Original Article

Role of Hematological Scoring System in Diagnosis of Neonatal Sepsis

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Abstract

Background: Neonatal sepsis is one of the major causes of morbidity and mortality in the newborn, more so in the developing countries. The incidence of neonatal sepsis has been reported to be 30/1000 live births according to National Neonatal Perinatal Database. **Objectives:** To analyze the diagnostic utility of hematological scoring system (HSS) and its correlation with C-reactive protein and blood culture in neonatal sepsis. **Materials and Methods:** This prospective study included 150 neonates admitted to Neonatal Intensive Care Unit with clinical suspicion of neonatal sepsis from November 2012 to April 2014, considering the inclusion and exclusion criteria. **Results:** HSS had the highest sensitivity (93.7%) and identified >90% of neonates with clinical suspicion of sepsis. Furthermore, total leukocyte count showed high specificity but least sensitivity, immature to total ratio and immature to mature ratio showed high specificity and high sensitivity, and platelet count showed high negative predictive value and least positive predictive value. **Conclusion:** HSS is a simple, easy, cheap, and rapid adjunct for the diagnosis of clinically suspected cases of neonatal sepsis.

Keywords: *Hematological scoring system, immature to mature neutrophils ratio, immature to total neutrophils ratio, neonatal sepsis*

Introduction

Neonatal sepsis is a clinical syndrome resulting from pathophysiologic effects of local and systemic infection in the 1st month of life. Septicemia usually consists of bacteremia with a constellation of signs and symptoms caused by microorganisms or their toxic products in the circulation. The presence of signs and symptoms distinguishes this condition from transient bacteremia observed in some healthy neonates.[1]

The infection can be contracted from the mother through transplacental route, ascending infection, during passage through an infected birth canal, or exposure to infected blood at delivery.[2] The newborn infants are more prone to bacterial invasion than the older children or adults, due to their weaker immune system, premature babies being even more susceptible.[3]

Neonatal sepsis was one of the common causes of neonatal mortality, contributing to 16% of all intramural deaths.[3] Early diagnosis of sepsis is difficult due to its nonspecific clinical presentation. Although blood culture is considered to be the gold standard for diagnosis of septicemia, the technique is time consuming and demands a well-equipped laboratory, which is not available in most of the community hospitals.

Various studies have shown that hematological parameters are simple, quick, and cost-effective tools in the early diagnosis of neonatal sepsis. When these were studied together as combination of tests, it had proved that they increased both sensitivity and specificity. They are also useful early predictors of neonatal septicemia; thus helping to initiate early treatment with appropriate antibiotics.[4]

Here, in this study, we evaluate the performance of the hematological scoring system (HSS) of Rodwell *et al*. in 110 neonates for the early detection of sepsis in high-risk infants, which should improve the diagnostic accuracy of the complete blood cell count as a screening test.[5] The present study is undertaken to evaluate the utility of the HSS in the early diagnosis of neonatal sepsis.

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Materials and Methods

The present prospective study was conducted in Department of Pathology, Shri B. M. Patil Medical College and Hospital, Bijapur, from November 2012 to April 2014. A total number of 150 neonates were included in this study with clinical suspicion of sepsis. Under complete aseptic conditions, 0.5–1 ml of blood sample was obtained by peripheral venipuncture. The samples were collected in tripotassium EDTA containing nonsiliconized vacutainer tubes. Sepsis workup involved complete blood counts along with hematological score and culture. Total leukocyte and differential counts, absolute neutrophil counts (ANCs), and platelet counts were measured using Sysmex XN-1000 automated analyzer. Peripheral smears were examined by Leishman's stain for immature neutrophils and degenerative changes in neutrophils. Differential counts were performed on these smears by counting at least 200 cells. All the peripheral blood smears were analyzed by pathologists blinded to the infection status of these infants, using HSS of Rodwell *et al*. HSS assigns a score of 1 for each of seven findings significantly associated with sepsis: abnormal total leukocyte count, abnormal total polymorphonuclear neutrophil (PMN) count, elevated immature PMN count, elevated immature to total (I:T) PMN ratio, immature to mature (I:M) PMN ratio ≥0.3, platelet count ≤150,000/cumm, and pronounced degenerative or toxic changes in PMNs. An abnormal total PMN count is assigned score of two instead of 1 if no mature polymorphs are seen on the peripheral smear to compensate for the low I:M ratio [Table 1].

