International Journal of Medicine
pISSN 1468-3814 | eISSN 2667-7008
https://theinternationalmedicine.com/

Original Researcher Article *DOI: 10.61336/im/26-05-158*

Evaluation of Procalcitonin, C-Reactive Protein and Hematological Inflammatory Indices for Early Prediction of Sepsis Severity in Children: A Prospective Clinical Laboratory Study.

Dr. Pooja Shivkumar [1], Dr. Syed Shah Naseeruddin Sarmast [2], Dr. Vinod Kumar [2*].

[1]*Consultant Pathologist, Vishwa Hospital, Bidar, Karnataka, India.*

[2]*Associate Professor, Department of Pediatrics, Mahaveer Institute of Medical Sciences, Shivareddypet, Vikarabad, Telangana.*

Correspondence:
Dr. Vinod Kumar.
Associate Professor, Department of Pediatrics, Mahaveer Institute of Medical Sciences, Shivareddypet, Vikarabad, Telangana.

Email:
gornalevinod@gmail.com

Received: 20-02-2026
Revised: 28-03-2026
Accepted: 03-04-2026
Published: 15-05-2026

Abstract

Introduction: Sepsis is a major cause of morbidity and mortality in children, and early identification of patients at risk of severe sepsis or septic shock remains challenging. Procalcitonin (PCT), C-reactive protein (CRP), and hematological inflammatory indices may provide useful information for early risk stratification. This study evaluated their association with sepsis severity and diagnostic performance in children. ***Materials and Methods:*** This prospective clinical laboratory study included 30 children diagnosed with sepsis. Participants were categorized into sepsis (n = 15), severe sepsis (n = 10), and septic shock (n = 5) groups. Serum PCT and CRP were measured at enrollment, along with complete blood count parameters. Neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), and systemic immune-inflammation index (SII) were calculated. Comparisons between severity groups, correlation analysis, and receiver operating characteristic analysis were performed. ***Results:*** PCT increased progressively from 3.18 ± 1.74 ng/mL in sepsis to 8.72 ± 4.31 ng/mL in severe sepsis and 17.64 ± 7.28 ng/mL in septic shock ($p < 0.001$). CRP similarly increased from 72.4 ± 31.6 mg/L to 126.8 ± 48.5 mg/L and 189.6 ± 62.7 mg/L, respectively ($p < 0.001$). PCT showed the strongest correlation with severity ($r = 0.78$, $p < 0.001$). For identifying severe sepsis or septic shock, PCT demonstrated the highest AUC (0.91), with 86.7% sensitivity and 86.7% specificity. SII and CRP showed AUCs of 0.88 and 0.87, respectively. ***Conclusion:*** PCT, CRP, NLR, and SII were associated with increasing pediatric sepsis severity. PCT demonstrated the strongest association and discriminatory performance and may serve as a useful adjunct for early risk stratification.

Keywords: Procalcitonin; C-reactive protein; Pediatric sepsis; Neutrophil-to-lymphocyte ratio; Sepsis severity.

This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC-BY) license (http://creativecommons.org/licenses/by/4.0/).

INTRODUCTION

Sepsis is a life-threatening clinical syndrome characterized by a dysregulated host response to infection leading to organ dysfunction and, in severe cases, circulatory failure and death [1]. Children are particularly vulnerable to rapid deterioration because of age-related physiological differences and limited compensatory reserves [2]. Early recognition of sepsis severity is therefore essential for timely initiation of antimicrobial therapy, hemodynamic support, and appropriate monitoring [3]. However, the clinical presentation of sepsis in children can be variable, and conventional clinical parameters may not always reliably identify those at risk of progression to severe sepsis or septic shock [4].

Biomarkers of systemic inflammation have gained increasing attention as adjunctive tools for early identification and risk stratification of pediatric sepsis [5]. Procalcitonin (PCT) is released in response to systemic bacterial infection and has been investigated extensively as a marker of bacterial infection and disease severity [6]. C-reactive protein (CRP), an acute-phase reactant synthesized predominantly by the liver, is another widely used inflammatory biomarker. Although both PCT and CRP may provide useful information regarding the inflammatory response, their individual diagnostic and prognostic performance can vary according to the timing of presentation, underlying infection, and severity of illness [7]. Evaluating these biomarkers together may therefore provide a more comprehensive assessment of the inflammatory burden.

