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Haematological Scoring System: An Early Predictor of Newborn Sepsis as Compared to Blood Culture at tertiary care centre

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ABSTRACT

Background: Newborn sepsis is a clinical syndrome characterised by infection-related signs and symptoms in the first month of life, with or without bacteraemia. Sepsis is defined by the Brazilian Health Surveillance Agency (ANVISA) as a systemic reaction with at least two or more of the following signs and symptoms: thermal instability, bradycardia, apnea, intolerance, worsening of respiratory discomfort, hypoactivity and lethargy.

Materials and Methods: This cross-sectional study was conducted in the Bal Chikitsalaya, M. B. Government Hospital, Udaipur (Rajasthan). A total of 100 sample sizes were included in between 6-month periods from March 2019 to August 2019. Blood culture reports were compared to haematological scoring parameters, C-reactive protein (CRP) levels, and other factors.

Results: 27% of the 100 cases under investigation had positive blood cultures. There were 65% male. 35% of neonates had very low birth weights and 60% were premature. 74% of cases of septicemia had an early onset, compared to 26% of cases with a late onset. In 37.1% of cases, klebsiella was the most frequent organism identified, followed by E. coli and Coagulase Positive Staphylococcus. It has a higher sensitivity and a lesser specificity. The PPV range of the haematological grading criteria was 47% to 65%. C-reactive protein has extremely high sensitivity (81.5%) and extremely low specificity (9.6%), respectively.

Conclusion: The early diagnosis of newborn sepsis can be made with the help of the Haematological Scoring System (HSS), which is a rapid, easy-to-use, readily accessible, bedside, cost-effective diagnostic. As opposed to blood cultures, haematological scoring factors are effective early diagnostic and treatment tools. Since the indicators have excellent sensitivity and specificity, antibiotics can be administered to asymptomatic patients with negative culture results. The accuracy of the sepsis diagnosis is improved.

KEYWORDS: Newborn sepsis, infection, haematological, CRP, blood culture.

ARTICLE DETAILS

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INTRODUCTION

Newborn sepsis is a clinical syndrome characterised by infection-related signs and symptoms in the first month of life, with or without bacteraemia. The term "neonatal sepsis" refers to a range of systemic infections that can affect a newborn, including septicemia, pneumonia, meningitis, osteomyelitis, arthritis, and urinary tract infections[1]. Local infections are typically used to describe superficial infections like oral thrush and pustules.

Sepsis is defined by the Brazilian Health Surveillance Agency (ANVISA)[2] as a systemic reaction with at least two or more of the following signs and symptoms: thermal instability, bradycardia, apnea, intolerance, worsening of respiratory discomfort, hemodynamic instability, hypoactivity, and lethargy. Sepsis has no known cause other than infection.

Neonatal Perinatal Database (NNPD)[3] data show that between 1 to 10 newborns per 1000 live births are reported to have neonatal sepsis in developed nations. Neonatal sepsis affects 30 out of every 1000 live births in India[4]. Around 2% of all foetuses worldwide develop infections while in utero, and 10% do so within the first month of life[5].

It is challenging to determine the true incidence in developing nations[6,7] like India because data from community settings are unavailable, and even in hospitals, and the diagnosis is frequently made solely on the basis of clinical factors. The most frequent cause of neonatal morbidity and mortality in developing nations is neonatal sepsis, which reports for 30–50% of all neonatal deaths there each year[3]. In India, sepsis in newborns is thought to be a factor in 15% of neonatal deaths. According to published data, sepsis accounts for about 10% of all maternal deaths and 26% of all neonatal deaths[8]. Over the past 20 years, sepsis-related mortality has risen by about 13.7% annually in developed nations[9].

Neonatal sepsis can have an early or late onset depending on when the first signs and symptoms appear, usually within the first 24 hours after birth[10]. Prematurity, low birth weight, invasive medical procedures, and prolonged hospitalisation are the main risk factors for neonatal sepsis.

Neonates have a weak immune system, making them more vulnerable to invasive infections. Infants who are born prematurely are more susceptible to infections than term newborns[11].

