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Original Research Article

Study of Efficacy of Haematological Scoring System in Neonatal Sepsis

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Abstract:

Background: Neonatal sepsis is a clinical syndrome represented by signs and symptoms of infection, with or without associated bacteremia, in first 28 days of life. It is one of the commonest and most important cause for morbidity and mortality of neonates in developing countries like India. The gold standard test for sepsis is blood culture. But culture based diagnosis has its own constraints as it is time demanding with an assay time of up to 48-72 hours. In 1988, Rodwell gave a haematological scoring system for prompt diagnosis of neonatal sepsis. It covers numerous simple, bedside, cheap but reliable laboratory tests.

Aim: To study the haematological parameters including the changes in the peripheral blood smears of neonates clinically suspicious of having sepsis.

Objectives: To categorise haematological findings according to Rodwell haematological scoring system and to correlate the haematological score with blood culture.

Methods: This was a two year prospective study conducted from august 2022 to august 2024 at Department of Pathology, Jhalawar Medical College, Jhalawar, Rajasthan. Total 130 neonates clinically suspicious of neonatal sepsis were included in this study. Statistical correlation between Rodwell's HSS and blood culture was obtained using Chi square test.

Results: Out of total 130 cases, 71 neonates (54.62%) had a haematological score of ≥4 and 59 neonates (45.38%) had a haematological score <4. Rodwell's HSS achieved sensitivity of 95.0%, specificity 63.3%, positive predictive value 53.5% and negative predictive value 96.6%. The diagnostic accuracy of Rodwell's HSS was 73.07%.

Conclusion: When all the haematological parameters are used in combination as in Rodwell's HSS, the diagnostic accuracy is high. Because of its high sensitivity when HSS score ≥4 is used as a cut off for the presence of sepsis, HSS can be used as a useful screening tool against neonatal sepsis. Thus, Rodwell's haematological scoring system can aid in giving timely cure, shorten the hospital stay, reduce mortality and minimize the possibility of emergence of resistant organisms due to improper administration of antibiotics.

Keywords: Neonates, Sepsis, Rodwell's haematological scoring system, C-reactive Protein, Blood culture.

Introduction

Neonatal sepsis or septicaemia neonatorum is a clinical syndrome represented by signs and symptoms of infection, with or without accompanying bacteremia, in first 28 days of life. [1] Neonatal sepsis encompasses systemic infection of newborn including septicaemia, meningitis, pneumonia, arthritis ,osteomyelitis and UTI of newborn.1The overall incidence of neonatal sepsis varies between 1-8% cases of all live birth. [2] It is one of the commonest and most important cause for morbidity and mortality of neonates in developing countries like India. Neonatal sepsis leads to about 4 million deaths worldwide annually, 99% of which occur in developing countries. [3]

Neonates are uniquely prone to invasive disease because of their lack of fully responsive innate immunity. Attenuated immune responses often result in minimal or nonspecific clinical manifestations, and effective treatment requires attention to subtle signs of infection. Compared to older infants, newborns are often treated empirically while awaiting results of laboratory investigations. Preterm infants are particularly susceptible to infection because of their decreased innate immune and barrier defences and their prolonged stay in hospital settings.

Fortunately, Neonatal sepsis is a treatable condition if diagnosed early and treated with antibiotics promptly. However, the early warning signs and symptoms of neonatal sepsis are subtle and non specific. No dependable single tests are available making accurate and timely diagnosis a challenge for paediatricians. The search for a specific stand-

alone laboratory test or biochemical marker has evoked numerous researchers.

The gold standard test for sepsis is blood culture. But culture based diagnosis has its own constraints as it is time consuming with an assay time of up to 48-72 hours. It also requires a well-equipped microbiology laboratory. Statistically, out of the 7-13% of neonates assessed for sepsis, only 3-8% have culture-demonstrated sepsis. [4] Empirical use of antibiotics before culture often increases the risk of antibiotic side effects and emergence of drug resistant microorganisms.

The ideal diagnostic tests should give quick results with easy availability, should be cost effective and have high sensitivity, specificity, positive and negative predictive values.

