PROGNOSTIC VALUE OF RED CELL DISTRIBUTION WIDTH IN NEONATAL SEPSIS: A PROSPECTIVE OBSERVATIONAL STUDY FROM A DISTRICT HOSPITAL IN SOUTH INDIA

Dr. Girish Hiremath[1], Dr. Prabhakar Dharmatti[2], Dr. Harsha[3], Dr. S G Matti[4*]
[1]Associate Professor, Department of Paediatrics, KIMS, Koppal, Karnataka, India.
[2]Resident, Department of Paediatrics, KIMS, Koppal, Karnataka, India.
[3]Assistant Professor, Department of Paediatrics, KIMS, Koppal, Karnataka, India.
[4*]Professor and Head, Department of Paediatrics, KIMS, Koppal, Karnataka, India.
Corresponding Author: Dr. S G Matti
Professor and Head, Department of Paediatrics, KIMS, Koppal, Karnataka, India – 583231.
Email: shailesh.matti@gmail.com.

ABSTRACT

Background: Neonatal sepsis is a leading cause of neonatal mortality, and early identification of severity remains challenging in resource-limited settings. Red cell distribution width (RDW), a routinely reported haematological index, has emerged as a potential low-cost prognostic biomarker in sepsis.

Objective: To evaluate the prognostic value of RDW in neonatal sepsis and its correlation with disease severity, and to identify associated risk factors.

Methods: This prospective observational study enrolled 100 neonates aged 1–28 days with clinical features suggestive of sepsis to Koppal Institute of Medical Sciences, Koppal, India. Institutional ethical clearance and written consent from parents or guardian was taken. Neonates were classified as no sepsis, sepsis, or septic shock. RDW, complete blood count, CRP, and blood culture were assessed on day 1 and day 3 of illness. Sensitivity, specificity, and receiver operating characteristic (ROC) curve analysis were used to evaluate RDW as a predictor of CRP positivity.

Results: Mean RDW increased with severity: 15.99 in neonates without sepsis, 17.43 in sepsis, and 18.25 in septic shock (correlation coefficient 0.49, moderate positive correlation). On day 1, RDW-CV (cut-off ≥16.00%) predicted CRP positivity with 88.9% sensitivity and 51.1% specificity (AUC 0.689, p=0.008), while RDW-SD (cut-off ≥66.30 fL) showed 50.0% sensitivity and 78.7% specificity (AUC 0.585, p=0.048). Blood culture was positive in 20% of neonates, most commonly Klebsiella pneumoniae (9%). Mortality was higher among outborn (20.3%) than inborn (12.2%) neonates.

Conclusion: RDW rises progressively with the severity of neonatal sepsis and is a highly sensitive, inexpensive, and readily available screening biomarker. Its moderate specificity limits its use as a standalone diagnostic test, and it should be interpreted alongside CRP and clinical assessment. Larger multicentric studies are recommended to validate cut-off values before routine clinical adoption.

Keywords: Neonatal Sepsis, Red Cell Distribution Width, Biomarker, C - reactive protein, Septic Shock, Neonatal Mortality.

INTRODUCTION

Neonatal sepsis remains one of the leading causes of morbidity and mortality among newborns worldwide, and this burden is more in low- and middle-income countries where healthcare infrastructure and diagnostic resources are often limited.[1] The condition is classified as early-onset sepsis (EOS), presenting within the first few days of life and typically resulting from vertical transmission of pathogens from mother to infant, and late-onset sepsis (LOS), which develops later and is linked to hospital-acquired infection.

www.ajmrhs.com
eISSN: 2583-7761

Date of Received: 03-06-2026
Date Acceptance: 14-06-2026
Date of Publication: 13-07-2026

[2] Maternal risk factors such as prolonged rupture of membranes, chorioamnionitis, and untreated genitourinary infection, together with neonatal factors including prematurity, low birth weight, and invasive interventions increases the risk of sepsis.[3,4]

Clinical diagnosis of neonatal sepsis is challenging because presenting features like poor feeding, lethargy, temperature instability, and respiratory distress are nonspecific and overlap with several other neonatal conditions. Blood culture remains the reference standard for confirming bacterial infection, but its diagnostic yield is limited by delayed turnaround time, prior antibiotic exposure, and low sensitivity.[5]Commonly used markers such as C-reactive protein (CRP) and procalcitonin support the diagnosis but have variable specificity, high cost, and limited availability in peripheral

centres. [6,7] This has driven interest in simple, inexpensive, and widely available haematological indices that could help in resource-limited settings.

