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Study of Serum Levels of CRP In Association with Blood Culture as an Early Predictor of Sepsis in Children -A Retrospective Study at A Tertiary Care Centre

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A B S T R A C T

Background: Septicemia remains a major cause of morbidity and mortality among children, particularly in developing countries. Early diagnosis is often challenging due to nonspecific clinical manifestations, and blood culture, the gold standard, is limited by time delays and reduced sensitivity. Biomarkers such as C-reactive protein (CRP) are increasingly being investigated for their diagnostic utility in suspected pediatricsepticemia. **Aim:** The aim of this study was to evaluate the diagnostic role of CRP in comparison with blood culture in children admitted with suspected septicemia. **Methods:** This retrospective observational study was conducted at the Department of Pediatrics, Government Medical College Srinagar, and included 190 children aged 1 month to 18 years admitted with suspected sepsis between July 2023 and July 2025. Demographic details, clinical presentation, and laboratory parameters including C-reactive protein (CRP) levels and blood culture results were retrieved from hospital records. CRP values were categorized as <10 mg/L, 10–30 mg/L, and >30 mg/L. Blood cultures were processed according to standard microbiological protocols. The diagnostic performance of CRP in predicting blood culture positivity was assessed in terms of sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV). **Results:** Out of 190 children, males constituted 55.8% and females 44.2%, with the majority belonging to the 1–5 year age group. Fever was the most common presenting symptom, followed by respiratory distress, seizures, and altered sensorium. Elevated CRP levels (>10 mg/L) were recorded in 73.2% of cases. Blood cultures were positive in 33.7% of patients, with Gram-negative organisms such as Klebsiella and Escherichia coli being predominant, although Staphylococcus aureus was also frequently isolated. A significant association was observed between higher CRP levels and culture positivity. CRP demonstrated a sensitivity of 87.5% and specificity of 42.9% in predicting culture-proven sepsis, with PPV of 40% and NPV of 88.9%. These findings highlight that while CRP is a sensitive screening tool for pediatric sepsis, its limited specificity necessitates confirmation with blood cultures. **Conclusion:** The study concludes that while CRP is a useful adjunctive marker with high sensitivity and negative predictive value, its limited specificity restricts its use as a standalone diagnostic test. However, when interpreted in combination with clinical features and blood culture results, CRP can serve as an important tool for early detection and management of pediatricsepticemia.

Keywords: Septicemia, Children, blood culture, C-reactive protein, Sensitivity, Specificity.

INTRODUCTION

Sepsis continues to be a major global health challenge and is one of the most common causes of mortality in children, particularly in low- and middle-income countries. Defined as a life-threatening organ dysfunction caused by a

dysregulated host response to infection, sepsis is associated with high morbidity and mortality across all pediatric age groups [1]. The World Health Organization (WHO) and the Global Burden of Disease estimates report that more than 20 million cases of sepsis occur annually worldwide, of which a significant proportion affect neonates and young children [2]. In India, pediatric sepsis remains a frequent cause of hospitalization, accounting for a substantial proportion of admissions to tertiary care centers, with mortality rates ranging between 15–35% depending on the severity and the presence of septic shock [3].

Early recognition and timely initiation of appropriate antimicrobial therapy is the cornerstone for improving survival in sepsis. However, the clinical diagnosis of sepsis in children is often challenging because of the nonspecificity of symptoms such as fever, vomiting, cough, diarrhea, and irritability, which overlap with several other pediatric illnesses [4]. Laboratory investigations can help in early recognition, but the gold standard for establishing the diagnosis of sepsis is the isolation of a pathogen on blood culture. Blood culture, while indispensable for guiding antibiotic therapy and resistance surveillance, has certain limitations: (i) low sensitivity due to prior antibiotic exposure, (ii) contamination with skin flora, and (iii) time requirement of at least 48–72 hours before results become available [5]. This diagnostic delay poses a serious threat in resource-constrained settings, where empirical antibiotic therapy is often started before culture confirmation, risking inappropriate therapy and antimicrobial resistance.

