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RESEARCH ARTICLE

"UTILITY OF HEMATOLOGICAL SCORING SYSTEM IN DIAGNOSIS OF NEONATAL SEPTICEMIA"

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Abstract

Objectives: To evaluate the utility of the hematological parameters and HSS score for early detection of neonatal septicemia and to correlate results with blood culture reports and C-reactive protein (CRP) levels.
Material and Methods: Blood samples of 60 neonates with the clinical diagnosis of neonatal septicemia were collected. Peripheral smears of these neonates were evaluated and scored as hematological parameters of Rodwell's criteria (score of < 2 – unlikely septicemia, 3 or 4- possible septicemia and > 5 very likely septicemia).A comparison of the HSS score, CRP value and blood culture report was done.
Statistical analysis: Data was entered in a Microsoft Excel spread sheet & analyzed using SPSS Software Version 16.
Result: Out of 60 caseswith the clinical diagnosis of neonatal septicemiastudied, HSS score of 15cases (25%) score 4, 28 cases (46.6%) scored 5 and 17(28.3%) cases had a score of 6. Sensitivity of the Immature Neutrophil Count andDegenerative changes was 100%. In 30 cases (50 % cases) blood culture report was positive. In neonates with positive blood culture reports had > 5 HSS score in 86 % of the cases and raised CRP in 80 % of the cases. In neonates with negative blood culture reports had > 5 HSS score in 63 % of cases and raised CRP in 80 % of cases.
Conclusion: HSS is a rapid, simple and reliable test that helps in early diagnosis and treatment of neonatal septicemia.

Introduction:-

Neonatal septicemia refers to an infection involving the bloodstream in newborninfants less than 28 days. It is characterized by nonspecific signs and symptoms caused by invasion of pathogens.

According to WHO estimate 2022, Globally 2.3 million children died in the first 20days of life. There are approximately 6500 newborn deaths every day, amounting to 47% of all child deaths under the age of 5 years. [1]

Neonatal septicemia is associated with high morbidity and mortality in developing countries. It is the second major cause of mortality among neonates, killing more than one million neonates annually[2].The baseline neonatal mortality rate (NMR) in India is 23/1,000 live births.[3]Early diagnosis and treatment significantly improve the outcome of neonatal septicemia.

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Different modalities of diagnosis of septicemia includemicrobiological culture method, inflammatory biomarkers including acute-phase reactantslike C-reactive proteins and Procalcitonin, Interleukins, Cell adhesion moleculesand Hematological indices.

Septicemia is considered culture-proven if confirmed by microbial growth on blood cultures or other sterile bodily fluids. The diagnosis of confirmed septicemia relies on conventional microbiologic culture techniques, which can be time-consuming. In neonates, low or intermittent bacteremia and maternal intrapartum antimicrobial exposure may decrease the sensitivity of blood cultures. The delay in pathogen identification and antibiotic susceptibility testing increases exposure to broad-spectrum antibiotics, which may lead to bacterial antibiotic resistance and delay in targeted antimicrobial therapy.Debate exists over the occurrence of culture-negative septicemia and whether antibiotics should be continued in culture-negative cases. The diagnosis of "culture-negative" septicemia or 'clinical septicemia' has led to a 10-fold increase in antibiotic use in neonates with evidence of unintended harm including increased risk for necrotizing enterocolitis, fungal infections, bronchopulmonary dysplasia, and death.[4]

C-reactive protein (CRP) is another marker which is been the most studied biomarker. Serum CRP concentrations rise within 10 to 12 hours in response to bacterial infections and peak after 36–48 hours, with concentrations correlating with illness severity. Due to the delay in elevation, it is unreliable for early diagnosis of neonatal septicemia (low sensitivity). Furthermore, other non-infectious maternal and neonatal conditions may also result in elevated CRP levels, thus making it a nonspecific biomarker.

Rodwell et al.[5] 1988 developed a hematological scoring system (HSS) based on the White Blood Cell Count (WBC), Immature Cell Count, Immature Neutrophils to Mature Neutrophils and Total Count Ratios, Platelet Count and Degenerative Changes in Neutrophils liketoxic granulations, vacuolations and Döhle bodies.It is a simple cost-effective test and can be used as a screening test for early diagnosis of neonatal septicemia.

The present studyevaluatesthe efficacy of the quick and cost-effective Hematological Scoring System (HSS) thathelpsin the early diagnosis of neonatal septicemia.