Red cell distribution width (RDW) is a quantitative measure of anisocytosis that is generated automatically as part of every complete blood count.[8] Although traditionally used in the evaluation of anaemia, RDW has increasingly been recognised as a marker of systemic inflammation: pro-inflammatory cytokines suppress erythropoiesis and alter red-cell maturation, widening the distribution of circulating red-cell volumes.[9,10] Elevated RDW has been associated with adverse outcomes in adult sepsis and septic shock,[11,12] and literature suggests that RDW correlates with the presence and severity of neonatal sepsis and may add prognostic value alongside CRP.[13,14,15,16]

Because RDW is obtained at negligible additional cost with every complete blood count, it is an effective and affordable biomarker for centres where advanced diagnostics such as procalcitonin assays or molecular testing are not readily available. [17,18]

District-level teaching hospitals in India care for large numbers of neonates, often with limited access to advanced diagnostics and inconsistent referral pathways. [19,20] So, a low-cost biomarker such as RDW in this setting is relevance. We conducted this prospective observational study to evaluate the prognostic value of RDW in neonates with sepsis, to determine its correlation with disease severity, and to identify risk factors associated with neonatal sepsis in this population.

MATERIALS AND METHODS

Study design and setting

This prospective observational study was conducted in the Department of Paediatrics, Koppal Institute of Medical Sciences (KIMS), a tertiary-level district teaching hospital in Koppal, Karnataka, India, over a period of 18 months (1 July 2023 to 31 December 2024).

Study population

Neonates aged 1–28 days admitted with clinical features suggestive of sepsis (fever, respiratory distress, lethargy, poor feeding, or other signs of systemic infection) were eligible for inclusion. Neonates were additionally classified by gestational age (full-term, late preterm, moderate preterm, very preterm, and extreme preterm, using the New Ballard Score) and by birth weight (low birth weight <2.5 kg, very low birth weight <1.5 kg, and extremely low birth weight <1 kg). Neonates older than 28 days and those with major congenital anomalies, perinatal asphyxia, or a diagnosis of anaemia were excluded.

Sample size

Sample size was calculated using the standard formula for estimation of a population proportion (Z=1.96 for 95% confidence, expected proportion p=0.30, allowable error e=9%), which yielded a minimum requirement of approximately 100 neonates. A total of 100 neonates were enrolled.

Clinical and laboratory evaluation

A structured case record form was used to document antenatal, intrapartum, and postnatal history (maternal fever, prolonged rupture of membranes, foul-smelling or meconium-stained liquor, prolonged labour), Apgar scores, and clinical examination findings, including vital signs (heart rate, respiratory rate, oxygen saturation, capillary refill time, and temperature). Peripheral venous blood was sampled aseptically on day 1 and day 3 of illness for complete blood count with RDW (measured on an automated haematology analyser), CRP, and, in neonates with clinical suspicion of sepsis, blood culture and sensitivity testing; neonates without clinical features of sepsis served as an internal comparison group and did not undergo blood culture. Neonates were categorised into three severity groups – no sepsis, sepsis, and septic shock – based on standard clinical and laboratory criteria.

Ethical considerations

The study was approved by the Institutional Ethics Committee of KIMS, Koppal. Written informed consent was obtained from the parent or legal guardian of each participating neonate prior to enrolment.

Statistical analysis

Data were analysed using standard statistical software. Continuous variables were summarised as means and compared between severity groups using the independent-sample t test; categorical variables were compared using the chi-square test. Sensitivity, specificity, positive and negative predictive values, and diagnostic accuracy of RDW – both coefficient of variation (RDW-CV) and standard deviation (RDW-SD) – for predicting CRP positivity were calculated for day 1 and day 3, and receiver operating characteristic (ROC) curve analysis was used to identify optimal cut-off values and the area under the curve (AUC). A two-tailed p value <0.05 was considered statistically significant.