MATERIAL AND METHODS

This cross-sectional study was conducted in the Bal Chikitsalaya, M. B. Government Hospital, Udaipur (Rajasthan). Total 100 sample size included in between 6 month periods from March 2019 to August 2019. After taking into consideration the inclusion and exclusion criteria, all newborns (0-28 days of age) with clinically suspected infections admitted to Bal Chikitsalaya, M. B. Government Hospital, Udaipur (Rajasthan), were included. A thorough clinical history and physical examination of the patient were obtained.

The current study was conducted to compare the haematological scoring system to blood culture as an early predictor of neonatal sepsis in 100 cases. In each case, blood cultures were performed, and blood culture reports were compared to haematological scoring parameters, C-reactive protein levels, and other factors.

The neonate needs to undergo a physical examination after a thorough clinical history, perinatal risk factors, and significant maternal history were obtained. Following the initial clinical suspicion of infection, blood was drawn for quantitative C-reactive protein, blood culture, and tests for white blood cell count with differential cell count (haematological parameters).

RESULT

In this study, 100 newborns are tested for sepsis based on their clinical histories, signs, and symptoms they may have at the time of admission. Out of 100 cases, there were 65 male (65%) and 35 female (35%), for a male to female ratio of 1.85:1.

Out of 100 cases in the current research, 60% were preterm and 40% were full term. Preterm men were more impacted by early-onset sepsis (63.80%) than preterm females were by late-onset sepsis (62.50%). Males who were term in the EOS and LOS were 36.2% and 44.4%, respectively in (Table no. 1).

Table 1: Distribution of sepsis cases according to gestational age

Gestational age	Early onset (n=74)		Late onset (n=26)		Total
	Male	Female	Male	Female	
	No. (n=47) (%)	No. (n=27) (%)	No. (n=18) (%)	No. (n=8) (%)	No. (n=100) (%)
Pre Term	30 (63.8)	15 (55.6)	10 (55.6)	5 (62.5)	60 (60)
Term	17 (36.2)	12 (44.4)	8 (44.4)	3 (37.5)	40 (40)

Table 2: Blood culture distribution of sepsis

S. No.	Blood Culture	Positive	Negative
1	E. coli	7	73
2	Klebsiella	10	
3	Proteus	1	
4	Pseudomonas	1	
5	Coagulase Positive Staphylococcus	4	
6	Coagulase Negative Staphylococcus	2	
7	Streptococcus Faecalis	2	
	Total	27	73

In our analysis of 100 samples, 27 had positive blood cultures whereas 73 had negative blood cultures. Out of 27 blood culture positive cases, 10 showed growth of Klebsiella, 7 showed growth of E. coli, 4 showed growth

of Coagulase positive staphylococcus, and 2 showed growth of Coagulase negative staphylococcus and Streptococcus Faecalis in each case. Proteus and Pseudomonas both grew in one case.

Table 3: The sensitivity, specificity, positive predictive value, negative predictive value and p-value of haematological score parameters and C-reactive protein

Parameters	Sensitivity (%)	Specificity (%)	Positive predictive value (%)	Negative predictive value (%)	P-value
Total WBC count ≤5000/cu.mm or ≥25000/cu.mm, ≥30000/cu.mm and ≥21000/cu.mm, at birth, 12-24 hours and day 2 onwards respectively	85.2	71.2	52.3	92.9	<0.001
Total PMNs cell count	74.1	83.5	62.5	97.1	<0.001
Immature PMNs cell count	66.7	86.3	64.3	87.5	<0.001
I/T Ratio (>0.2)	74.1	79.5	57.1	89.2	<0.001
I/M Ratio (>0.3)	92.6	79.5	62.5	96.7	<0.001
Platelet count (<150000/cu.mm)	74.1	69.9	47.6	87.9	<0.001
Degenerative changes in PMNs (Toxic granules, Cytoplasmic vacuolations and Dohle bodies)	81.5	75.3	55	91.7	<0.001
C-Reactive protein ((>16 mg/L on 1st and 2nd day, >10mg/L on subsequent days)	81.5	9.6	25	58.3	0.222
>2 Parameters positive	88.9	86.3	70.6	95.5	<0.001
Haematological Score ≤ 2	11.1	38.4	6.3	53.9	-
Haematological score 3-4	25.9	65.8	21.9	70.6	-
Haematological score ≥ 5	63	95.9	85	87.5	-