Objective of the study:-

To evaluate the utility of the hematological parameters and HSS score for early detection of neonatalsepticemia and compare these hematological parameters with blood culture and C-reactive protein levels.

Materials and Methods:-

Thisprospective studywas conducted at GIMS Kalaburagi, from July2023 to October 2023. Blood samples of 60 clinically suspected neonatal septicemia cases were studied for HSS score, blood culture, and CRP levels.

Neonates with major congenital anomalies, inborn error of metabolism, malignancyand neonates with blood transfusion were excluded from the study.

Blood samples of clinically suspected neonatal septicemia cases werecollected in EDTA and Plain Vacutainers. EDTA samples were processed in, a 5-partanalyzer (Sysmex XN- 330) for CBC. Good-quality peripheral smearswere prepared,stained with Leishman stains; and studied under a microscope.Hematology findings were scored as per Hematological Scoring System[Table 1 &2]

Quantitative evaluation of C-reactive protein was done in 60 clinically suspected neonatal septicemia cases**.**

Blood samples were also sent for culture and sensitivity.

Table 1:-Hematological Scoring System.

Criteria	Abnormality	Score
Total WBC count	≤5,000/ µL ≥25,000/µLat birth, ≥30,000/µLat 12–24hr, ≥21,000/ µLat day 2 onward.	1 1
Total PMN count	1800–5400/ µL Increased or decreased No mature PMN seen	0 1 2
Immature PMN count	<600 / µL >600/ µL	0 1
I: T PMN ratio	<0.120/µL >0.120 /µL	0 1
I: M PMN ratio	<0.3 / µL ≥0.3 / µL	0 1
Degenerative changes in PMN	Toxic granules /cytoplasmic vacuoles	1
Platelet count	<150,000/ µL	1

Table 2:- Scoring System Interpretation.

Score	Interpretation
≤2	Septicemia is unlikely
3– 4	Septicemia is suspected
≥5	Septicemia or infection is likely

Statistical analysis:
Data was entered in a Microsoft Excel spreadsheet &analyzed using SPSS Software Version 16.

Results:-

A total of 60 cases having clinical features of neonatal septicemia were studied. 36 cases were male and 24 were female with a ratio of 1.5:1 (M:F) showing male predominance. Hematological parameters were studied and scored as per HSS criteria.

Out of60 cases, 15(25%) cases had an HSS score of 4, 28(46.6%)cases scored 5,and 17(28.3%) cases had a score of 6. [Table: 3]

Table 3:-HSS Scoring System Interpretation.

Score	Interpretation	Total Number of Cases (%)
≤2	Septicemia is very unlikely	00
3– 4	Septicemia is suspected	15(25%)
≥5	Septicemia or infection is more likely	45(75%)

TLC with score 1 (Leukocytosis/Leukopenia) was seen in eight out of sixty cases. Total PMN count with a score of 1 (<1800 or > 5400/µL) was seen in 48 (80%) cases,in culture-positive group76% of cases showed score of 1.

Immature PMN countswith a score of 1 (< 600 or >600/µL) was seen in 57 (95%) of total cases, and in the culture-positive group, 96% of the cases showed a score of 1 of immature neutrophils count.

High I:T ratio (≥0.12)was seen in 56 cases (93.3%) of total 60 casesand 93.3% showed high I:T ratio in culture positive group. A high I: M ratio (≥0.3) was seen 18 (30%) cases and 26% of the cases showed high I:T ratio in culture-positive group. Low platelets count (< 1,50,000/µL) seen in 23(76.6%) of culture-positive group and 15(50%) cases seen in culture-negative group.

Degenerative changes such as toxic granules, cytoplasmic vacuolations andDöhlebodies were noted in all cases of culture-positive (100%) and 29 (96%) cases of the culture-negative group. [Figure: 1, 2]