In 1988, Rodwell gave a haematological scoring[5,6] for timely detection of neonatal sepsis. It includes various simple, bedside, cheap but reliable laboratory tests.

The current study is undertaken to evaluate the efficacy of the Rodwell haematological scoring system as an early indicator of neonatal sepsis.

Aim: To study the haematological parameters including the changes in the peripheral blood smears of neonates clinically suspicious of having sepsis.

Objectives:

1. To categorise haematological findings according to Rodwell haematological scoring system.
2. To correlate the haematological score with blood culture.

Materials and Methods

This was a two year prospective study conducted from august 2022 to august 2024 at Department of Pathology, Jhalawar Medical College, Jhalawar, Rajasthan. The inclusion criteria for the study were all the neonates (age less than <28 days) with clinically suspected infection(with fever, lethargy, poor feeding, low APGAR score and need for supplemental oxygen). The exclusion criteria included neonates with major congenital anomaly, Inborn errors of metabolism, Jaundiced due to blood group incompatibility and babies with respiratory distress syndrome. Total 130 neonates clinically suspicious of neonatal sepsis were included in this study. Under sterile precautions, blood sample was taken by peripheral venepuncture and the sepsis workup was done. 2 ml of the blood was collected in EDTA vial for routine haematological investigations including TLC, total PMN count, platelet count and PBF. 0.5 ml of the blood was transferred to the conventional blood culture tube for culture and sensitivity study. Haematological score obtained was finally correlated with the blood culture.

All the statistical calculations were done through SPSS for windows (version 29.0.2.0; SPSS Inc., IL, USA). P value was calculated using Chi-Square test. P value of less than 0.05 was considered to be significant.

Results:

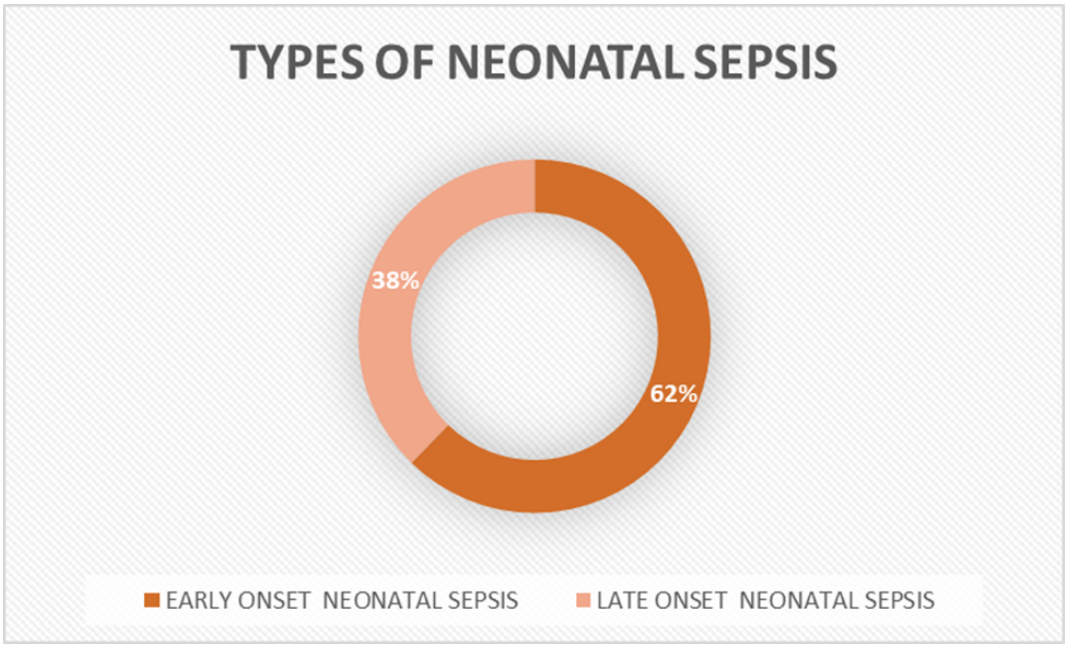

Figure 1: Distribution of neonates according to onset of disease (n=130)

Among the study population of 130 neonates, majority of the neonates (n=81, 62.3%) had early onset neonatal sepsis whereas 37.7% (n=49) had late onset neonatal sepsis.