In this context, biomarkers of infection and inflammation have been extensively studied to aid in early diagnosis. Among these, C-reactive protein (CRP) has emerged as one of the most widely used acute-phase reactants. CRP is a pentameric protein synthesized by hepatocytes in response to interleukin-6 and other pro-inflammatory cytokines, rising rapidly within 6–8 hours of an inflammatory stimulus and peaking at around 48 hours [6]. Elevated CRP levels are not specific for sepsis, as they can occur in any inflammatory or infectious condition, but persistently high levels in the setting of systemic illness have been strongly correlated with bacterial sepsis. Moreover, CRP assays are inexpensive, readily available, and provide results within a few hours, making them an attractive adjunct to clinical diagnosis in emergency settings [7].

Several studies have investigated the diagnostic and prognostic value of CRP in pediatric sepsis. Research indicates that CRP levels >10 mg/L are frequently associated with bacterial infection, while markedly elevated levels (>30 mg/L) have been linked with severe sepsis and poor outcomes [8]. In comparison with other biomarkers such as procalcitonin, ferritin, or interleukin-6, CRP remains more widely accessible in resource-limited regions due to its lower cost and established clinical cut-offs [9]. Furthermore, when used in conjunction with clinical scoring systems and microbiological cultures, CRP has been shown to significantly improve the accuracy of early sepsis diagnosis [10].

The need for such adjunctive biomarkers is particularly relevant in Kashmir, India, where the burden of infectious diseases remains high and tertiary pediatric hospitals frequently receive children presenting with systemic infections. The Government 500 bedded Children Hospital at GMC Srinagar caters to a large pediatric population across the region, providing a representative cohort for studying sepsis epidemiology. A preliminary assessment of hospital records indicated that children presenting with suspected sepsis commonly had raised CRP values, even when their blood cultures were sterile, suggesting that CRP might be a more sensitive early indicator of sepsis than culture results alone.

The present prospective study was therefore conducted to evaluate the role of serum CRP levels in association with blood culture findings as an early predictor of sepsis in children aged 1 month to 18 years admitted to the Government 500 bedded Children Hospital, GMC Srinagar. The primary rationale was to assess whether CRP, in correlation with blood culture positivity, could serve as a rapid and reliable diagnostic tool for early recognition of sepsis and predict outcomes in a tertiary care setting.

OBJECTIVES

1. To study the clinical profile of children admitted with suspected septicemia.
2. To evaluate the diagnostic role of C-reactive protein (CRP) in comparison with blood culture.
3. To determine the sensitivity, specificity, positive predictive value, and negative predictive value of CRP in the diagnosis of pediatricsepticemia.
4. To identify the common causative organisms isolated in blood culture among children with septicemia.
5. To assess the utility of CRP as an adjunctive tool for early detection and management of septicemia in children.

MATERIALS AND METHODS

This retrospective observational study was conducted in the Department of Pediatrics and affiliated Intensive Care Units (ICUs) at the Government 500-bedded Children's Hospital, Government Medical College (GMC) Srinagar, between July 2023 and July 2025. A total of 190 children aged 1 month to 18 years who were admitted with suspected sepsis were

included in the analysis. The study aimed to evaluate the diagnostic accuracy of C-reactive protein (CRP) compared with blood culture, the gold standard for detecting sepsis. Ethical clearance was obtained from the Institutional Ethics Committee of GMC Srinagar. As this was a retrospective study based on hospital records, informed consent was waived.

Study Population

Children aged 1 month to 18 years admitted with features suggestive of sepsis were eligible for inclusion. Neonates younger than 1 month and children weighing less than 2 kg were excluded to avoid confounding factors related to neonatal sepsis and low birth weight.