[In table no.3] I/M ratio (92.6%), total WBC count (85.2%), degenerative alterations in PMNs (81.5%), and CRP (81.5%) shown high sensitivity in the current study. Immature PMN cell count (86.3%) had the highest specificity, which was followed by total PMN cell count (83.5%), I/T ratio (79.5%), and I/M ratio (79.5%). Immature PMN showed the most positive predictive value (PPV) (64.3%) and Total PMN showed the highest negative predictive value (NPV) (97.1%). In the current study, CRP had a p-value more than 0.05 and all seven haematological scoring factors had p-values less than 0.05.

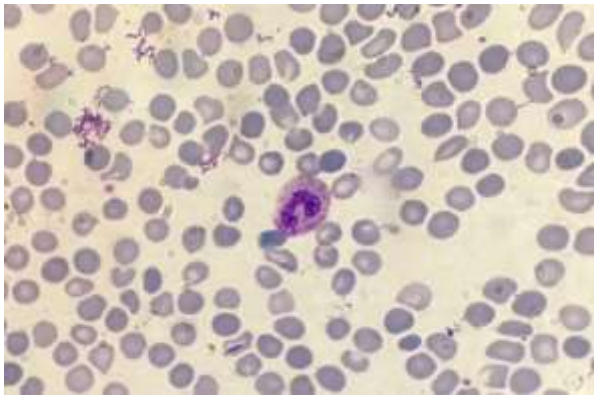

Figure 1: Mature and immature PMN – Giemsa stain (100X)

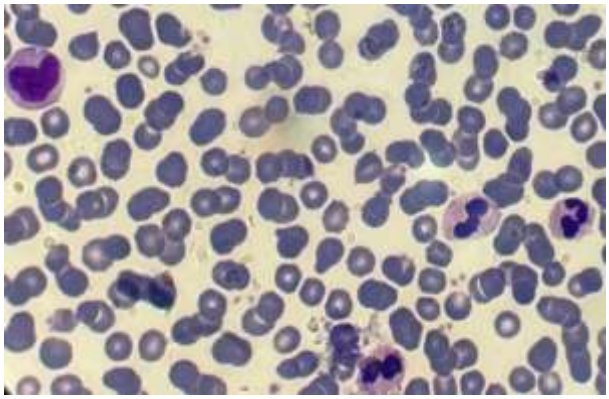

Figure 2: Band form with cytoplasmic vacuolations - Giemsa stain (100X)

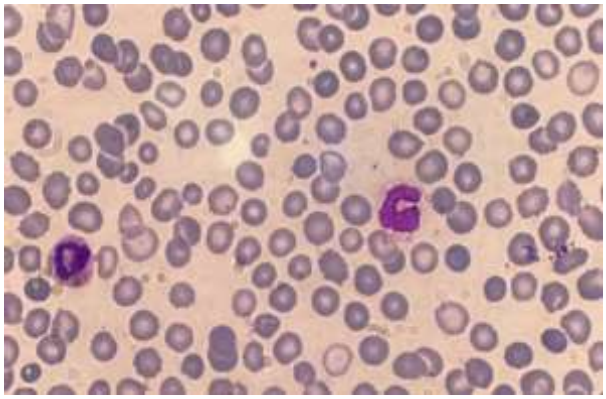

Figure 3: Band from with toxic granulations-Giemsa stain (100X)

For patients of sepsis with a positive culture, all haematological scoring values were significant. The sensitivity and specificity of the screening tests increased by more than 80% if two or more of the above tests were positive.

