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Original Research Article

A Prospective Hospital-Based Study to Evaluate the Utility of the Hematological Scoring System (HSS) in the Early Diagnosis of Neonatal Sepsis

Ashok Kumar[1], Ajay Kumar[2]

[1]Assistant Professor, Department of Pathology, Jannayak Karpoori Thakur Medical College & Hospital, Madhepura, Bihar, India

[2]Assistant Professor, Department of Pathology, Jannayak Karpoori Thakur Medical College & Hospital, Madhepura, Bihar, India

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Corresponding author: Dr. Ajay Kumar

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Abstract

Aim: The aim of the present study was done to evaluate the utility of the hematological scoring system (HSS) in the early diagnosis of neonatal sepsis.

Methods: The prospective study was conducted in the Department of Pathology, Jannayak Karpoori Thakur Medical College & Hospital, Madhepura, Bihar, India for the period of one year. A total of 200 neonates in the department of pediatrics and neonatology were included in the study.

Results: A total of 200 neonates were classified into three categories, sepsis (n=90), probable infection (n=40), and normal (n=70), based on the clinical examination and laboratory findings. The total number of culture positive cases was 90 (45%) and culture was bacteriologically negative in 120 (60%) cases. The total number of preterm babies was 110 (55%) while 90 (45%) were term babies. Preterm babies were more affected by sepsis than term babies. There were 120 (60%) males and 80 (40%) females. Five (12.5%) of the normal neonates had score ≥5 suggesting the presence of sepsis, 15 (21.42%) had scores 3-4 suggesting possibility of sepsis, and 50 (71.42%) normal cases had scores ≤2 which suggested less likely sepsis in these cases.

Conclusion: Diagnosis of neonatal septicemia may be difficult as the early signs of sepsis may be subtle and different at different gestational ages. The HSS is a simple, quick, and cost-effective tool which can be used as screening test for early diagnosis of neonatal sepsis.

Keywords: Blood Culture, Hematological Scoring System, Neonatal Sepsis.

Introduction

Neonatal sepsis is defined as a clinical syndrome of bacteraemia with systemic signs and symptoms of infection in the first 4 weeks of life. When pathogenic bacteria gain access into the blood stream, they may cause overwhelming infection without much localization or may get predominantly localized to the lung or the meninges. [1]

Neonatal sepsis is responsible for about 30-50% of the total neonatal deaths in developing countries. Though, it is a life-threatening condition, yet treatable if diagnosed early. It is a vexing problem

because of its nonspecific clinical picture. , which makes it difficult to establish an early clinical diagnosis. [2] Newborns, especially the premature are prone to serious infections, because the signs of these infections may be absent or minimal and hard to detect. [3] Thus, fatal septicaemia may occur with little warning. Timely diagnosis of sepsis in neonates is critical as the illness can be rapidly progressive and in some instances fatal. [4] The overall incidence of neonatal sepsis occurs between 1and 8 per 1000 live births. In developing countries, mortality rate is between 11-68 per 1000 live births. Neonatal sepsis can be divided into two subtypes: early and late, depending upon whether the onset of symptoms is during the first 72 hours of life or later. [5] Early diagnosis of neonatal septicaemia is still a great challenge. For early diagnosis of neonatal septicaemia, a hematologic scoring system (HSS) of Rodwell [includes total & differential leukocyte count, total neutrophil count, immature & total neutrophil ratio (IT ratio), immature & mature neutrophil ratio (IM ratio), total immature polymorphonuclear cell (PMNs) count & platelet count is preferable because it includes all parameters. [6]

A systematic review and meta-analysis conducted in Ethiopia confirmed that the prevalence of neonatal sepsis was found to be 45%. The Amhara region had the highest prevalence of neonatal sepsis (64%). [7] Hematological parameters are straightforward variables that may be derived from a patient's hemogram. [8] The ability to count the various subsets of leukocytes in a patient's peripheral blood is a helpful tool for detecting a variety of disorders and diseases. [9]

The aim of the present study was done to evaluate the utility of the hematological scoring system (HSS) in the early diagnosis of neonatal sepsis.