In addition to conventional biomarkers, routinely available hematological parameters can be used to derive inflammatory indices such as the neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), and systemic immune-inflammation index (SII) [8]. These indices reflect different components of the systemic inflammatory and immune response and have been investigated as inexpensive and readily accessible markers of disease severity in various infectious and inflammatory conditions. Their potential advantage in resource-limited settings is that they can be calculated from routinely performed complete blood counts without requiring additional specialized testing [9]. However, evidence

regarding the comparative utility of these indices alongside PCT and CRP for early prediction of sepsis severity in children remains limited.

Early identification of children likely to progress to severe sepsis or septic shock could facilitate more intensive monitoring and timely escalation of treatment [10]. A combined evaluation of established biomarkers such as PCT and CRP with routinely derived hematological inflammatory indices may improve clinical risk stratification and provide a practical approach to early assessment. Therefore, the present study aimed to evaluate the association and predictive performance of procalcitonin, C-reactive protein, and hematological inflammatory indices, including NLR, PLR, and SII, for early prediction of sepsis severity in children.

MATERIALS AND METHODS

This prospective clinical laboratory study was conducted in the Department of Pediatrics in collaboration with the Department of Pathology at a tertiary care hospital. The study included 30 children diagnosed with sepsis during the study period. Children were enrolled consecutively after fulfilling the predefined eligibility criteria. Written informed consent was obtained from the parents or legal guardians before participation, and assent was obtained from older children wherever applicable. The study protocol was reviewed and approved by the Institutional Ethics Committee before commencement of the study.

Children aged 1 month to 18 years with a clinical diagnosis of sepsis were eligible for inclusion. Sepsis severity was categorized clinically into sepsis, severe sepsis, and septic shock based on the presence and severity of organ dysfunction and circulatory compromise. Children with known chronic inflammatory or autoimmune disorders, malignancy, hematological disorders, recent major surgery or trauma, or conditions known to significantly alter inflammatory biomarkers were excluded.

Children receiving immunosuppressive therapy or those for whom complete clinical or laboratory data were unavailable were also excluded. Demographic characteristics, presenting symptoms, vital signs, requirement for respiratory or vasoactive support, blood culture results, and clinical outcomes were recorded using a structured case record form.

Venous blood samples were collected at enrollment, preferably before or immediately after initiation of antimicrobial therapy. Serum procalcitonin (PCT) and C-reactive protein (CRP) were measured using standard laboratory methods according to the manufacturer's instructions. A complete blood count was performed to determine total leukocyte count, differential leukocyte count, and platelet count.

Hematological inflammatory indices were subsequently calculated from the complete blood count parameters, including the neutrophil-to-lymphocyte ratio (NLR), platelet-to-lymphocyte ratio (PLR), and systemic immune-inflammation index (SII). NLR was calculated as the absolute neutrophil count divided by the absolute lymphocyte count, PLR as the platelet count divided by the absolute lymphocyte count, and SII as platelet count × neutrophil count / lymphocyte count. All laboratory investigations were performed in the institutional clinical laboratory using standardized quality-controlled procedures.

Statistical analysis was performed using appropriate statistical software. Continuous variables were expressed as mean ± standard deviation, while categorical variables were presented as frequency and percentage. Differences in continuous laboratory parameters across the three sepsis-severity groups were assessed using one-way analysis of variance, with appropriate post-hoc pairwise comparisons where applicable.

Correlations between inflammatory biomarkers, hematological indices, and sepsis severity were evaluated using Pearson's correlation analysis. Receiver operating characteristic (ROC) curve analysis was performed to determine the diagnostic performance and optimal cut-off values of PCT, CRP, NLR, PLR, and SII for identifying severe sepsis or septic shock. Sensitivity, specificity, area under the ROC curve (AUC), and 95% confidence intervals were calculated. A two-sided p-value <0.05 was considered statistically significant.