Immature polymorphs include promyelocyte, myelocyte, metamyelocytes, and band forms. Band cell is described as a PMN in which the nucleus is indented by more than one-half, but in which, the isthmus between the lobes is wide enough to reveal two distinct margins with nuclear material in between. Degenerative changes include vacuolization, toxic granulations, and Dohle bodies [Figure 1]. Score of ≤ 2 is considered as lower risk; score 3-4 as moderate risk; and score ≥ 5 as higher risk for developing sepsis. Minimum score that can be obtained is 0 and maximum score up to 7.

Statistical analysis

Sensitivity, specificity, positive and negative predictive values (NPVs) were calculated for each parameter; *P* value was also calculated for different parameters.

The research work was approved by the Institutional Ethical Committee and the informed consent was also obtained from the parents of all the neonates.

Results

Out of the 150 neonates, 40 (26.7%) were preterm and 110 (73.3%) were term. The study had 100 (66.7%) males and 50 (33.3%) females [Table 2].

Total culture-positive cases - 48 (32%) and culture-negative cases - 102 (68%) [Figure 2].

Out of 150 cases, all 48 (32%) culture-positive cases showed hematological score ≥5. Among culture-negative cases, 25 (16.7%) cases had score 0–2 and 77 (51.3%) cases had score 3–4. This result was statistically significant ($P < 0.001$) [Table 3].

Out of 150 cases, all 43 (89.6%) C-reactive protein (CRP) reactive cases showed hematological

Table 1: Hematological scoring system

Criteria	Abnormality	Score
Total leukocyte count (cells/cumm)	<5000 >20,000	1
ANC (cells/cumm)	<1800	1
Immature neutrophil count (cells/cumm)	<1200	1
I:T	≥0.2	1
I:M	≥0.3	1
Platelet count (cells/cumm)	<150,000	1
Degenerative changes in neutrophils	Toxic granules cytoplasmic vacuoles	1

I:T – Immature to total neutrophils ratio; I:M – Immature to mature neutrophils ratio; ANC – Absolute neutrophil count

Table 2: Association of neonatal age and sex with culture results

Culture	Preterm		Term		Total
	Male	Female	Male	Female	
Positive	25	6	8	9	48
Negative	9	0	58	35	102
Total	34	6	66	44	150

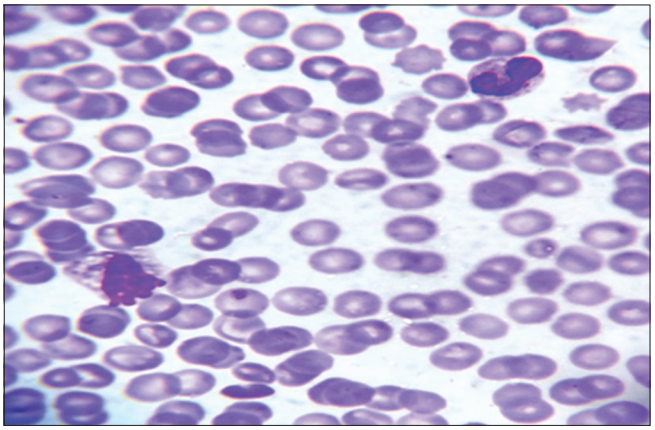

Figure 1: Peripheral blood film showing band form and cytoplasmic vacuolization, (Leishman stain, ×1000)

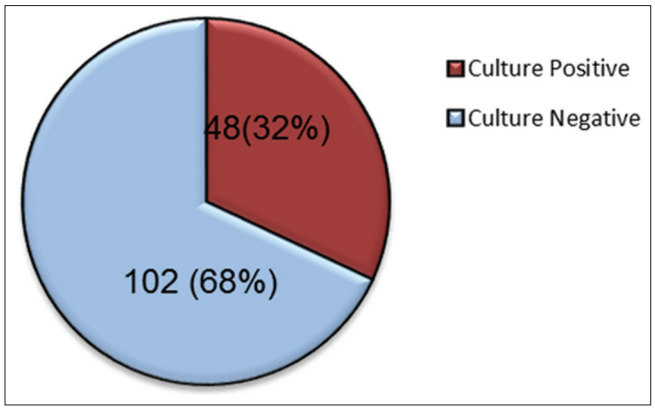

Figure 2: Pie chart showing distribution of cases according to culture results

score ≥5 and 54 (70.1%) cases with score 3–4 showed CRP reactive. All 25 cases with score 0–2 showed CRP nonreactive. This result was statistically significant ($P < 0.001$) [Table 4].