RESULTS

Total of 100 neonates were enrolled, of which 41 (41.0%) were male and 59 (59.0%) were female. On the basis of clinical and laboratory criteria, 34 neonates (34.0%) had no sepsis, 43 (43.0%) had sepsis, and 23 (23.0%) had septic shock. Forty-one neonates (41.0%) were inborn and 59 (59.0%) were out born (Table 1).

Table 1. Demographic Characteristics and Clinical Profile of the Study Population (N = 100)

Variable	Category	No Sepsis	Sepsis	Septic Shock
Sex	Female	16 (39.02%)	14 (34.15%)	11 (26.83%)
	Male	18 (30.51%)	29 (49.15%)	12 (20.34%)
Birth Weight (kg)	1.0–1.5	3 (16.67%)	13 (56.52%)	3 (30.00%)
	1.6–2.5	8 (44.44%)	7 (30.43%)	6 (60.00%)
	2.6–3.5	7 (38.89%)	3 (13.04%)	1 (10.00%)
	>3.5	0 (0.00%)	0 (0.00%)	0 (0.00%)

Lower birth weight was associated with higher disease severity, neonates weighing 1.0–1.5 kg had the highest proportion of sepsis (56.5%), while those 1.6–2.5 kg accounted for the large number of septic shock cases (60.0%); no neonate weighing more than 3.5 kg developed sepsis or septic shock.

Deranged vital signs were in line with severity. Tachycardia, respiratory rate above 60/min, oxygen saturation below 92%, capillary refill time exceeding 3 seconds, and hypothermia were all more frequent in sepsis and septic shock than in neonates without sepsis. Capillary refill time and hypothermia showing the strongest association with septic shock (Table 2).

Table 2. Association of vital signs with severity of illness

	Vital sign	No sepsis n (%)	Sepsis n (%)	Septic shock n (%)
Heart rate	Normal	20 (50.0)	15 (37.5)	5 (12.5)
	Tachycardia	14 (23.3)	28 (46.7)	18 (30.0)
Respiratory rate	≤ 60/min	26 (36.6)	26 (36.6)	19 (26.8)
	> 60/min	8 (27.6)	17 (58.6)	4 (13.8)
SpO_2	Normal (>92%)	32 (37.2)	35 (40.7)	19 (22.1)
	Abnormal (<92%)	2 (14.3)	8 (57.1)	4 (28.6)
CRT	CRT < 3 sec	33 (49.3)	27 (40.3)	7 (10.4)
	CRT > 3 sec	1 (3.0)	16 (48.5)	16 (48.5)
Temperature	Normal	21 (38.9)	27 (50.0)	6 (11.1)
	Hypothermia	1 (5.3)	7 (36.8)	11 (57.9)
	Hyperthermia	12 (44.4)	9 (33.3)	6 (22.2)

Mean RDW increased progressively with severity, from 15.99% in neonates without sepsis to 17.43% in sepsis and 18.25% in septic shock (Table 3)

Table 3. Mean Red Cell Distribution Width (RDW) By Severity Group

Severity group	Mean RDW (%)
No sepsis	15.99
Sepsis	17.43
Septic shock	18.25

Blood culture was positive in 20 of 100 neonates (20.0%); Klebsiella pneumoniae was the most frequent isolate (9.0%), followed by Acinetobacter species (6.0%), Citrobacter species (3.0%), Pseudomonas aeruginosa (1.0%), and Streptococcus species (1.0%) (Table 4).

Table 4. Blood Culture Profile of the Study Population

Organism	n	%
Negative	80	80.0
Klebsiella pneumoniae	9	9.0
Acinetobacter spp.	6	6.0
Citrobacter spp.	3	3.0
Pseudomonas aeruginosa	1	1.0
Streptococcus spp.	1	1.0

On ROC analysis, day 1 RDW-CV at a cut-off of ≥16.00% predicted CRP positivity with 88.9% sensitivity and 51.1% specificity (AUC 0.689, p = 0.0078), while day 1 RDW-SD at a cut-off of ≥66.30

fL showed lower sensitivity (50.0%) but higher specificity (78.7%; AUC 0.585, p = 0.0484). By day 3, RDW-CV (cut-off ≥14.80%) retained high sensitivity (95.6%) but specificity fell to 25.0% (AUC 0.471, p = 0.042), and RDW-SD (cut-off ≥58.30 fL) showed intermediate, non-significant performance (AUC 0.564, p = 0.241) (Table 5).