RESULTS

The study included 30 children with sepsis, with a mean age of 6.8 ± 4.2 years. Children aged ≤5 years constituted the largest age group (40.0%), followed by those aged 6–10 years (33.3%) and >10 years (26.7%). Males predominated, accounting for 17 (56.7%) children, while 13 (43.3%) were females. Fever was the most frequent clinical feature, observed in 27 (90.0%) children, followed by tachycardia in 22 (73.3%), tachypnea in 20 (66.7%), respiratory distress in 16 (53.3%), altered sensorium in 9 (30.0%), and hypotension in 8 (26.7%). Mechanical ventilation and vasoactive support were required in 7 (23.3%) and 6 (20.0%) children, respectively. Blood cultures were positive in 12 (40.0%) children (Table 1).

Table 1. Baseline Demographic and Clinical Characteristics of the Study Population (N = 30)

Characteristic	n (%) / Mean ± SD
Age (years), mean ± SD	6.8 ± 4.2
Age group, n (%)	
≤5 years	12 (40.0%)
6–10 years	10 (33.3%)
>10 years	8 (26.7%)
Male sex	17 (56.7%)
Female sex	13 (43.3%)
Fever	27 (90.0%)
Tachycardia	22 (73.3%)
Tachypnea	20 (66.7%)
Hypotension	8 (26.7%)
Altered sensorium	9 (30.0%)
Respiratory distress	16 (53.3%)
Requirement for mechanical ventilation	7 (23.3%)
Requirement for vasoactive support	6 (20.0%)
Positive blood culture	12 (40.0%)

According to clinical severity, 15 (50.0%) children were classified as having sepsis, while 10 (33.3%) had severe sepsis and 5 (16.7%) had septic shock. Thus, half of the study population belonged to the sepsis category, whereas one-third had severe sepsis and approximately one-sixth presented with septic shock (Table 2).

Table 2. Distribution of Children According to Sepsis Severity (N = 30)

Sepsis severity	n (%)
Sepsis	15 (50.0%)
Severe sepsis	10 (33.3%)
Septic shock	5 (16.7%)
Total	**30 (100.0%)**

A progressive increase in inflammatory biomarkers was observed with increasing sepsis severity. Mean procalcitonin levels increased from 3.18 ± 1.74 ng/mL among children with sepsis to 8.72 ± 4.31 ng/mL in severe sepsis and 17.64 ± 7.28 ng/mL in septic shock. Similarly, mean CRP increased from 72.4 ± 31.6 mg/L to 126.8 ± 48.5 mg/L and 189.6 ± 62.7 mg/L, respectively. TLC, neutrophil percentage, NLR, PLR and SII also showed progressively higher values with increasing severity, whereas lymphocyte percentage and platelet count demonstrated a progressive decline. These differences were statistically significant for all evaluated parameters (Table 3).

Table 3. Comparison of Procalcitonin, CRP and Hematological Inflammatory Indices According to Sepsis Severity

Laboratory parameter	Sepsis (n = 15) Mean ± SD	Severe sepsis (n = 10) Mean ± SD	Septic shock (n = 5) Mean ± SD	p-value
Procalcitonin (ng/mL)	3.18 ± 1.74	8.72 ± 4.31	17.64 ± 7.28	<0.001
CRP (mg/L)	72.4 ± 31.6	126.8 ± 48.5	189.6 ± 62.7	<0.001
TLC (×10⁹/L)	14.2 ± 4.3	17.8 ± 5.1	21.6 ± 6.4	0.006
Neutrophils (%)	74.8 ± 8.2	82.1 ± 6.4	87.4 ± 4.9	0.002
Lymphocytes (%)	18.6 ± 6.1	13.2 ± 4.8	9.1 ± 3.6	0.001
Platelet count (×10⁹/L)	218.4 ± 61.7	176.2 ± 54.8	128.6 ± 42.1	0.003
NLR	4.52 ± 2.18	7.46 ± 3.21	10.82 ± 4.36	<0.001
PLR	142.6 ± 51.3	171.8 ± 62.4	204.6 ± 75.1	0.028
SII	1038 ± 492	1596 ± 714	2398 ± 1016	<0.001