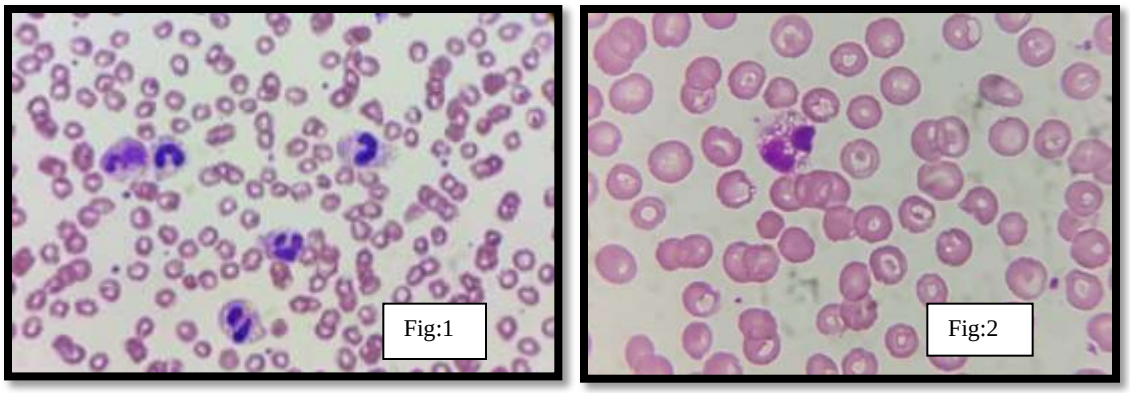

Fig.1,2:- Peripheral blood film showing immature neutrophils (band forms) & cytoplasmic vacuolations in neutrophil (Leishman stain; X1000)

Table 4:-

Hematological parameters	**HSS score**	**Culture positive group**	**Culture negative group**	**Total cases**	**Sensitivity(%)**	**(NPV) (%)**
Total Leukocytes Count	**0**	27	25	52	10	48.08
	1	03	05	08		
Total PMN count	**0**	08	06	14	76.67	16.67
	1	22	24	46		
Immature PMN count	**0**	01	02	03		
	1	29	28	57	**96.67**	66.67
I:T ratio (≥0.12)	**0**	02	02	04		
	1	28	28	56	**93.33**	50
I:M ratio (≥0.3)	**0**	22	20	42	27	48
	1	08	10	18		
Degenerative changes	**0**	00	01	01		
	1	30	29	59	**100**	**100**
Platelets (<1,50,000)	**0**	07	15	22	76.67	68.33
	1	23	15	38		
CRP (> 6mg/L)		24 cases	25 cases	49	80	45.45

WBC: White blood cell count, PMN: Polymorphonuclear cell count (neutrophils),
I: T PMN ratio: Immatureneutrophilcount: Total neutrophil count ratio,
I:M PMN ratio: Immatureneutrophil count: Mature neutrophil count ratio

Among the seven hematological parameters of HSS score studied, degenerative changes in neutrophil, immature neutrophil count and I:T ratio showed the highest sensitivity and NPV. Total Immature PMNs, Degenerative changes and I:T ratio scoresweresignificant in culture-negative group of clinically suspected septicemiacases.

Compared to other hematological markers, degenerative changes andimmature PMNs count may be the most sensitive indicator of neonatal septicemia.

C-reactive protein was seen to significantly increase (> 6mg/L) in 24 cases (80%) in a culture-positive group of septicemia and increased in 25 cases (83%) of the culture-negative group.

Among the 60 cases studied, 30 cases showed culture-positivity. Staphylococcus aureus was seen in 20 (60%) cases followed by Klebsiella pneumonia in 7 (23%),E. coli in 2 (6%) cases, and 1 case showed Candida infection.

Discussion:-

Neonatal septicemia is a serious illness with high morbidity as well as mortality. Early diagnosis with prompt antibiotic therapy can significantly improve the outcome. So, areliable screening test is very helpful for the diagnosis and treatment of neonatal septicemia.

Blood culture which is considered the gold standard has low sensitivity due to pre- and post-analytic factors and is also not available within the therapeutic window.[6] Our study showed a culture positivity in 30(50%) out of 60 cases of clinically suspected neonatal septicemia. Other studies done by Aparna.Setal.[7]and Tushar et al [8]showed culture positivity in 9.6% and 27% of the clinically suspected neonatal septicemia respectively.

The present study showed predominance in maleswith M:F ratio of 1.5:1, which was in concordance with studies done by Aparna.S et al (3:1). [7]and Rajashree.K.et al (1.3:1).[9]Male predominance is attributed to the fact that there are X-linked regulatory genes involved in globin synthesis and immune regulation, males have a single X chromosome, making them more susceptible toinfections.[9]

TheTotal HSS scorein the present study showed a sensitivity of 86.6%, and an NPV of 73.33% which is similar to the study done by Rodwell et al. In his study, sensitivity was 96%, and negative predictive value (NPV) was 99%. He concluded that the HSS improves diagnostic accuracy and can be used as a screening test for septicemia. This study also has been compared with other studies like Rajashree.K. et al. [9] Derbalaet al.[10]and Abbas F et al. [11] [Table; 5]

Table 5:-

Author	Sensitivity (%)	Specificity(%)	PPV(%)	NPV(%)
Rajashree et al (2018)	100%	54.70%	54.70%	100%
Abbas et al (2020)	81.58%	84.48%	77.50%	88.33%
Derbala et al (2021)	95%	96.70%	26%	100%
Present study	86.67%	36.67%	57.78%	73.33%

In the present study, the highest sensitivity was seen in 3 hematological parameters which include, degenerative changes in neutrophil (100%), immature neutrophil count (96.67%) and I:T ratio (93.33%).