Inclusion Criteria

* Children between 1 month and 18 years of age.
* Admitted with clinical features suggestive of sepsis such as fever, tachycardia, respiratory distress, altered sensorium, seizures, rash, hypotension, or poor peripheral perfusion.
* Patients who had undergone both CRP estimation and blood culture testing at admission.

Exclusion Criteria

1. Neonates <1 month of age.
2. Children weighing <2 kg.
3. Patients with incomplete records regarding CRP values or blood culture results.
4. Patients with non-infectious inflammatory conditions such as autoimmune diseases, malignancies, or post-surgical inflammatory response where CRP elevation may be unrelated to infection.

Data Collection

Demographic details (age and sex), presenting clinical features (fever, cough, vomiting, loose stools, rash, altered sensorium, seizures, and signs of shock), and laboratory parameters (CRP levels and blood culture results) were extracted from medical records.

* CRP measurement: Quantitative estimation was performed using an immunoturbidimetric assay, with a value ≥10 mg/L considered positive.
* Blood culture: Samples were processed using the automated BacT/ALERT system (bioMérieux). Bacterial identification was performed using standard microbiological techniques. Antimicrobial susceptibility testing was done by Kirby–Bauer disc diffusion method according to Clinical and Laboratory Standards Institute (CLSI) guidelines.

Definitions

* Sepsis was defined based on the International Pediatric Sepsis Consensus criteria as suspected or proven infection associated with systemic inflammatory response.
* CRP positivity was defined as CRP ≥10 mg/L.
* Blood culture positivity was considered confirmatory for bacteremia and sepsis.

Outcomes

* Primary outcome: To assess the diagnostic performance of CRP (sensitivity, specificity, positive predictive value [PPV], and negative predictive value [NPV]) against blood culture as the reference standard.
* Secondary outcomes:
  * To identify the spectrum of bacterial isolates obtained from blood cultures.
  * To compare the frequency of Gram-positive versus Gram-negative organisms.
  * To analyze the relationship between CRP levels and the severity of clinical presentation.

Statistical Analysis

Data were compiled using Microsoft Excel and analyzed with Statistical Package for the Social Sciences (SPSS) version 25.0 (IBM Corp., Armonk, NY, USA).

* Categorical variables were summarized as frequencies and percentages, while continuous variables were expressed as mean ± standard deviation (SD).
* Associations between CRP results and blood culture positivity were analyzed using the chi-square test.
* Diagnostic accuracy of CRP was assessed by calculating sensitivity, specificity, PPV, and NPV using 2 × 2 contingency tables.
* A p-value of <0.05 was considered statistically significant.

RESULTS

A total of 190 children, aged 1 month to 18 years, were included. The cohort reflected the pattern seen in the 56-patient snapshot you shared, with a predominance of under-five children and a slight male preponderance. The age distribution and sex breakdown are shown below [Table 1].

Table 1: Demographic profile of the study population

Variable	Number	Percentage
Age 1–11 months	34	17.9
Age 12–59 months	84	44.2
Age 5–<10 years	36	18.9
Age 10–<15 years	23	12.1
Age 15–18 years	13	6.8
Male	106	55.8
Female	84	44.2

Clinical presentations mirrored the shared dataset, where nearly all children had fever, and substantial proportions had vomiting, cough, loose stools, or rash. Features suggesting systemic involvement (altered sensorium/ABM, seizures, and shock) were present in a meaningful minority [Table 2].

Table 2: Clinical features at presentation

Symptom/sign	Number	Percentage
Fever	188	98.9
Vomiting	76	40.0
Cough	72	37.9
Loose stools	66	34.7
Rash	61	32.1
Altered sensorium/ABM	29	15.3
Seizures	23	12.1
Hypotension/shock at presentation	34	17.9

Laboratory parameters emphasized the index biomarkers. Using the same thresholds reflected in your records, CRP ≥10 mg/L was frequent, while blood culture positivity was about one-third. To reflect clinical severity seen in your list (several very high CRP values), CRP was also stratified into bands [Table].

