Original Article

Estimation of Parameters of Haematological Scoring System in Early Diagnosis of Neonatal Sepsis

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Abstract

Background: Neonatal septicemia is one of the major factors contributing to high perinatal and neonatal mortality and morbidity. The definite diagnosis of septicemia is made by a positive blood culture which requires a minimum period of 48-72 hours and yields a positive result in 30-70% of cases. Hence there is a critical need for laboratory tests that aid in rapid diagnosis of neonatal sepsis.

Materials and Methods: Study was conducted in neonates with suspicion of sepsis admitted to NICU. Prospective study was done for 114 clinically suspected neonatal septicemia cases. Hematological parameters were measured and culture positivity and CRP was taken as the criterion for definitive diagnosis of neonatal septicemia.

Results: 59.6% were culture & CRP positive, 67% were male, and 67% were low birth weight neonates (<2.5 kg). Immature PMN cell, Immature : Total Neutrophil Ratio and Immature : Mature Neutrophil Ratio shows highest sensitivity (69%), Total Leucocyte Count shows highest specificity (70%) and Platelet count shows highest predictive values.

Conclusion: Hematological parameters are particularly useful in resource poor settings for early screening of septicemia as availability of blood culture is limited and time consuming. Clinical profile of neonates was also useful in screening of infected individuals. So, amalgamation of clinical and hematological parameters is useful in screening as it is simple, quick, cost effective and readily available tool.

Keywords: Hematological scoring system; Neonatal septicemia; Early diagnosis; Neutrophil; Platelet count

Introduction

Neonatal septicemia is one of the commonest clinical problems encountered by the pediatricians. It accounts for major cases of neonatal mortality and morbidity and at the same time its diagnosis remains challenging.

The early signs of neonatal septicemia may be subtle and it is important not only to recognize the neonates with septicemia but also to identify the non infected neonates. The illness progresses more rapidly in newborns than the adults.

The primary objective of the clinician caring for infants at risk for neonatal infections is to identify all potential cases of bacterial diseases quickly and begin antibiotic therapy promptly. It is important, however, to determine which of these cases represent true infection and thus require a full course of antibiotics and which do not.

Definite diagnosis of neonatal sepsis requires positive blood culture, a process which takes around 48- 72 hours.

Rodwell et al [1] gave a Hematological Scoring System (HSS) for early diagnosis of neonatal sepsis in high risk infants. This scoring system takes seven hematological parameters into account and assigns a score. The total score thus ranges from 0-8, and it has been suggested that if the total score is less than 2, sepsis is very unlikely and if the score is more than 5 the likelihood of sepsis is very high.

Measures of cytokines, acute phase proteins, cell surface antigens and bacteria genomes are used for the early diagnosis of sepsis either alone or in combination. Though these markers are sensitive and specific, they are expensive and are not readily available in resource poor settings.

The Hematological scoring system under such situation gives quick results and has good sensitivity, so that unnecessary antibiotic is avoided and early treatment can be started. Also there would be a decrease in neonatal morbidity. Hence the current study was undertaken to evaluate the Hematological scoring system for early diagnosis of neonatal sepsis and to find out its significance.

Materials and Methods

The study was conducted in all neonates with suspicion of sepsis admitted to the neonatal intensive care unit at Sir T. Hospital, Bhavnagar from 01/11/2025 to 31/10/2023 according to inclusion and exclusion criteria, after permission from Institutional Review Board. A detailed history of all neonates was taken for detection of maternal risk factors of sepsis (rupture of membrane >18 hrs, maternal urinary tract infection, maternal intrapartum pyrexia >38°C) and infant risk factors like prematurity, low birth weight, required resuscitation, invasive procedures.

Inclusion Criteria:

- Neonates with features suggestive of sepsis: Fever, lethargy, poor feeding, low APGAR score, low birth weight, meconium stained liquor

- Neonates with history of maternal infection: Maternal intrapartum fever >38°C, premature rupture of membrane <37 weeks, prolonged rupture of membrane > 12 hrs, maternal UTI

- Neonates with blood culture and CRP confirmed reports.

Exclusion Criteria:

- Neonates with major congenital anomaly, inborn errors of metabolism, administration of antibiotics prior to admission, neonates with respiratory distress syndrome with clinical confirmation.

- Neonates of mothers with pregnancy induced hypertension and asphyxia

Sample collection :

> Blood samples were collected by the pediatrician in EDTA vacutainer under complete aseptic condition and sent to laboratory. This sample was used to study the hematological parameters in automated hematology analyser and peripheral blood smears. Each hematological parameter was given a score based on Rodwell et al [1] Hematological scoring system and interpreted for neonatal sepsis.