Table 5. Diagnostic Performance of RDW-CV and RDW-SD for Predicting CRP Positivity on Day 1 and Day 3

Day / index	Cut-off	AUC	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)	Accuracy (%)	p value
Day 1 RDW-CV	≥16.00	0.689	88.9	51.1	41.0	92.3	61.5	0.0078
Day 1 RDW-SD	≥66.30	0.585	50.0	78.7	47.4	80.4	70.8	0.0484
Day 3 RDW-CV	≥14.80	0.471	95.6	25.0	74.1	71.4	73.8	0.0420
Day 3 RDW-SD	≥58.30	0.564	73.3	45.0	75.0	42.9	64.6	0.2414

Risk factors more common among neonates with sepsis and septic shock, including clinical features of sepsis at presentation, maternal febrile illness with suspected bacterial infection, foul-smelling or meconium-stained liquor, and prolonged labour (Table 6).

Table 6. Antenatal and Intrapartum Risk Factors By Severity Group

Risk factor	No sepsis n (%)	Sepsis n (%)	Septic shock n (%)
Clinical features of sepsis	10 (27.0)	20 (54.1)	7 (18.9)
Maternal febrile illness with suspected bacterial infection (≤2 wk pre-delivery)	7 (35.0)	7 (35.0)	6 (30.0)
Foul-smelling / meconium-stained liquor	4 (30.8)	7 (53.8)	2 (15.4)
Rupture of membranes >24 h	9 (45.0)	6 (30.0)	5 (25.0)
≥3 sterile / unclean vaginal examinations in labour	3 (60.0)	1 (20.0)	1 (20.0)
Prolonged labour (1st + 2nd stage >24 h)	1 (20.0)	2 (40.0)	2 (40.0)

DISCUSSION

In this study 100 neonates were evaluated for sepsis, Mean RDW increased progressively with severity, from 15.99% in neonates without sepsis to 17.43% in sepsis and 18.25% in septic shock – supporting its role as a marker in neonatal sepsis. This observation is consistent with similar studies where elevated RDW was linked to greater severity and mortality in neonatal sepsis. [9,10,13,15,16]

Similar associations between RDW and adverse outcomes have also been described in adult sepsis and septic shock, where higher RDW independently predicted mortality on multivariable analysis. [11,12]

The diagnostic performance of RDW in our study showed similar pattern that is reported in the wider literature: RDW-CV was highly sensitive but only moderately specific for predicting CRP positivity, whereas RDW-SD showed the reverse pattern of lower sensitivity but better specificity.[17] This trade-off suggests that RDW-CV is best suited as a screening test to flag neonates who require closer evaluation, while a normal RDW-SD may help identify neonates at lower risk. The decline in specificity of RDW-CV from day 1 to day 3, with sensitivity remaining high, indicates that RDW alone becomes progressively less discriminating as illness evolves and is better used for early screening than for serial monitoring. This is consistent with prior work showing RDW is a useful adjunct rather than a stand-alone diagnostic marker for neonatal sepsis, and supports combining it with CRP or other inflammatory markers to improve accuracy.[14]

Low birth weight neonates in our study experienced sepsis and septic shock more frequently than those with birth weight above 2.5 kg, and no neonate above 3.5 kg developed sepsis or septic shock. This is in keeping with previous reports identifying low birth weight as a major risk factor for neonatal sepsis and its complications.[22] Antenatal and intrapartum risk factors – including maternal febrile illness, foul-smelling or meconium-stained liquor, and prolonged labour – were more common among neonates who developed sepsis or septic shock, corroborating risk factors reported in earlier Indian cohorts and systematic reviews.[3,4]

