e-ISSN: 0975-1556, p-ISSN:2820-2643
Available online on www.ijpcr.com
International Journal of Pharmaceutical and Clinical Research 2024; 16(5); 539-543

Original Research Article

Role of Modified Rodwell's Haematological Scoring System in Early Diagnosis of Neonatal Sepsis: A Study in Tertiary Care Centre of Central India

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Received: 25-02-2024 / Revised: 23-03-2024 / Accepted: 20-04-2024
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Conflict of interest: Nil

Abstract:

Background: Neonatal sepsis is the commonest and most important cause for the morbidity and mortality in developing countries like India. Neonatal sepsis, sepsis neonatorum and neonatal septicemia are terms that have been used to describe the systemic response to infection in newborn infants. The inability of neonates to completely muster the minimum inflammatory response makes them more susceptible to bacterial invasion of the blood stream than older children and the risk are even higher in preterm infants. HSS is very significant because of its easy availability, accessibility, low cost, less time consuming and can improve the diagnostic accuracy of complete blood count and it can be employed as screening test for diagnosis of sepsis.

Methods: This is cross sectional study. A total of 108 cases of neonatal age group were taken in this study. Blood culture, C-reactive protein and Modified Rodwell's Hematological Scoring System were measured in all cases.

Results: Of the 108 neonates in the present study, 35 had positive blood picture. Majority of neonates presented with early onset type of sepsis (88.57%). Individual hematological parameter like I:T PMN ratio (>0.2) and Degenerative changes is seen in most of septicemia. Hematological scoring system (HSS) >3 and >4 had better specificity and negative predictive value (NPV).

Conclusion: Hematologic scoring system is a useful test to distinguish the infected from non-infected infants. The hematologic scoring system is a simple, quick, cost effective and readily available tool with high sensitivity and specificity in the early diagnosis of neonatal sepsis. So it can be very well used as a screening test for early diagnosis of neonatal sepsis.

Keyword: Hematological scoring system, C-reactive protein, Septicemia.

Introduction

In developing countries, the incidence of neonatal sepsis varies from 1.8 to 18 per 1000 Live birth [1]. Neonatal mortality rate in India is 23/ 1000 Live births [2]. Neonatal sepsis is a devastating condition with a case fatality rate ranging from 30 to 50%. Early recognition and treatment can reduce the case related mortality to 10% [3]. Neonatal sepsis is a clinical syndrome resulting from pathophysiological effects of local and systemic infection in the first month of life. Neonatal sepsis is the response of neonates to any kind of infection. Neonatal sepsis can be early or late and most of the cases of early sepsis are within 24 hours. Most neonatal infection occur during the first week of life (early onset sepsis) and resulting from spread of microorganism colonizing the maternal genital tract into amniotic cavity. Male gender and low birth weight were frequently associated with sepsis; this is attributed to factors regulating synthesis of globulin which is situated on the X-chromosome and the low maternal IgM seen in low-birth-weight babies. [4] As the immune systems of neonates are weak, they are more susceptible to invasive infections. Premature are prone to serious infection by organ-

isms and partly because the signs of these infections may be absent or minimal and hard to detect, thus fatal septicemia may occur with little warning. Hence the timely diagnosis of sepsis in neonates is critical as the illness can be rapidly progressive and, in some instances, fatal [3].

The major problem in neonatal infections is the identification of the infected infant and the equally important task is of identifying the non-infected infant because sign and symptoms of neonatal sepsis are subtle and non-specific which makes it difficult to diagnose clinically. Blood culture is gold standard test but time consuming, which requires a minimum of 48-72 hrs and yields positive results in only 10-60% cases as shown in various studies [5,6]. Timely diagnosis of neonatal sepsis is very important because it can rapidly progress to critical condition as compared to adults. Early diagnosis of neonatal sepsis is the corner stone to reduce the case fatality rate. HSS may provide an effective guideline to make decisions regarding judicious use of antibiotic therapy which will be lifesaving, provide early cure, reduce mortality, shorten the hospital stay and as well as minimize the emergence of resistant organism due to misuse of antibiotics. It is estimated that 31% of global annual neonatal deaths related sepsis could be attributed to antimicrobial resistance. [7] In this study, we have attempted to diagnose the sepsis earlier, certain hematological parameters are evaluated and each of them is assessed to find the most suitable parameter and to correlate the results with blood culture report and C- reactive protein levels (CRP). Modified Rowell's hematological scoring system has been described in Table 1.[8,9,10]