Pairwise analysis demonstrated that procalcitonin and CRP levels were significantly higher in children with severe sepsis compared with those with sepsis and were further elevated among children with septic shock. The mean difference in procalcitonin was 5.54 ng/mL between sepsis and severe sepsis and 14.46 ng/mL between sepsis and septic shock. Similarly, CRP differed by 54.4 mg/L between sepsis and severe sepsis and by 117.2 mg/L between sepsis and septic shock, with statistically significant differences across the severity comparisons (Table 4).

Table 4. Pairwise Comparison of Procalcitonin and CRP Between Sepsis Severity Groups

Parameter	Sepsis vs Severe Sepsis	Sepsis vs Septic Shock	Severe Sepsis vs Septic Shock
Procalcitonin, mean difference	5.54 ng/mL	14.46 ng/mL	8.92 ng/mL
p-value	0.002	<0.001	0.011
CRP, mean difference	54.4 mg/L	117.2 mg/L	62.8 mg/L
p-value	0.008	<0.001	0.031

Correlation analysis demonstrated a significant positive correlation between increasing sepsis severity and procalcitonin (r = 0.78), CRP (r = 0.71), SII (r = 0.73), NLR (r = 0.68), neutrophil percentage (r = 0.55), TLC (r = 0.49), and PLR (r = 0.39). In contrast, lymphocyte percentage (r = −0.59) and platelet count (r = −0.51) showed significant inverse correlations with increasing severity. Procalcitonin demonstrated the strongest correlation among the evaluated biomarkers and hematological indices (Table 5).

Table 5. Correlation of Biomarkers and Hematological Inflammatory Indices With Sepsis Severity

Parameter	Correlation coefficient (r)	p-value
Procalcitonin	0.78	<0.001
CRP	0.71	<0.001
TLC	0.49	0.006
Neutrophil percentage	0.55	0.002
Lymphocyte percentage	−0.59	0.001
Platelet count	−0.51	0.004
NLR	0.68	<0.001
PLR	0.39	0.033
SII	0.73	<0.001

ROC analysis showed that procalcitonin had the highest discriminatory ability for identifying children with severe sepsis or septic shock, with an AUC of 0.91 (95% CI: 0.81–1.00), at a cut-off of >5.2 ng/mL, yielding 86.7% sensitivity and 86.7% specificity. SII demonstrated an AUC of 0.88, followed by CRP with an AUC of 0.87 and NLR with an AUC of 0.82. PLR showed comparatively lower discriminatory performance, with an AUC of 0.72 (Table 6).

Table 6. Diagnostic Performance of Procalcitonin, CRP and Hematological Inflammatory Indices for Identifying Severe Sepsis/Septic Shock

Marker	Optimal cut-off	Sensitivity (%)	Specificity (%)	AUC (95% CI)	p-value
Procalcitonin	>5.2 ng/mL	86.7	86.7	0.91 (0.81–1.00)	<0.001
CRP	>105 mg/L	80.0	80.0	0.87 (0.73–1.00)	<0.001
NLR	>5.8	80.0	73.3	0.82 (0.67–0.97)	0.002
PLR	>158	66.7	66.7	0.72 (0.54–0.90)	0.028
SII	>1250	86.7	80.0	0.88 (0.75–1.00)	<0.001

Comparison according to clinical outcome demonstrated substantially higher inflammatory marker levels among children who died compared with survivors. Mean procalcitonin was 17.46 ± 8.21 ng/mL among non-survivors compared with 5.82 ± 5.31 ng/mL among survivors. Similarly, CRP and NLR were higher among non-survivors, with mean values of 188.4 ± 61.7 mg/L and 10.72 ± 4.16, respectively, compared with 91.6 ± 57.4 mg/L and 5.84 ± 3.21 among survivors. The differences in all three parameters were statistically significant (Table 7).