Abnormal vital signs tachycardia, tachypnoea, hypoxaemia, prolonged capillary refill time, and hypothermia were c associated with severity in our study, a pattern was seen other studies.[23] The high

rate of culture-negative sepsis (80.0%) in our study is consistent with other reports from similar settings and likely reflects a combination of prior antibiotic exposure and the limited sensitivity of conventional blood culture. Klebsiella pneumoniae was the predominant isolate among culture-positive cases, echoing the organism profile reported from other Indian and regional neonatal units.[24,25,26]

Taken together, our findings support RDW as an accessible, low-cost adjunct biomarker that can be obtained from a routine complete blood count and used for early screening of neonates at risk of severe sepsis, particularly in resource-limited settings where procalcitonin or molecular diagnostics are not readily available.[17,18] However, given its moderate specificity, RDW should not be used in isolation; incorporating it into a composite score alongside CRP, clinical severity indices, and vital-sign trends is likely to improve diagnostic and prognostic accuracy.[21]

Limitations

This study has several limitations. It was conducted at a single centre with a small sample size of 100 neonates, which may limit generalisability. The relatively short follow-up period did not allow assessment of long-term outcomes. Reliance on a single biomarker, cannot fully capture neonatal sepsis, and future work should evaluate RDW as part of a multi-marker panel.

CONCLUSION

RDW increases progressively with the severity of neonatal sepsis and is a highly sensitive, low-cost, and readily available screening biomarker that can be derived from a routine complete blood count. Its moderate specificity means it is best used as an early screening tool rather than a stand-alone diagnostic test, and should ideally be interpreted together with CRP, clinical severity assessment, and other available biomarkers. Larger, multicentric, prospective studies with longer follow-up are recommended to validate optimal RDW cut-off values and to define its place within a composite diagnostic and prognostic panel for neonatal sepsis, particularly in resource-limited settings.

Acknowledgements

The authors thank the Department of Paediatrics and the laboratory staff of Koppal Institute of Medical Sciences, Koppal, for their support in patient recruitment.

Conflict of Interest

The authors declare no conflict of interest.

Source of Funding

No funding received for the study

REFERENCES

1. Kariniotaki C, Thomou C, Gkentzi D, Panteris E, Dimitriou G, Hatzidaki E. Neonatal sepsis: a comprehensive review. Antibiotics. 2024 Dec 25;14(1):6.
2. Simonsen KA, Anderson-Berry AL, Delair SF, Davies HD. Early-onset neonatal sepsis. Clin Microbiol Rev. 2014 Jan;27(1):21–47.
3. Yancey MK, Duff P, Kubilis P, Clark P, Frentzen BH. Risk factors for neonatal sepsis. Obstet Gynecol. 1996 Feb;87(2):188–94.
4. Murthy S, Godinho MA, Guddattu V, Lewis LE, Nair NS. Risk factors of neonatal sepsis in India: a systematic review and meta-analysis. PLoS One. 2019 Apr 25;14(4):e0215683.
5. Celik IH, Hanna M, Canpolat FE, Pammi M. Diagnosis of neonatal sepsis: the past, present and future. Pediatr Res. 2022 Jan;91(2):337–50.
6. Markic J, Saraga M, Dahlem P. Sepsis biomarkers in neonates and children: C-reactive protein and procalcitonin. J Child Sci. 2017 Jan;7(01):e89–95.
7. Bhandari V. Effective biomarkers for diagnosis of neonatal sepsis. J Pediatric Infect Dis Soc. 2014 Sep 1;3(3):234–45.
8. Constantino BT. Red cell distribution width, revisited. Lab Med. 2013 May 1;44(2):e2–9.
9. Salvagno GL, Sanchis-Gomar F, Picanza A, Lippi G. Red blood cell distribution width: a simple parameter with multiple clinical applications. Crit Rev Clin Lab Sci. 2015 Mar 4;52(2):86–105.
10. Hu ZD, Lippi G, Montagnana M. Diagnostic and prognostic value of red blood cell distribution width in sepsis: a narrative review. Clin Biochem. 2020 Mar 1;77:1–6.
11. Jo YH, Kim K, Lee JH, Kang C, Kim T, Park HM, et al. Red cell distribution width is a prognostic factor in severe sepsis and septic shock. Am J Emerg Med. 2013 Mar 1;31(3):545–8.
12. Sadaka F, O'Brien J, Prakash S. Red cell distribution width and outcome in patients with septic shock. J Intensive Care Med. 2013 Sep;28(5):307–13.
13. Ellahony DM, El-Mekkawy MS, Farag MM. A study of red cell distribution width in neonatal sepsis. Pediatr Emerg Care. 2020 Aug 1;36(8):378–83.
14. Mousa SO, Moustafa AN, Aly HM. Prognostic value of red cell distribution width, platelet parameters, and the hematological scoring system in neonatal sepsis. Egypt J Haematol. 2019 Jul 1;44(3):183–9.
15. Martin SL, Desai S, Nanavati R, Colah RB, Ghosh K, Mukherjee MB. Red cell distribution width and its association with mortality in neonatal sepsis. J Matern Fetal Neonatal Med. 2019 Jun 18;32(12):1925–30.