Total leukocyte count showed high specificity (74.5%) but least sensitivity (66.7%). ANC showed high specificity (92.1%) but least sensitivity (45.8%). I:T ratio showed high specificity (92.1%) and high sensitivity (91.6%). I:M ratio showed high specificity (94.2%) and high sensitivity (93.7%). Platelet count showed high NPV (58%) and least positive predictive value (PPV) (56%) [Table 5].

Discussion

Neonatal sepsis is a serious illness with high morbidity and mortality. Although it is a life-threatening condition, it is treatable due to advancement in antibiotic therapy. The limitations in the diagnosis of neonatal sepsis are frustrating for clinicians; at present, there is no single test which meets the criteria of an ideal diagnostic test.[6,7,8,9] Although blood culture is the most definitive test for the diagnosis of neonatal sepsis, it has low sensitivity and leads to delay in the diagnosis.

Nowadays, prophylactic use of antibiotics came under vigorous scrutiny due to the development of drug resistance, cost of unnecessary therapy, and problems of drug toxicity. Therefore, quick diagnostic tests with greater sensitivity are desirable, and we need a useful screening protocol where a balance must be achieved between sensitivity and specificity.[10] Hence, consider four characteristics of laboratory tests when evaluating neonates for possible sepsis, i.e., sensitivity, specificity, PPV, and NPV. Thus, realizing the importance of early and correct diagnosis of neonatal septicemia and unnecessary burden of antibiotics in these cases, many studies have made an attempt to diagnose septicemia by means of simple scoring called as HSS.

Table 3: Comparison of hematological scoring system with culture results

HSS	Culture		Total
	Positive	Negative	
0-2	0	25	25
3-4	0	77	77
≥5	48	0	48
Total	48	102	150

HSS – Hematological scoring system

Table 4: Hematological scoring system comparison with C-reactive protein

HSS	CRP		Total
	Reactive (%)	Nonreactive (%)	
0-2	0	25 (100)	25
3-4	54 (70.1)	23 (29.9)	77
≥5	43 (89.6)	5 (10.4)	48
Total	97	53	150

HSS – Hematological scoring system; CRP – C-reactive protein

Table 5: Sensitivity, specificity, positive predictive value, and negative predictive value of each test

	Sensitivity (%)	Specificity (%)	PPV (%)	NPV (%)
TLC	66.7	74.5	48	87
ANC	45.8	92.1	46	92
I:T	91.6	92.1	92	93
I:M	93.7	94.2	93	94
Platelet	56.3	55.9	56	58

TLC – Total leukocyte count; ANC – Absolute neutrophil count; I:T – Immature to total neutrophil ratio; I:M – Immature to mature neutrophil ratio; PPV – Positive predictive value; NPV – Negative predictive value

In our study, we correlated the sensitivity, specificity, PPV, and NPV of the various parameters with different groups and also with the other studies. Elevated I:T ratio was found to be the most reliable indicator of sepsis in our study and also in various other studies like those done by Ghosh *et al*. and Narasimha and Harendra Kumar.[10-12]

Thrombocytopenia was frequently associated with sepsis and indicated poor prognosis. This is thought to be due to increased platelet destruction, sequestration secondary to infections, failure in platelet production due to reduced megakaryocytes or damaging effects of endotoxin. This correlated well with various other studies done by Speer *et al*., Rodwell *et al*., Sriram, and Makkar *et al*.[13-15]

Variety of other rapid detection methods of microorganisms such as DNA probes, automated blood culture system, and fluorometric detection systems are available, but HSS can still be used as a screening test for diagnosing sepsis.

Conclusion

HSS is simple, quick, and cost-effective tool which includes blood parameters and can be performed easily at the primary health care center level also as routine screening of all clinically suspected cases of neonatal septicemia thus helps to provide early diagnosis and effective guidelines for the management of neonatal sepsis.

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Conflicts of interest

There are no conflicts of interest.

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