Table 7. Comparison of Procalcitonin and CRP According to Clinical Outcome

Outcome	PCT (ng/mL), Mean ± SD	CRP (mg/L), Mean ± SD	NLR, Mean ± SD
Survived (n = 25)	5.82 ± 5.31	91.6 ± 57.4	5.84 ± 3.21
Died (n = 5)	17.46 ± 8.21	188.4 ± 61.7	10.72 ± 4.16
p-value	<0.001	0.001	0.002

DISCUSSION

The present study demonstrated a clear relationship between increasing sepsis severity and elevation of inflammatory biomarkers among children. Procalcitonin showed the most pronounced gradient across the severity categories, increasing from 3.18 ± 1.74 ng/mL in sepsis to 8.72 ± 4.31 ng/mL in severe sepsis and 17.64 ± 7.28 ng/mL in septic shock. CRP showed a similar progressive increase from 72.4 ± 31.6 mg/L to 126.8 ± 48.5 mg/L and 189.6 ± 62.7 mg/L, respectively.

These findings are consistent with the prospective study by Rey et al., which evaluated PCT and CRP across different categories of systemic inflammation in critically ill children and reported markedly higher PCT concentrations in severe sepsis and septic shock. The authors also found superior discriminatory performance of PCT compared with CRP, with an AUC of 0.912 for PCT versus 0.750 for CRP, supporting the value of PCT for severity stratification in critically ill children [11].

The strong association between PCT and sepsis severity observed in the present study is further supported by pediatric studies evaluating PCT as a marker of disease progression. Enguix et al. reported that PCT was a better diagnostic marker than CRP and serum amyloid A for bacterial sepsis in critically ill children, with a PCT concentration >8.1 ng/mL identifying all children with bacterial sepsis in their study [12]. Similarly, Arkader et al. demonstrated that admission PCT concentrations were substantially higher in children with septic shock than in children with localized bacterial or viral infections and reported an AUC of 0.96 for PCT compared with 0.83 for CRP [13]. In another pediatric cohort, higher PCT concentrations were associated with greater organ dysfunction, and PCT levels from the first several days of illness were related to the development of multiple-organ dysfunction syndrome [14]. These observations are consistent with the present study, in which PCT demonstrated a strong correlation with increasing sepsis severity ($r = 0.78$) and the highest discriminatory performance for severe sepsis or septic shock (AUC = 0.91) [12-14]. The hematological inflammatory indices also demonstrated a progressive relationship with disease severity in the present study. NLR increased from 4.52 ± 2.18 in sepsis to 7.46 ± 3.21 in severe sepsis and 10.82 ± 4.36 in septic shock, while SII increased from 1038 ± 492 to 1596 ± 714 and 2398 ± 1016, respectively. NLR and SII showed positive correlations with sepsis severity, with correlation coefficients of 0.68 and 0.73, respectively. These findings are in agreement with Zhong et al., who reported that NLR was significantly associated with severe pediatric sepsis and demonstrated its potential as a readily available predictive marker [15]. The authors further reported that combining NLR with PCT and the PRISM III score improved discrimination for severe pediatric sepsis. Similarly, Zhu et al. found significantly increased NLR, PLR, and SII among neonates with sepsis compared with healthy controls, supporting the potential value of routinely derived hematological inflammatory indices as adjunctive markers of systemic infection [16]. However, differences in age distribution, clinical definitions, underlying infections, and timing of blood sampling should be considered when comparing absolute values and diagnostic cut-offs between studies.

The present study additionally demonstrated substantially higher PCT, CRP, and NLR values among children who died compared with survivors, suggesting that greater inflammatory activation may be associated with adverse clinical outcomes. The progressive reduction in lymphocyte percentage and platelet count with increasing severity may further reflect the hematological response accompanying severe systemic inflammation. The findings are broadly consistent with prospective pediatric research demonstrating associations between inflammatory biomarkers and markers of clinical severity. For example, a prospective study of 248 children with sepsis found that PCT-positive patients showed greater clinical severity, including increased requirements for inotropic support and more pronounced renal and hepatic dysfunction, compared with patients classified according to CRP [17]. Nevertheless, the prognostic findings of the present study should be interpreted cautiously because only 30 children were included and only five deaths occurred. The small sample size may result in imprecise effect estimates and potentially inflated estimates of ROC performance; therefore, the observed diagnostic and prognostic associations require validation in larger, multicenter pediatric cohorts.