> Blood samples of neonates collected by the pediatrician in plain red vacutainer and culture bottle under complete aseptic condition were sent to microbiology laboratory. These samples were used to study the blood culture and CRP of the patient.

Results

The study included 114 neonates based on the selection criteria. 68 (59.6%) were culture and CRP positive.

Out of 114 suspected patients, 67% are male patients and 33% are female patients. The male to female ratio is 2.02:1. In culture & CRP positive patients (n=68), the male to female ratio is 2.23:1.

In this study, the age of patient varies from 1 to 22 days. 60% of culture and CRP positive cases are seen in the age group between 2- 7 days.

In this study, 67% neonates have birth weight of <2499 grams. 71% of culture and CRP positive cases have birth weight of <2499 grams.

59% of neonates in the culture and CRP positive group are preterm.

In this study, incidence of normal and cesarean section delivery are almost equal in suspected neonatal septicemia.

Most common maternal risk factor in the study is urinary tract infection. Others are prolonged labour, premature rupture of membrane, maternal pyrexia and foul smelling per vagina.

In this study, Immature PMN cell count, Immature : Total Neutrophil Ratio and Immature : Mature Neutrophil Ratio shows highest sensitivity (69%) and Total Leucocyte Count shows highest specificity (70%). Platelet count shows highest positive predictive value (62%) and highest negative predictive value (43%).

In this study, 49% neonates have a hematological score of >5 and 55% neonates with score >5 belong to culture positive group.

Table 1: Distribution of suspected neonatal septicemia according to gender (n=114)

Gender	Total No. Cases	Percentage (%)	Culture & CRP Positive		Culture & CRP Negative	
			No. of cases	Percentage (%)	No. of cases	Percentage (%)
Male	76	67	47	69	29	63
Female	38	33	21	31	17	37
Total	114	100	68	100	46	100

Table 2: Distribution of suspected neonatal septicemia according to age (n=114)

Age (in days)	Total No. Cases	Percentage (%)	Culture & CRP Positive		Culture & CRP Negative	
			No. of cases	Percentage (%)	No. of cases	Percentage (%)
1	35	31	21	31	14	30
2- 7	60	53	41	60	19	41
>7	19	17	6	9	13	28
Total	114	100	68	100	46	100

Table 3: Distribution of suspected neonatal septicemia according to birth weight (n=114)

Birth weight (grams)	Total No. Cases	Percentage (%)	Culture & CRP Positive		Culture & CRP Negative	
			No. of cases	Percentage (%)	No. of cases	Percentage (%)
<2499	76	67	48	71	28	61
2500-2999	20	18	9	13	11	24
>3000	18	16	11	16	7	15
Total	114	100	68	100	46	100

Table 4: Distribution of suspected neonatal septicemia according to gestational age (n=114)

Gestational age (in weeks)	Total No. Cases	Percentage(%)	Culture & CRP Positive		Culture & CRP Negative	
			No. of cases	Percentage (%)	No. of cases	Percentage (%)
Preterm(<37)	61	54	40	59	21	46
Term(>37)	53	46	28	41	25	54
Total	114	100	68	100	46	100

Table 5: Comparison of sensitivity, specificity and predictive values of hematological parameters in neonatal septicemia

Hematological parameters	Sensitivity(%)	Specificity(%)	Positive Predictive Value(%)	Negative Predictive Value(%)
Total Leucocyte Count	26	70	56	39
Absolute Neutrophil Count	66	28	58	36
Immature PMN cell count	69	18	55	28
Immature : Total Neutrophil Ratio	69	26	58	36
Immature : Mature Neutrophil Ratio	69	26	58	36
Degenerative changes in neutrophils	54	46	60	40
Platelet Count	57	48	62	43

Discussion

We observed male is affected more than female. Similar observations were made in studies done by Nayana et al [2] and Tushar et al [3]. Male neonates are more prone to sepsis than female neonates. The hypothesis to explain this difference is that factors regulating immunoglobulin (IgG) synthesis may be located on X-chromosome. Therefore, the presence of pair
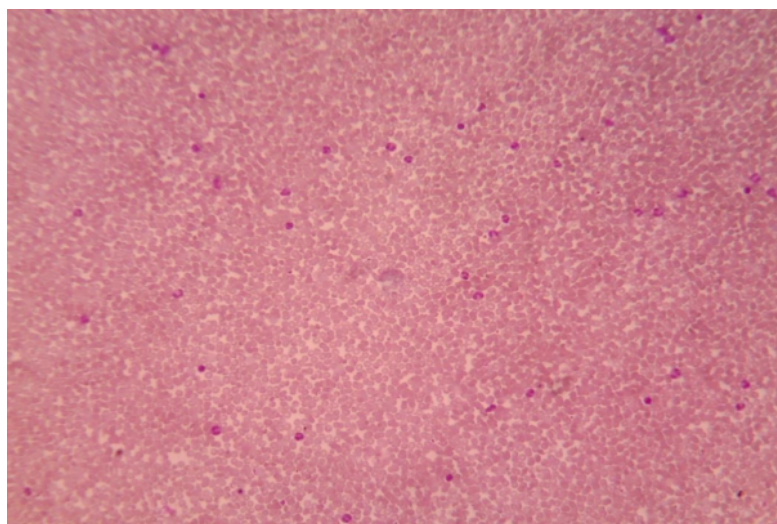
Figure 1: Microphotograph of peripheral smear, Leucocytosis (Leishman stain 40X)