Material and Methods

This cross sectional study was conducted in the Department of Pathology Dr. Bhim Rao Ambedkar Memorial Hospital, Raipur, Chhattisgarh during the period from March 2022- September 2022. A total of 108 neonates were taken in this study, of which 35 had positive blood culture for sepsis.

Inclusion Criteria: Neonates (<28days of age).

Exclusion Criteria: Neonates who have received antibiotics earlier.

- Neonates with immunodeficiency disorders.

Table 1: Modified Rodwell's hematological scoring system

Parameters	Abnormality	Score
Total WBC Count	< 5000µl	2
	≥ 25000 at birth	1
	≥ 30000 at 12-24hrs```````	1
	≥ 21000 day 2 onwards	1
Total PMN count	1800-5400 (Normal)	0
	No mature PMN	2
	Increased or decreased count	½
I:T PMN ratio	<0.2	0
	>0.2 (Increased)	1
Degenerative changes in PMN	Present	1
	Absent	0
Platelet count	≤ 1.5 lakhs/µl	1
	>1.5 lakhs/µl	0
Nucleated RBCs	<5%	0
	>5%	1

Ethical Clearance: The Institutional Ethics committee of Pt. J.N.M. Medical College Raipur, Chhattisgarh, India has approved the research work purposed to be carried out at Pt. J.N.M. Medical College Raipur, Chhattisgarh, India Date: 17/11/2022 with reference number MCR/ISC/ADM-2020/ST/218.

Statistical Analysis: Sensitivity, specificity, positive predictive value and negative predictive value were calculated for each parameter: p value was calculated for different parameters.

Appropriate statistics was used and $P < 0.05$ will be consider statistically significant.

Results

In this present study, the blood culture was positive in 32.4% of cases and negative in the remaining 67.6% of cases. 50.92% had preterm and 49.08% had term neonates, 58.33% of babies were males and 41.67% were females and male to female ratio was 1.4:1. Commonest age presentation group was 1 to 5 days with 77.77% of neonates, followed by 6 to 10 days with 13.88% and 11 to 30 days comprised of 8.33% of neonates. 47.22% of the neonates had normal birth weight which is ≥2500 grams, 37.96% of the neonates had low birth weight between 1500-2499 grams, 8.33% of the neonates had very low birth weight between 1000-1499 grams and 6.48% of the neonates had

extremely low birth weight which is less than 1000 grams. The mean birth weight was 2355.95 grams. In the present study, 54.62% of mothers had normal delivery, out of which, one was delivered by forceps. 45.37% of mothers had caesarean sections. In this study of 108 neonates, maternal risk factor for neonatal sepsis included prematurity in 55 cases, premature rupture of membranes in 47 cases and meconium stained liquor in 14 cases. These features showed overlapping in many cases. In the present study, lethargic and refusal to feed were the commonest complaints present in 52 and 39 neonates respectively. The other complaints were reduced movements, fever, seizures etc. Majority of the symptoms show overlapping. Peripheral blood film examination revealed thrombocytopenia as the most common finding present in 65 out of 108 cases, followed by neutrophilia in 52 cases, degenerative changes in 35 cases, nucleated RBCs (>5/100WBCs) in 33 cases, I:T PMN ratio in 20 cases, leucopenia in 15 cases, neutropenia in 15 cases and leucocytosis in 09 cases.

