disorders, chronic inflammation, malignancy and other non-infective disorders can lead to an increase in CRP; this may contribute to the increased number of false-positive results observed. So, while still very useful, because of its convenience and low cost, CRP may not be so effective as a standalone tool to diagnose sepsis early [19].

Procalcitonin showed a higher diagnostic accuracy rate of 82.9%, as compared to CRP with a diagnostic accuracy of 73.2%. There was also better positive predictive value and negative predictive value for procalcitonin. This suggests that procalcitonin might be more useful for diagnostic purposes when clinical signs and symptoms of sepsis are present, but the diagnosis is still unclear. In emergency situations a low negative predictive value is of special importance as it can help the clinicians to realize that the patient may not require intensive treatment of sepsis, and it may be possible to observe the patient [20].

The patients with elevated procalcitonins had a higher incidence of adverse outcome including ICU admission, vasopressor requirement, and mortality in the present study. This indicates that procalcitonin might also be a parameter of disease severity, as well as a diagnostic parameter. Patients with medium to high levels of one or more biomarkers may be at risk of severe systemic infection, higher inflammatory response and hemodynamic instability. The association of CRP to sepsis was also present, but the link with severe clinical outcomes seemed to be less strong than procalcitonin [21].

This study's results support the role of procalcitonin as being a more effective early biomarker for sepsis in emergency department patients. Biomarkers should not be used in lieu of clinical judgment, however. A combination of history, physical exam, vital signs, organ dysfunction assessment, lab tests, cultures and treatment response is used to diagnose sepsis. Procalcitonin might be useful as an adjunct to clinical judgement, qSOFA or SOFA scores, lactate levels, blood culture and other standard investigations.

This study has some limitations. It was performed at one center and the sample size was only 82 patients, which limits generalizability to all emergency settings. The measurement of procalcitonin and CRP were not repeated over time, potentially adding information on the progress of this disease and its response to treatment. Not all patients with sepsis had blood cultures positive, and this may influence the definition of sepsis.All sepsis was not associated with blood culture positivity, which is often seen in clinical practice and may impact upon diagnosis. Future multicenter studies with more people and serial biomarker monitoring are suggested to validate these results and establish appropriate cut-off values for clinical use at the local level.

CONCLUSION

Serum procalcitonin and C-reactive protein were both significantly elevated among patients with sepsis presenting to the emergency department. However, serum procalcitonin showed better diagnostic performance than C-reactive protein, with higher sensitivity, specificity, positive predictive value, negative predictive value, and overall accuracy. Procalcitonin was also more strongly associated with culture positivity and adverse clinical outcomes such as ICU admission, vasopressor requirement, and mortality. These findings suggest that serum procalcitonin is a more reliable biomarker than CRP for early diagnosis of sepsis in emergency department patients. However, it should be used alongside clinical assessment and other laboratory parameters rather than as a standalone diagnostic test.

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