16. Liu ZY, Jiang HZ, Wang L, Chen MX, Wang HT, Zhang JX. Diagnostic accuracy of red blood cell distribution width for neonatal sepsis. Minerva Pediatr. 2022 Apr 1;74(2):202–12.
17. Sultana GS, Haque SA, Sultana T, Ahmed AN. Value of red cell distribution width (RDW) and RBC indices in the detection of iron deficiency anemia. Mymensingh Med J. 2013 Apr 1;22(2):370–6.
18. Karabulut B, Arcagok BC. New diagnostic possibilities for early onset neonatal sepsis: red cell distribution width to platelet ratio. Fetal Pediatr Pathol. 2020 Jul 3;39(4):297–306.
19. Popescu CR, Cavanagh MM, Tembo B, Chiume M, Lufesi N, Goldfarb DM, et al. Neonatal sepsis in low-income countries: epidemiology, diagnosis and prevention. Expert Rev Anti Infect Ther. 2020 May 3;18(5):443–52.
20. Sturrock S, Sadoo S, Nanyunja C, Le Doare K. Improving the treatment of neonatal sepsis in resource-limited settings: gaps and recommendations. Res Rep Trop Med. 2023 Dec 31:121–34.
21. Kennedy UK, Moulin J, Bührer L, Nian JL, Halter L, Böhni L, et al. Sex differences in pediatric sepsis mortality: a systematic review and meta-analysis. Crit Care Explor. 2025 Apr 1;7(4):e1226.
22. Alshaikh B, Yusuf K, Sauve R. Neurodevelopmental outcomes of very low birth weight infants with neonatal sepsis: systematic review and meta-analysis. J Perinatol. 2013 Jul;33(7):558–64.
23. Sharma D, Farahbakhsh N, Shastri S, Sharma P. Biomarkers for diagnosis of neonatal sepsis: a literature review. J Matern Fetal Neonatal Med. 2018 Jun 18;31(12):1646–59.
24. Fairchild KD, Lake DE, Kattwinkel J, Moorman JR, Bateman DA, Grieve PG, et al. Vital signs and their cross-correlation in sepsis and NEC: a study of 1,065 very-low-birth-weight infants in two NICUs. Pediatr Res. 2017 Feb;81(2):315–21.
25. Tsai MH, Hsu JF, Chu SM, Lien R, Huang HR, Chiang MC, et al. Incidence, clinical characteristics and risk factors for adverse outcome in neonates with late-onset sepsis. Pediatr Infect Dis J. 2014 Jan 1;33(1):e7–13.
26. Almohammady MN, Eltahlawy EM, Reda NM. Pattern of bacterial profile and antibiotic susceptibility among neonatal sepsis cases at Cairo University Children Hospital. J Taibah Univ Med Sci. 2020 Feb 1;15(1):39–47.

How to cite this article: Dr. Girish Hiremath, Dr. Prabhakar Dharmatti, Dr. Harsha, Dr. S G Matti, PROGNOSTIC VALUE OF RED CELL DISTRIBUTION WIDTH IN NEONATAL SEPSIS: A PROSPECTIVE OBSERVATIONAL STUDY FROM A DISTRICT HOSPITAL IN SOUTH INDIA, Asian J. Med. Res. Health Sci., 2026; 4 (2): 2065-2070.
Source of Support: Nil, Conflicts of Interest: None declared.