Criteria	Abnormality	Score
Total leucocyte count (TLC)	< 5000/mm³	1
	>25000/mm³ at birth	
	>30000/mm³ at 12-24 hours	
	>21000/mm³ from day 2 onwards	
Total neutrophil count (TNC) (Normal – 1800-5000/mm³)	No mature neutrophils seen	2
	Increased/decreased	1
Immature neutrophil count (INC) (Normal-600/mm³)	Increased	1
I:T ratio (Immature neutrophils : TLC)	>0.2 Increased	1
I:M ratio (Immature : Mature neutrophils)	>0.3	1
Degenerative changes in neutrophils	Toxic granules/cytoplasmic vacuoles	1
Platelet count	<1,50,000/mm³	1

Figure 2: Rodwell HEMATOLOGICAL SCORING SYSTEM

of X-chromosomes in females probably confers a greater genetic diversity to the female immunological system and accounts for relatively more strength to fight infection.

In the studies carried out by Nayana et al [2], Tushar et al [3], higher incidence of sepsis was observed in less than 7 days old neonates. The present study also observed similar findings.

The present study shows highest number of cases with weight of <2499 grams. Similar observations were made in studies done by Nayana et al [2], Champa et al [4] and Tushar et al [3]. Low birth weight babies are more prone to neonatal septicemia probably because of impaired defense mechanisms and low immunoglobulin G levels.

In the present study, 54% of the neonates were preterm (<37 weeks of gestational age). In the study carried out by Champa et al [4], Suhail et al [5] and Swati et al [6], >50% of the neonates were preterm. The higher incidence of sepsis in preterm neonates can be attributed to complications of labour and resuscitation which are more common in preterm babies than normal full-term babies. Also, these neonates require more intensive care after birth thereby they are exposed to repeated handling and a longer stay in hospital which in turn increase their chances of infection. Placental transfer of IgG from maternal to fetal circulation increases with maturity. This transport is hampered in small for date infants having low IgG levels and hence more susceptible to infection.

The present study shows Cesarean Section as mode of delivery in 49% of Culture and CRP positive neonates which is in concordance with the study of Tushar et al [3]. This can be attributed to higher incidence of maternal complications and comorbidities in tertiary health centre.

In the present study, most frequent maternal risk factor observed was urinary tract infection. The similar result was found in the study conducted by Suhail et al [5].

Sensitivity, specificity, positive predictive value and negative predictive values have been compared for the present study with various other similar kind of studies i.e., Swati et al [6], Tushar et al [3], Manoj et al [8], Dipika et al [9] and Hiral et al [7].

In the study carried out by Pramana, K. et al [10], elevated IT ratio was found to be the most reliable indicator of sepsis and also in various other studies like those by Narasimha et al [11]. It is in concordance with the present study. The result of the present study was in contrast to a study by Anwer et al [12] which showed that Total leukocyte count is the most specific test with better positive and negative predictive value than IT ratio. Total leukocyte count is of little clinical use in the diagnosis of neonatal infection because of the wide variation in values.

In the study carried out by Makkar M et al [13], it was found that elevated I:T ratio was found to be the most reliable indicator of sepsis, and that Immature PMN count and I:T PMN ratio were also a very sensitive indicator of neonatal sepsis.

In the present study, total PMN count did not contribute to the incidence of neonatal sepsis. The variation in the results of these parameters in different studies might be due to difference in the blood sampling time, the severity of infection, and the age of the neonates.

Degenerative changes in PMN can help diagnose neonatal sepsis. Moreover, the presence of toxic granules indicates the production of unusual PMN during infection and stress induced leukopoiesis. Their presence invariably indicates sepsis, but their count is not always increased. Degenerative changes in PMN made no significant contribution to the diagnosis in this study.

Neonates with sepsis develop thrombocytopenia, possibly because of disseminated intravascular coagulation (DIC) and the damaging effects of endotoxin on platelets. Thrombocytopenia is frequently associated with sepsis and indicated a poor prognosis. This is thought to be due to increased platelet destruction, sequestration secondary to infections, failure in platelet production due to reduced megakaryocytes. In this study most cases had thrombocytopenia. This correlated well with various other studies [13, 14].