The major strength of the present study was its prospective design and simultaneous evaluation of established inflammatory biomarkers, including procalcitonin and CRP, together with routinely available hematological inflammatory indices such as NLR, PLR, and SII, allowing a broader assessment of their relationship with sepsis severity in children. The study also incorporated correlation and ROC curve analyses to assess both the association and discriminatory performance of these parameters. However, the study has several limitations. The small sample size of 30 children and single-center design limit the statistical power and generalizability of the findings. The relatively small number of children with septic shock and deaths may have resulted in imprecise estimates of diagnostic and prognostic performance. In addition, biomarkers were assessed primarily at admission, and serial changes in PCT, CRP, and hematological indices were not evaluated. Potential confounding factors such as the underlying source of infection, causative organism, prior antibiotic exposure, and comorbid conditions may also have influenced biomarker concentrations. Therefore, the findings should be considered preliminary and validated in larger, multicenter prospective pediatric studies.

CONCLUSION

Procalcitonin, CRP, and hematological inflammatory indices demonstrated significant associations with increasing sepsis severity in children. Procalcitonin showed the strongest correlation with disease severity and the highest discriminatory performance for identifying severe sepsis or septic shock, while NLR and SII also demonstrated useful diagnostic potential. The progressive increase in these inflammatory markers, together with declining lymphocyte and platelet counts, suggests that combined assessment of biochemical and hematological parameters may provide a practical approach for early risk stratification of pediatric sepsis. Although these findings are promising, the small sample size warrants cautious

interpretation, and larger multicenter studies are required to validate the observed cut-off values and establish their clinical utility in routine pediatric practice.

Acknowledgement: None
Funding: None
Conflict of Interest: None.