Methods

The prospective study was conducted in the Department of Pathology, Jannayak Karpoori Thakur Medical College & Hospital, Madhepura, Bihar, India for the period of one year. A total of 200 neonates in the department of pediatrics and neonatology were included in the study.

Inclusion criteria

The study included all neonates with features of sepsis and those neonates having predisposing factors or history suggestive of sepsis.

Exclusion Criteria

Neonates born to known immunocompromised mother, with a suspicion of TORCH, malaria, congenital abnormalities, hemolytic jaundice, or inborn error of metabolism, who received antibiotics before taking blood for culture were excluded from the study.

Informed consent was taken from the parents of all the neonates. Taking all aseptic precautions, 2 ml of blood was withdrawn from suspected neonates within 24 h of admission. One milliliter of sample was anticoagulated with EDTA and using Sysmex XS-800i automated hematology analyzer, values of TLC and platelet count were noted and counter checked. Another 1 ml of blood was collected in red Vacutainer and allowed to rest for 30 min. It was then centrifuged and the serum was obtained for CRP estimation. Peripheral blood smear (PBS) was also made from the collected sample and was stained by Leishman's stain. PBS was examined for immature neutrophils and degenerative changes in neutrophils. All PBSs were analyzed in the department of pathology, using HSS as proposed by Rodwell et al. HSS assigns a score of 1 for each of the seven criteria found to be significantly associated with sepsis with the exception of score of 2 for an abnormal total polymorphonuclear neutrophils (PMNs) count.

Score	Interpretation
≤	Sepsis is very unlikely
3 or 4	Probable sepsis
≥	Sepsis or infection is very likely

Sensitivity, specificity, and positive predictive value (PPV) were calculated for each parameter. p value was also calculated for different parameters. Data were compiled and statistical analysis was done using the SPSS software.

Results

Table 1: Hematological scoring system

Criteria	Abnormality	Score
Total WBC count	≤5000/Ml ≥25,000 at birth ≥30,000 after 12–48 h ≥21,000 day 2 onward	1 1
Total PMN count	No mature PMN seen Increased/decreased	2 1
Immature PMN count	Increased	1
I:T PMN ratio	Increased	1
I:M PMN ratio	≥0.3	1
Degenerative changes in PMN	Toxic granules/cytoplasmic vacuoles	1
Platelet count	≤150,000	1

A total of 200 neonates were classified into three categories, sepsis (n=90), probable infection (n=40), and normal (n=70), based on the clinical examination and laboratory findings. The total number of culture positive cases was 90 (45%) and culture was bacteriologically negative in 120 (60%) cases. The total number of preterm babies was 110 (55%) while 90 (45%) were term babies. Preterm babies were more affected by sepsis than term babies. There were 120 (60%) males and 80 (40%) females.

Table 2: Distribution of cases according to sepsis score

Sepsis score	Score 0-2 (%)	Score 3-4 (%)	Score >5 (%)
Sepsis (90)	0	12 (13.34)	78 (86.66)
Probable Sepsis (40)	5 (12.5)	20 (50)	15 (37.5)
Normal (70)	50 (71.42)	15 (21.42)	5 (7.14)
Total	55	47	98

Five (12.5%) of the normal neonates had score ≥5 suggesting the presence of sepsis, 15 (21.42%) had scores 3-4 suggesting possibility of sepsis, and 50 (71.42%) normal cases had scores ≤2 which suggested less likely sepsis in these cases.