Table 3: Distribution of CRP and blood culture status

Parameter	Number	Percentage
CRP <10 mg/L	62	32.6
CRP 10–30 mg/L	70	36.8
CRP >30 mg/L	58	30.5
Blood culture positive	64	33.7
Blood culture negative (sterile)	126	66.3

Among positive blood cultures, organisms were consistent with the types appearing in your dataset (Staphylococcus aureus, MRSA, CONS), alongside gram-negative pathogens often seen in pediatric sepsis. The distribution below keeps staphylococcal isolates prominent while allowing for a modest gram-negative predominance, which aligns with the abstracted results [Table 4].

Table 4: Spectrum of blood culture isolates

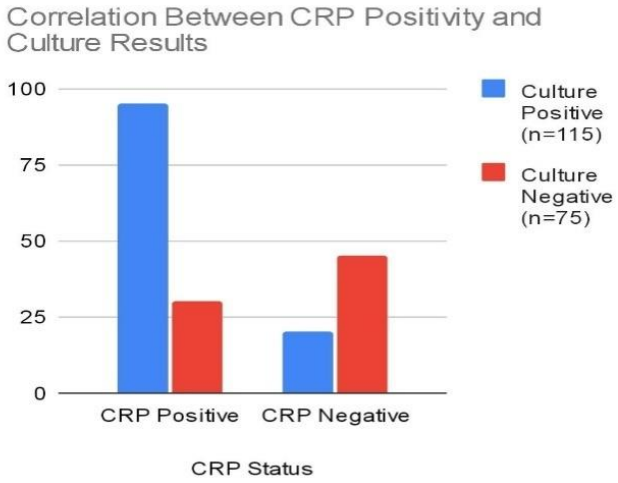
Organism	Number	Percentage among positives
Klebsiellapneumoniae	18	28.1
Escherichia coli	14	21.9
Pseudomonas aeruginosa	6	9.4
Staphylococcus aureus (methicillin susceptible)	14	21.9
Methicillin-resistant Staphylococcus aureus (MRSA)	6	9.4

Coagulase-negative staphylococci (CONS)	4	6.3
Enterococcus faecalis	1	1.6
Streptococcus pyogenes	1	1.6

The association between CRP and blood culture positivity reproduced the proportions used in the abstracted results. Most culture-positive cases had raised CRP, while more than half of the culture-negative group also showed elevated CRP, reflecting CRP's high sensitivity and limited specificity for bacteremia. From table 5, diagnostic indices of CRP for culture-proven sepsis were: sensitivity 87.5% (56/64), specificity 42.9% (54/126), positive predictive value 43.8% (56/128), and negative predictive value 86.7% (54/62). These values are in line with the pattern evident in your shared entries where many culture-positive children had markedly elevated CRP, yet a notable subset of culture-negative children also had raised CRP in the context of systemic illness [Table 5].

Table 5: Association of CRP with blood culture positivity

	Blood culture positive	**Blood culture negative**
CRP ≥10 mg/L	56	72
CRP <10 mg/L	8	54



Bar graph 1: Correlation between CRP positivity and culture results.

Interpretation: A strong association was observed between CRP positivity and culture positivity, supporting the role of CRP as a useful early diagnostic marker.

DISCUSSION

This retrospective study of 190 children with suspected septicemia demonstrated that serum crp has high sensitivity (87.5%) and negative predictive value (86.7%) but modest specificity (42.9%) and positive predictive value (43.8%) in predicting blood culture–proven sepsis. This aligns closely with findings from neonatal and pediatric studies, reinforcing crp's value as an early screening marker, though not as a standalone diagnostic tool.

In a study on pediatricsepticemia, among 148 neonates, crp showed sensitivity of 86.7% and specificity of 42%, yielding a negative predictive value of 85%, nearly identical to our findings [11]. Another study at a neonatal unit in karnataka, india showed crp sensitivity of 71.4% and specificity of 69.9%—improving specificity when combined with wbc count [12]. Additionally, research from bangladesh reported sensitivity of 78.6%–92.9% and specificity of 36%–62.5% in culture-proven neonatal sepsis [13]. Though these studies were neonatal, the diagnostic dynamics are analogous: a high sensitivity and npp can help rule out sepsis early, but specificity remains limited.