Sensitivity is highest for hematological score >5. Hence, higher scores may provide a guideline to the clinicians to make decisions regarding judicious use of antibiotic therapy which will be lifesaving, provide early cure, reduced mortality, shorten the hospital stay, and as well as will minimize the risk of emergence of resistant organism due to improper use of antibiotics. Thus unnecessary exposure of the neonates to antibiotic therapy can be avoided.

Limitations of the study: Being a tertiary institute, higher admission of neonates with prior antibiotic therapy was observed. Hence higher number of neonates were excluded and higher sample size could not be achieved. It is a single center study design.

Conclusion

Neonatal sepsis is a serious illness associated with high mortality, so a high index of suspicion is important in the diagnosis and treatment of neonatal infection. A variety of maternal, neonatal, clinical and hematological profile were studied in the present study. Incidence of neonatal septicemia was higher in males, age <7 days, preterms and low birth weight neonates.

This study concluded that diagnostic ability of hematological parameters is higher when used in combination with each other rather than individually. Clinical profile of neonates was also useful in screening of infected individuals. So, amalgamation of clinical and hematological parameters is useful in screening as it is simple, quick, cost effective and readily available tool with high sensitivity. Hematological parameters are particularly useful in resource poor settings for early screening septicemia, as availability of blood culture is limited and also time consuming.

References

1. Rodwell, R. L., Leslie, A. L., & Tudehope, D. I. (1988). Early diagnosis of neonatal sepsis using a hematologic scoring system. The Journal of pediatrics, 112(5), 761-767.

2. Nayana NS, Sreenivas N. Neonatal Septicemia- A Smooth Technique of Diagnosis in Developing Countries. Int J Res Med Sci 2016;4(6):2305-8.

3. Priyanka T H. Basic Haematological Scoring System-Is It The Most Accurate Neonatal Sepsis Predictor July 2018;7(3):PO29-PO33

4. Panwar C, Kaushik SL, Kaushik R, Sood A. Correlation of Neonatal and Maternal Clinico-Hematological Parameters as Predictors of Early Onset Neonatal Sepsis. Int J Contemp Pediatr Jan 2017;4(1):36-42.

5. Naik SA, Ahmad A, Irshad M, Et Al. Clinical Profile and Bacteriological Spectrum of Neonatal Sepsis, In A Tertiary Care Hospital, Kashmir India. J. Evolution Med. Dent. Sci. 2019;8(06):346-351.

6. Lal S, Shankar M, Adhikari BC, Chaudhary AK. Study of Hematological Parameters in The Early Diagnosis of Neonatal Sepsis in Tertiary Care Center in Jharkhand. Indian J Child Health. 2020; 7(2):82-84

7. Hiral PS, Bharti MJ. Early Diagnosis and Evaluation of Neonatal Septicemia by Haematological Scoring System. Int J Med Sci Public Health 2019;8(6):409-414.

8. Sawadkar, Dr & Dharwadkar, Dr & Gore, Charusheela & Chandanwale, Shirish & Buch, Archana. (2020). Hematological Scoring System and its Significance in Early Diagnosis of Neonatal Sepsis. Saudi Journal of Pathology and Microbiology. 05. 108-114. 10.36348/sjpm.2020.v05i02.012.

9. Dey, Dipika & Sulltana, Razia & Ahmed, Wazir & Chowdhury, Mahmood & Akter, Farhana & Dasgupta, Srabony. (2020). Role of Hematological Score in Early Diagnosis of Neonatal Sepsis. Chattagram Maa-O-Shishu Hospital Medical College Journal. 18. 45-48. 10.3329/cmoshmcj.v18i2.47776.

10. Pramana, K., Kardana, I., Nilawati, G. 2016. Diagnosis accuracy of hematological scoring system in early identification of neonatal sepsis. Bali Medical Journal 5(3): 488-492.

11. Narasimha A, Kumar MLH. Significance of hematological scoring system (HSS) in early diagnosis of neonatal sepsis. Indian J Hematol Blood Transfus. 2011;27:14-7

12. Anwer SK, Mustafa S. Rapid identification of neonatal sepsis. J Pak Med Assoc. 2000;50:94-8.

13. Makkar M, Gupta C, Pathak R, Garg S, Mahajan NC. Performance evaluation of hematologic scoring system in early diagnosis of neonatal sepsis. J Clin Neonatol 2013;2:25-9

14. Basu S, Guruprasad, Narang A, Garewal G. Diagnosis of sepsis in the high-risk neonate using a hematologic scoring system. Indian J Hematol Blood Transf. 1999;17:32-4