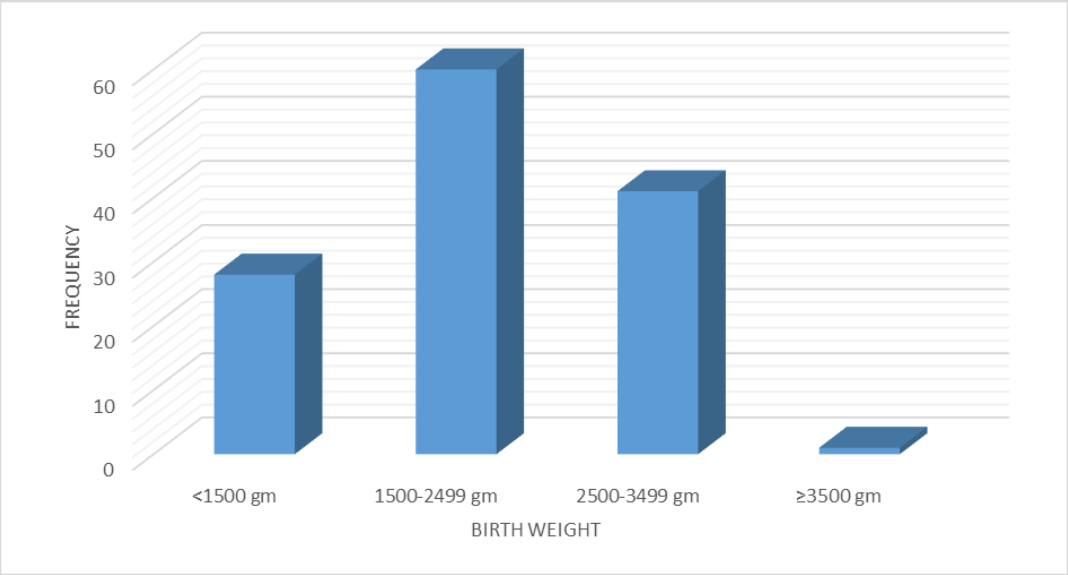

Figure 2: Distribution of neonates according to birth weight (n=130)

In the present study, majority of the neonates (n=60, 46.15%) had low birth weight and 21.54% (n=28) neonates had very low birth weight. 32.31% (n=42) neonates had normal birth weight. The mean birth weight of neonates was 2050 gm with standard deviation 650 gm.