Table 2: Distribution of microbiological profile

S. No.	Microbiological profile (organism)	No. Of cases (n=35)
1	Coagulase negative staphylococcus	9
2	Staphylococcus aureus	7
3	Klebsiella pneumoniae	6
4	Acinobacter species	4
5	Candida species	4
6	E. coli	3
7	Streptococcus	1
8	Skin commensal growth	1

Commonest microbiological organism is Coagulase negative staphylococcus (25.71%, n=9) followed by Staphylococcus aureus (20%, n=7), Klebsiella pneumoniae (17.14%, n=6), Acinobacter species (11.42%, n=4), Candida species (11.42%, n=4) and E. coli (8.57%, n=3).**(Table 2)**

Table 3: Performance of of haematological scoring system

Score	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
≥2	94.28	73.34	64.70	96.49
≥3	82.85	91.78	82.85	91.78
≥4	51.42	98.63	94.73	80.89
≥5	20	100	100	72.27
≥6	5.71	100	100	68.86

In comparison with score ≥2, score ≥3 was more significant (P <0.0001). (Figure 1) Specificity and PPV were significantly higher as well 91.78% and 82.85% respectively. But considering the high specificity, positive predictive value this study implies that score ≥ 3 was more reliable as a screening tool for sepsis. (Table 3)

Table 4: Performance of individual haematological parameters

Findings	Sensitivity	Specificity	PPV	NPV	p-value
Thrombocytopenia	68.57%	43.83%	36.92%	74.41%	0.217
Neutrophilia	51.42%	53.42%	34.61%	69.64%	0.636
nRBC (>5nRBC/100WBC)	51.42%	79.45%	54.54%	77.33%	0.001
I:T PMN ratio (>0.2)	71.42%	98.63%	96.15%	82.80%	<0.001
Degenerative changes	80.00%	90.41%	80.00%	90.41%	<0.001
Neutropenia	25.71%	91.78%	60.00%	72.04%	0.013
Leucopenia	28.57%	93.15%	66.66%	73.11%	0.002
Leucocytosis	20.00%	97.26%	77.70%	71.71%	0.002

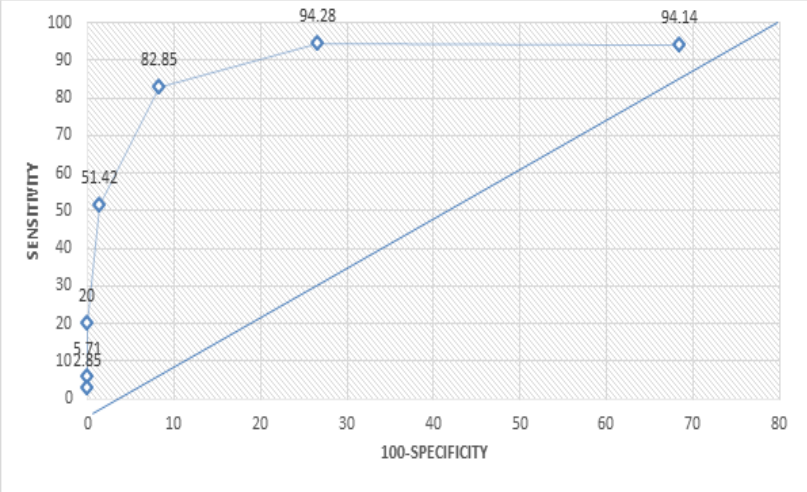

Figure 1: Receiver operating characteristics (ROC) curve of haematological scoring system. (Area under curve value for predicting sepsis was 0.6083, optimal cut-off value of Modified Haematological Scoring System for predicting presence of sepsis was ≥3 with p-value <0.001)

Discussion

Neonatal sepsis is a serious illness with high morbidity as well as mortality. Early diagnosis with prompt antibiotics therapy can significantly improve the outcome. So, a screening test is necessary for the detection and treatment of neonatal sepsis. Blood culture which is considered the gold standard has very low sensitivity due to pre and post-analytical factors and is also not available within the therapeutic window. In our study showed a culture positivity of 32.40%. The culture positive case were correlated with various hematological parameters, CRP reactivity and Modified Rodwell HSS to assess the sensitivity, specificity, positive predictive value, negative predictive value and their utility in the early diagnosis of sepsis.