REFERENCES

1. Jarczak D, Kluge S, Nierhaus A. Sepsis-Pathophysiology and Therapeutic Concepts. Front Med (Lausanne). 2021 May 14;8:628302. doi: 10.3389/fmed.2021.628302. PMID: 34055825; PMCID: PMC8160230.
2. Lambert V, Matthews A, MacDonell R, Fitzsimons J. Paediatric early warning systems for detecting and responding to clinical deterioration in children: a systematic review. BMJ Open. 2017 Mar 13;7(3):e014497. doi: 10.1136/bmjopen-2016-014497. PMID: 28289051; PMCID: PMC5353324.
3. Kim HI, Park S. Sepsis: Early Recognition and Optimized Treatment. Tuberc Respir Dis (Seoul). 2019 Jan;82(1):6-14. doi: 10.4046/trd.2018.0041. Epub 2018 Sep 28. PMID: 30302954; PMCID: PMC6304323.
4. Miranda M, Nadel S. Pediatric Sepsis: a Summary of Current Definitions and Management Recommendations. Curr Pediatr Rep. 2023;11(2):29-39. doi: 10.1007/s40124-023-00286-3. Epub 2023 May 9. PMID: 37252329; PMCID: PMC10169116.
5. Standage SW, Wong HR. Biomarkers for pediatric sepsis and septic shock. Expert Rev Anti Infect Ther. 2011 Jan;9(1):71-9. doi: 10.1586/eri.10.154. PMID: 21171879; PMCID: PMC3033193.
6. Lee H. Procalcitonin as a biomarker of infectious diseases. Korean J Intern Med. 2013 May;28(3):285-91. doi: 10.3904/kjim.2013.28.3.285. Epub 2013 May 1. PMID: 23682219; PMCID: PMC3654123.
7. Daud M, Khan MB, Qudrat QU, Ullah I, Khan S, Khan MZ, Yousuf I, Ahmad F. Role of C-reactive Protein and Procalcitonin in Early Diagnostic Accuracy and Their Prognostic Significance in Sepsis. Cureus. 2024 Sep 27;16(9):e70358. doi: 10.7759/cureus.70358. PMID: 39469363; PMCID: PMC11513552.
8. Feher KE, Tornai D, Papp M. Hematological Parameter-Derived Inflammatory Scores in Non-Pancreatic Hyperlipasemia (NPHL)-The Prognosis Lies in the Blood. Biomedicines. 2025 Jul 14;13(7):1719. doi: 10.3390/biomedicines13071719. PMID: 40722789; PMCID: PMC12292475.
9. Bhat A, Alsadhan N, Alsadhan N, Alnowaiser D, Gattoo I, Hussain M, Alotbi R, Alruwaili S, AlGoraini Y. Procalcitonin and C-reactive protein as early diagnostic markers of sepsis or septic shock in children who presented with fever to the pediatric emergency department at a tertiary hospital, in Riyadh, Saudi Arabia. Int J Emerg Med. 2025 Apr 29;18(1):87. doi: 10.1186/s12245-025-00888-2. PMID: 40301742; PMCID: PMC12039137.
10. Liu B, Ding X, Yang J. Effect of early goal directed therapy in the treatment of severe sepsis and/or septic shock. Curr Med Res Opin. 2016 Nov;32(11):1773-1782. doi: 10.1080/03007995.2016.1206872. Epub 2016 Sep 9. PMID: 27348416.
11. Rey C, Los Arcos M, Concha A, Medina A, Prieto S, Martinez P, Prieto B. Procalcitonin and C-reactive protein as markers of systemic inflammatory response syndrome severity in critically ill children. Intensive Care Med. 2007 Mar;33(3):477-84. doi: 10.1007/s00134-006-0509-7. Epub 2007 Jan 27. Erratum in: Intensive Care Med. 2007 Jun;33(6):1108-9. PMID: 17260130.
12. Enguix A, Rey C, Concha A, Medina A, Coto D, Diéguez MA. Comparison of procalcitonin with C-reactive protein and serum amyloid for the early diagnosis of bacterial sepsis in critically ill neonates and children. Intensive Care Med. 2001 Jan;27(1):211-5. doi: 10.1007/s001340000709. PMID: 11280637.
13. Arkader R, Troster EJ, Lopes MR, Júnior RR, Carcillo JA, Leone C, Okay TS. Procalcitonin does discriminate between sepsis and systemic inflammatory response syndrome. Arch Dis Child. 2006 Feb;91(2):117-20. doi: 10.1136/adc.2005.077446. Epub 2005 Dec 2. PMID: 16326799; PMCID: PMC2082702.
14. Zurek J, Vavrina M. Procalcitonin Biomarker Kinetics to Predict Multiorgan Dysfunction Syndrome in Children With Sepsis and Systemic Inflammatory Response Syndrome. Iran J Pediatr. 2015 Feb;25(1):e324. doi: 10.5812/ijp.324. Epub 2015 Feb 21. PMID: 26199699; PMCID: PMC4505981.
15. Zhong X, Ma A, Zhang Z, Liu Y, Liang G. Neutrophil-to-lymphocyte ratio as a predictive marker for severe pediatric sepsis. Transl Pediatr. 2021 Mar;10(3):657-665. doi: 10.21037/tp-21-47. PMID: 33880335; PMCID: PMC8041612.
16. Zhu S, Zhou Q, Hu Z, Jiang J. Assessment of neutrophil to lymphocyte ratio, platelet to lymphocyte ratio and systemic immune-inflammatory index, as diagnostic markers for neonatal sepsis. J Int Med Res. 2024 Aug;52(8):3000605241270696. doi: 10.1177/03000605241270696. PMID: 39180295; PMCID: PMC11344890.
17. Tyagi N, Gawhale S, Patil MG, Tambolkar S, Salunkhe S, Mane SV. Comparative Analysis of C-reactive Protein and Procalcitonin as Biomarkers for Prognostic Assessment in Pediatric Sepsis. Cureus. 2024 Jul 26;16(7):e65427. doi: 10.7759/cureus.65427. PMID: 39184737; PMCID: PMC11344993.