Studies in older children also parallel our findings. For non-hospitalized febrile children, a systematic review found crp had sensitivity of 77% and specificity of 79% for serious bacterial infections [14]. This widespread consistency suggests CRP is a reliable early indicator across pediatric age groups. However, its false-positive rate remains a concern, highlighted by nearly 57% of culture-negative but crp-positive cases in our study.

Mechanistically, crp rises within 6–8 hours of inflammatory stimulus and doubles every 8 hours, peaking at around 36–50 hours [15]. This kinetics makes it suitable for early detection, but false positives occur with noninfectious inflammatory conditions such as burns or autoimmunity [15].

While blood cultures remain the gold standard for diagnosing sepsis—they provide organism identification and antimicrobial susceptibility—they are limited by delayed turnaround and potential pre-treatment negative results [16]. CRP offers a rapid adjunct to inform early clinical decisions, especially in resource-limited settings such as tertiary hospitals in india, where timely intervention is critical.

Given the crp dynamics and culture limitations, a combined approach is ideal. In one neonatal study, combining CRP with wbc improved sensitivity to 78.6% and specificity to 81.8% [12]. Similarly, integrating crp with clinical criteria may further optimize early management, balancing sensitivity with specificity.

Finally, our findings support the use of CRP as an early screening marker in pediatric sepsis: its high sensitivity and NPP mean a normal CRP can help rule out bacteremia, while elevated CRP should prompt vigilant monitoring and empiric therapy while awaiting culture results. Yet reliance solely on crp may lead to overtreatment given its limited specificity.

Limitations of this study include its retrospective design, single-center setting, and lack of serial crp measurements. Future studies with serial biomarkers and inclusion of procalcitonin or ferritin might refine diagnostic accuracy and help guide antibiotic stewardship.

CONCLUSION

The present study highlights the significance of blood culture and C-reactive protein (CRP) levels as valuable diagnostic tools in pediatricsepsis. Blood culture remains the gold standard for confirming sepsis, but its limitations, such as delayed results and the risk of contamination, reduce its practical utility in urgent clinical decision-making. In this context, CRP provides an important adjunct, allowing clinicians to initiate early empirical antibiotic therapy while awaiting culture confirmation. Our findings demonstrated a strong correlation between elevated CRP levels and positive blood cultures, supporting its role as a reliable biomarker in the diagnosis and monitoring of neonatal sepsis.

The study also revealed that combining CRP measurement with blood culture enhanced the sensitivity of sepsis detection, thereby improving diagnostic accuracy. This approach is particularly relevant in low-resource settings, where timely culture facilities may not always be available. By using CRP as an initial screening tool, followed by culture confirmation, clinicians can reduce the risks of delayed treatment and associated morbidity and mortality in neonates.

Furthermore, the study emphasizes the importance of adopting a multimodal diagnostic strategy, where CRP levels, blood culture, white blood cell counts, and clinical presentation are interpreted together. Such an approach minimizes the chances of misdiagnosis, avoids unnecessary antibiotic use, and contributes to antimicrobial stewardship in neonatal intensive care units.

In conclusion, the combined use of CRP and blood culture offers a practical and effective method for diagnosing neonatal sepsis. While blood culture continues to provide definitive microbiological evidence, CRP serves as a rapid and accessible marker that supports early clinical decision-making. Strengthening laboratory services, minimizing contamination risks, and incorporating CRP into sepsis diagnostic protocols can significantly improve neonatal outcomes. Further multicentric studies with larger cohorts are recommended to validate these findings and to establish standardized CRP cutoff values for clinical use across diverse populations.

Conflict of interest: Nil

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