Out of 35 sepsis proven cases 30 cases were C-reactive protein positive and 5 cases were C-reactive protein negative. Out of 73 sepsis negative cases 18 cases were C- reactive protein positive and 55 cases were C- reactive protein negative. The sensitivity of C- reactive protein in predicting sepsis was 85.71%, specificity was 75.34%, positive predictive value was 62.50% and negative predictive value was 91.66% (p-value <0.001). Similar result were seen in Supreetha MS et al study [11] in which sensitivity, specificity, PPV and NPV of C- reactive protein was 82%, 70%, 54% and 91% respectively.

In this study to evaluate and highlight the importance of Modified Rodwells Hematological Scoring System in early diagnosis of neonatal sepsis we use different cut-off value of Modified Hematological Scoring System. In this study out of 35 proven sepsis cases 29 cases have Modified Hematological Score ≥3 and 6 cases have Modified Hematological Score <3. Out of 73 sepsis negative cases 67 cases have Modified Hematological Scoring System <3 and 6 cases have Modified Hematological Score ≥3. In this study sensitivity of Modified Hematological Score ≥3 was 82.85%, specificity was 91.78%, positive predictive value was 82.85%, negative predictive value was 91.78%. Similar result were seen in Winson Chitra et al study [10] in which sensitivity, specificity, PPV and NPV of Modified Hematological scoring system diagnostic value at ≥3 cutoff score was 82.1%, 83.6%, 67.6% and 83.6% respectively.

In this study, out of 35 neonates with sepsis 18 neonates had Modified Hematalogical Score ≥4 and 17 had <4 score. Out of 73 sepsis negative cases 72 cases have Modified Hematological Scoring System <4 and 01 cases have Modified Hematological Score ≥4. The sensitivity of Modified Hematological Score ≥4 was 51.42%, specificity was 98.63%, positive predictive value was 94.73%, negative predictive value was 80.89%.

In our study thrombocytopenia p-value = 0.217, similar finding was seen in Aparna S et al study [12] in which thrombocytopenia p-value was more than 0.05 which is not significant. According to Ghos et al [13] platelet count in isolation is not reliable predictor of sepsis since thrombocytopenia is common in first week of life.

In this study, parameters such as thrombocytopenia and neutrophilia had insignificant p-value. Similar inference was given by Dulay et al [14].

As per study done by Tripathi and Malik(15), they found increased nucleated RBC (nRBC) count immediately after birth could be an interesting marker of early-onset neonatal sepsis (EONS) in absence of hypoxia which awaits further evaluation.

Among the various parameters of Hematological scoring system, I:T ratio (>0.2) had a significant p-value ($p<0.001$) and degenerative changes which had a significant value ($p<0.001$). (Table 4) This was similar to the studies of Aparna S et al [12]. In our study, we correlate the sensitivity, specificity, PPV, NPV of the various parameters with different groups and with the other studies. Elevated I:T ratio (>0.2) was found to be the most reliable indicator of sepsis in our study and also in various other studies like Ghos et al [13] and Narasimha and Harendra Kumar [3]. Studies by Aparna S et al[12] have shown a high specificity (94%) with neutropenia (ANC <1800), present study showed 25.71%, 91.78%, 60% and 72.04% of sensitivity, specificity, PPV and NPV for neutropenia.

Conclusion

Modified Hematological scoring system is useful test in early diagnosis of neonatal sepsis and score ≥3 could be used as an early diagnostic tool for neonatal sepsis.

Financial support and sponsorship

Nil

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