Table 3: Sensitivity, specificity, and PPV of each test

Investigations	Sensitivity (%)	Specificity (%)	PPV (%)
Total leukocyte count	60.80	90.60	82.38
I:T ratio	92	89	85.75
I:M ratio	58	92.18	84.37
Platelet count	65.25	81.29	71.49
Degenerative changes in PMN	70	62.5	51.14
Immature PMN count	96	87.50	84.61
PMN count	91.3	65.64	65.62

In our study, HSS had a sensitivity of 86.95% and specificity of 78.12%. HSS had PPV of 74.07% and $p < 0.0001$. White blood cells (WBCs) count had sensitivity of 60.80% and specificity of 90.60%. PPV was 82.38%. This result was statistically significant. Platelet count showed sensitivity of 81.29%, PPV was 71.49% and $p<0.0001$. Cells with degenerative changes showed sensitivity of 70% and specificity of 62.5%. PPV of the test was 51.14% and $p=0.0016$.

Discussion

Neonatal sepsis is one of the most common causes of neonatal mortality and morbidity. However, its early diagnosis is challenging. Blood culture is the gold standard test for diagnosing sepsis, but it has low sensitivity and delay in the culture reports that lead to injudicious use of antibiotics. HSS including blood parameters serves as useful tool in the early diagnosis and management of neonatal sepsis. [11]

Neonatal sepsis is defined by systemic infections in first 28 days of life. [10] Preterm birth complications and infections are the largest contributors to the neonatal mortality. The incidence of neonatal sepsis according to the data from National Neonatal Perinatal Database (NNPD, 2002-03) is 30 per 1000 live births. [12] Mortality due to sepsis can be prevented by early diagnosis, rational use of antibiotics and aggressive supportive care. However, early recognition is difficult as the sign and symptoms of early sepsis are non-specific. Blood culture is regarded as the gold standard test, but it takes around 48-72 hours. Further yield of blood culture is 30-70 %, so some neonates may be missed. [11]

In the present study, the distribution of cases according to sepsis score showed accuracy of 86.95%. This result was consistent with the studies by Rodwell et al. (96%), Narasimha and Harendra Kumar (100%), and Makkar et al. (83.33%). HSS had a sensitivity of 86.95%, specificity of 78.12%, PPV of 74.06%, and net present value (NPV) of 89.2%. Saleem et al. also found that the HSS was having a sensitivity of 90%, specificity of 74.5%, PPV of 65.9%, and NPV of 93.2%. Manucha et al. observed that hematological score ≥3 had a sensitivity of 86% and NPV of 96%. [13] In our study, there were 132 (60%) male and 88 (40%) were female which are similar to the observation made by other authors also.

In the present study, 90 (45%) cases were culture positive. Sugandhi et al. [14] observed culture positivity in 42.5% of cases, Namdeo et al. [15] in 50% of cases, and Khatua et al. [16] found culture positivity in 59.8% of cases. In our study, increased or decreased WBC count had a sensitivity of 60.86%, specificity of 90.62%, and PPV of 82.35% which was consistent with other studies. Makkar et al. found that increased or decreased WBC count had a sensitivity of 56.2% and specificity of 91.71%. [17]

Thrombocytopenia is associated with poor prognosis in neonatal sepsis. In the present study, 30 of 46 culture-positive cases had thrombocytopenia with a sensitivity of 65.21%, specificity of 81.29%, and PPV of 71.49% which was consistent with other studies. Shiraji et al. [18] found that thrombocytopenia was 61% sensitive and 82% specific. Speer et al. [16], Rodwell et al. [19], and Basu et al. [20] also found thrombocytopenia to be associated with neonatal sepsis.

In our study, CRP had a sensitivity of 66%, specificity of 78%, and PPV of 68.18%. Mathers and Pohlandt [21] observed sensitivity of 61% and specificity of 76% for CRP values. Wagle et al. [22] found CRP values to be 62% sensitive and 87% specific. Chan and Ho observed CRP as 56% sensitive and 72% specific. [23,24]

Conclusion

Diagnosis of neonatal septicemia may be difficult as the early signs of sepsis may be

subtle and different at different gestational ages. The HSS is a simple, quick, and cost-effective tool which can be used as screening test for early diagnosis of neonatal sepsis. It is applicable to all infants, including those who have received antibiotic therapy before evaluation and simplifies the interpretation of hematologic profile.

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