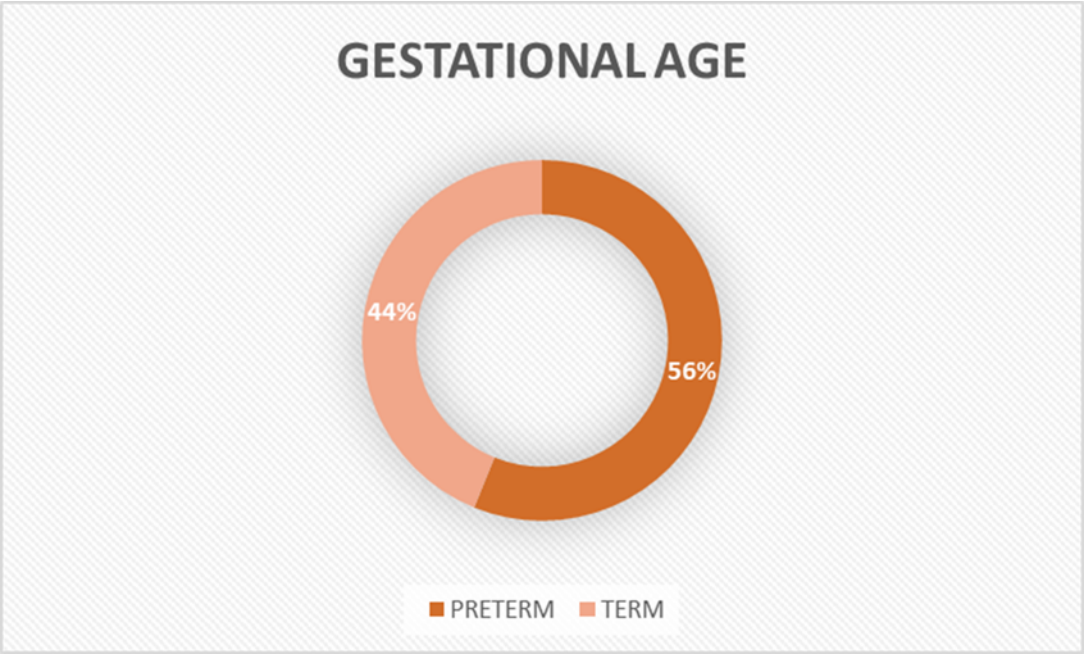

Figure 3: Distribution of neonates according to gestational age (n=130)

In the present study, majority of the neonates (n=73, 56.15%) were preterm.

Rodwell's haematological scoring system: According to Rodwell's haematological scoring system, 13.07% neonates were in the sepsis unlikely group(score ≤2), 65.38% neonates were in the sepsis possible group (score 3 or 4) and 21.55% neonates were in the sepsis very likely group(score ≥5).

Blood culture: In the present study, blood culture was positive in 30.77% cases (n=40) and negative in the remaining 69.23% cases (n=90).

Table 1: Comparison of haematological scoring system and blood culture (n=130)

Haematological score	Blood culture positive		Blood culture negative		Total	
	N	%	N	%	N	%
Sepsis unlikely (score ≤2)	0	0	17	13.07%	17	13.07%
Sepsis possible (score 3 or 4)	20	15.38%	65	50.00%	85	65.38%
Sepsis very likely (score ≥5)	20	15.38%	8	6.17%	28	21.55%
Total	40	30.77%	90	69.23%	130	100%

Out of all the 130 cases, occurrence of culture-positive cases is equal in sepsis possible group and sepsis very likely group (n=20, 15.38%). Among the culture-negative group, 17 cases (13.07%) were in sepsis unlikely group, 65 cases (50%) were in the sepsis possible group and only 8 cases (6.17%) were in the sepsis very likely group. This result was statistically significant (p value <0.001).

Statistical analysis: Taking haematological score 4 as a cut off, haematological scoring system was statistically analysed.

Table 2 : Diagnostic accuracy of haematological scoring system

Statistical parameters	
Sensitivity	95.0%
Specificity	63.3%
PPV	53.5%
NPV	96.6%
Accuracy	73.07%
P value	<0.001

The sensitivity of haematological scoring system was 95.0%, specificity was 63.3%, positive predictive value was 53.5%, negative predictive value was 96.6% and accuracy was 73.07%.

Table 3 : Performance of individual haematological parameters

Haematological parameters	Sensitivity	Specificity	PPV	NPV	P value
TLC	22.5%	77.8%	31.00%	69.3%	0.97
Total PMN count	90.00%	11.1%	31.00%	71.4%	0.85
Immature PMN count	95.00%	8.9%	31.7%	80%	0.44
I:T ratio	100%	38.9%	42.1%	100%	<0.001
I:M ratio	55.00%	83.3%	59.5%	80.6%	<0.001
Degenerative changes in PBF	57.5%	68.9%	45.1%	78.5%	0.004
Platelet count	35.00%	86.7%	53.8%	75.00%	0.004

I:T ratio, I:M ratio, degenerative changes in PBF and platelet count were significant indicators of sepsis (p value<0.05). Highest sensitivity was observed in I:T ratio followed by immature PMN count and total PMN count. Total leucocyte count had the lowest sensitivity. Highest specificity was observed in platelet count followed by I:M ratio and total leucocyte count. Immature PMN count had the lowest specificity. I:M ratio, platelet count, degenerative changes in PBF and I:T ratio had good positive predictive value. I:T ratio had the highest negative predictive value followed by I:M ratio, immature PMN count and degenerative changes in PBF.

Discussion

We conducted a cross sectional study, enrolling 130 cases in total.