Sensitivity, specificity, positive predictive value, and negative predictive value all increased in the current study as the haematological score increased. Haematological score ≥5 showed sensitivity, specificity,PPV and NPV, 63%, 95.9%, 85%, and 87.5% respectively

Males were affected more commonly than females. Males dominated females in the current study, with a ratio of 1.85:1. Male:female ratios of 1.29:1, 1.22:1, 1.40:1, and 2.52:1 were observed by Vandana G et al[17] (2017),

DISCUSSION

In underdeveloped nations like India, newborn sepsis continues to be a major cause of mortality and morbidity. Early diagnosis and rapid administration of antibiotics are of the utmost importance in newborns. Blood cultures are still the gold standard for determining if a newborn has sepsis. There has been a significant delay in receiving the final report on how sensitive organisms are to different antibiotics.

Chandrakoshi G et al[18] (2018), Pinky P et al[19] (2018), and Priyanka T et al[20] (2018), respectively.

While Sriram[12] (2011), Das et al[21] (2016), and Seth Riti J et al[22] (2018) found that blood culture positivity in such cases was 50.4%, 55%, and 51.25% respectively, Duhan et al[15]

(2016), Vandana G et al[17] (2017), and Pinky P et al[19] (2018) observed 24.2%, 23.4%, and 26.7% blood culture positivity respectively, which was similar to our study. The low culture positive in these studies may be related to neonatal antibiotic use prior to blood collection for culture investigation or intrapartum antibiotic administration to mothers, which may alter the blood culture results in neonates.

Table 4: Comparative studies of C-reactive protein

Study	Sensitivity (%)	Specificity (%)	Positive Predictive Value (%)	Negative Predictive Value (%)
Sriram[12] (2011)	52	61.5	91.4	14
Jadhav et al[13] (2013)	90.7	37.5	73.1	68.2
Vinay et al[14] (2015	81.2	50	86.6	40
Duhan et al[15] (2016)	51.6	79.4	44.4	83.7
Anand U et al[16] (2017)	73.1	83.7	61.3	90
Present study (2019)	81.5	9.6	25	58.3

In comparison to research for CRP conducted by Sriram[12] (2011), Duhan et al[15] (2016), and Anand U et al[16] (2017), which found sensitivity to be 52%, 51.6%, and 73.1%, and specificity to be 61.5%, 79.4%, and 83.7% respectively, the current study's sensitivity is higher and its specificity is lower. High sensitivity (90.7 and 81.2%, respectively) and low specificity (37.5% and 50%, respectively) were reported by Jadhav et al[13] (2013) and Vinay et al[14] (2015), which were similar to our study's findings. Both Sriram[12] (2011) and Vinay et al[14] (2015) discovered low NPV in the range of 10–40% and high PPV (91.4% and 86.6%, respectively). PPV was observed to be between 40% and 60%, and NPV was observed to be between 80% and 90% by Duhan et al[15] (2016) and Anand U et al[16] (2017).

All of the haematological scoring factors in our analysis had a significant correlation with culture-positive sepsis. We found that the I/M ratio and total WBC count were more sensitive. Total PMN cell count was followed by Immature PMN cell count, both of which demonstrated great specificity. I/M ratio came in second, with a high negative predictive value. The positive predictive values for each haematological scoring criteria ranged from 47% to 65%. The sensitivity and specificity of C-reactive protein were both very high (81.5%) and very low (9.6%), respectively. All seven of the haematological scoring indicators in our study were statistically significant predictors of newborn sepsis (p-value<0.05), although CRP was not (p-value >0.05). Sepsis risk rose with a higher haematological score (≥5).

CONCLUSION

For the early identification of neonatal sepsis, the Haematological Scoring System (HSS) is a quick, straightforward, readily accessible, bedside, reliable, and economical technique. It increases the accuracy of sepsis diagnosis. In comparison to blood cultures, haematological scoring factors are effective early diagnostic and treatment tools. In cases when a culture was negative and there were no symptoms, antibiotics might be administered because of the high sensitivity, specificity, and negative predictive value of the haematological data. This aids medical professionals in early newborn sepsis prediction and antibiotic medication initiation to minimize sepsis-related complications. Additionally, this helps to prevent the overuse of antibiotics and the emergence of resistance.

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