In this study, early onset neonatal sepsis was found in majority of cases (62.3%) and late onset neonatal sepsis in remaining 37.7%. This was similar to the data observed in studies done by Sriram et al [7] and Bhale et al [8]. The higher proportion of EONS cases may be due to the immature immunological responses of neonates in the first few days of life, making them more susceptible to infections within the first few days of life. In this study and various studies conducted in past(Sriram et al7 and Vinay et al17), it was observed that most of the neonates with sepsis had low birth weight (<2.5 kg). Low birth weight babies are more susceptible to infection because of low levels of immunoglobulins and lower defense mechanism.

In our study, the neonates were mostly preterm (56%) and similar finding was observed in studies by Munazza Saleem et al [9] and Niza Monga et al [10]. The higher prevalence of neonatal sepsis in

preterm neonates is due to their poor immune system, low levels of immunoglobulins and low weight at birth.

In this study out of 130 neonates, 31% neonates were proved to have sepsis by blood culture, remaining 69% neonates were blood culture negative. This finding was comparable with the study done by Sneha Goswami et al [11] .Taking a score of 4 as a cut off in our study, haematological scoring system was observed to have high sensitivity (95%) and high negative predictive value (96.6%) which was comparable with the study conducted by Khalada Binte Khair et al12 (100% sensitivity and 100% NPV).

In our study, specificity of HSS was found to be 63.3% which was comparable with the study conducted by Khalada Binte Khair et al12 (60%) whereas positive predictive value (53.5%) in our study was much higher than that observed in the study by Khalada Binte Khair et al [12].

Table 4: Comparison of statistical parameters of HSS in various studies

Statistical parameters	Khalada Binte Khair et al (2011)[12]	Present study
Sensitivity	100%	95%
Specificity	60%	63.3%
PPV	26%	53.5%
NPV	100%	96.6%

Among the various parameters of haematological scoring system, I:T ratio, I:M ratio, degenerative changes in PBF and platelet count were observed to have significant p value (p value <0.05). This was similar to the studies of Rodwell[6] and Khair KB[12]. In our study, I:T ratio, immature PMN count and total PMN count were found to have high sensitivities (100%,95% and 90% respectively). Few other studies have also analysed the strength of individual parameters used in HSS. Abnormal I:T ratio was found to be the most sensitive indicator for the diagnosis of neonatal sepsis in the studies conducted by Ghosh et al[13], Narasimha et al[14] and Majumdar et al[15].An increase in the I:T and I:M ratio is due to the left shift seen in sepsis. When mature circulating neutrophils migrate towards the infected site to kill the invading microorganism in bacterial infection, a decrease in mature neutrophils in the circulation stimulates the bone marrow to release immature neutrophils.

In this study, TLC and platelet count were found to have the lowest sensitivities (22.5%, 35% respectively). Similar to our study, Priyanka and Hemalata study[5] demonstrated very low sensitivities for TLC (23.6%) and platelet count (34.6%). We found that platelet count, I:M ratio and TLC had high specificities (86.7%, 83.3% and 77.8% respectively). Similar results were observed by Priyanka and Hemalata[5] except of high specificity for immature PMN count (96.7%) which was observed to be very low in our study (8.9%). The reason for thrombocytopenia in neonatal sepsis could be explained as direct toxic injury of platelets, megakaryocytic suppression or presence of immune component due to higher level of platelet associated immunoglobulins[16].

The different parameters used in the HSS have individual strengths and weaknesses. The HSS uses them in combination to improve the accuracy of diagnosis of neonatal sepsis. Studies conducted on HSS to date have come to different conclusions regarding the strength of individual parameters used in the HSS. Most of these studies showed that these parameters are more reliable in the detection of sepsis when used in combination as HSS rather than individually.

Conclusion

The gold standard test for sepsis is blood culture. But culture based diagnosis has its own restrictions since it is time consuming and also requires a well equipped microbiology laboratory.

Haematological scoring system with a cutoff score of 4 can be utilised as a screening tool in neonates with clinical suspicion of sepsis. This test can be quickly analyzed even in resource-poor setups and provide guideline to the physicians to make judgements regarding judicious use of antibiotic therapy.

Thus Rodwell's haematological scoring system can aid in giving timely cure, shorten the hospital stay, reduce mortality and minimize the possibility of emergence of resistant organisms due to improper administration of antibiotics.

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