Degenerative changes like toxic granules, cytoplasmic vacuolation, Döhlebodies showed the highest sensitivity (100%) and NPV (100%), which is similar to a study done by Aparna.S et al[7] (Sensitivity- 100%, NPV- 100%). Immature PMN count with a cut-off value >600 cells/mm^3 had good sensitivity (96.67%). A similar result was observedin the studies of Makkar et al.[12] (96.87%). I:T ratio >0.120 had a sensitivityof 93.3%, NPV and PPV of 50%. The studydone by Supreetha MS et al. [13]showed91% sensitivity and 51% NPV.

In the present study, thrombocytopenia had a sensitivity of 76.67%, specificity of 50%, PPV of 60.53%, and NPV of 68.33%.Platelet in isolation is not a reliable predictor of septicemia, as thrombocytopenia is common in the first week of life.This is thought to be due to platelet destruction and sequestration increased, and platelet production decreased. [14]

The sensitivity of total leukocyte count was very less (10%), similar to the study done by Narasimha A et al.[15] Sensitivity of I:M ratio was 27% which is in concordance with the study done Tushar et al. [8]

Conclusions:-

The hematological scoring system is a simple, quick, cost-effective tool thatis helpful as a screening test for early diagnosis of neonatal septicemia as compared to Blood culture and CRP levels in developing countries. Among all

seven hematological parameters of HSS score Degenerative changes, Immature PMNs and I:T ratios are more significant. This aidsclinicians in support of diagnosis of neonatal septicemia and institutingantibiotic therapy precisely. Thus, unnecessary exposure of infants to antibiotic therapy can be avoided.

References:-

1. World Health Organization. Perinatal mortality [Internet]. Geneva: World Health Organization; 2024 Mar 14. Available from: https://www.who.int/news-room/fact-sheets/detail/levels-and-trends-in-child-mortalityreport2021#:~:text=There%20are% 20 approximately%206700%20newborn,to%202.4%20million%20in%202020.
2. Shruti M, Myron AG, Vasudeva G, Leslie E, Simon L, Sreekumaran N. Risk factors of neonatal sepsis in India: A systematic review and meta-analysis. PLoS One. 2019 Apr 25;14(4). doi: 10.1371/journal.pone.0215683.
3. UNICEF. Investing in Newborn Health in South Asia. Country Report–India. New York: UNICEF; 2020. © UNICEF/India/UN0390458/Vishwanathan.
4. Istemi HC, Morcos H, Fuat EC, Mohan P. Diagnosis of neonatal sepsis: The past, present and future. Paediatr Res. 2022 Jan;91(2):337–50.
5. Rodwell RL, Leslie AL, Tudehope DI. Early diagnosis of neonatal sepsis using a hematological scoring system. J Pediatr. 1988;112(5):761–7.
6. Zea-Vera A, Ochoa TJ. Challenges in the diagnosis and management of neonatal sepsis. J Trop Pediatr. 2015;61(1):1-13.
7. Aparna S, Vivek G, Limi M, Lisha S, Sheela VV. Utility of hematological scoring system in diagnosis of neonatal sepsis. Ann Pathol Lab Med. 2020 Oct;7(10).
8. Tushar P, Hemalata. Basic hematological scoring system—is it the most accurate neonatal sepsis predictor? Natl J Lab Med. 2018;7(3):29-33.
9. Rajashree K, Jayaprakash CS. Hematological scoring system—a diagnostic tool for neonatal sepsis. How reliable is it? IP J DiagnPathol Oncol. 2018 Jul-Sep;3(3):219-22.
10. Derbala SG, Handoka NM, Eldin Hasan BB, El-Sayed HF. Scoring system for early diagnosis of neonatal sepsis in a neonatal intensive care unit of a developing country. J Neonatal Intensive Care. 2021;15(3):123-130
11. Abbas F, Ahmad B, Shabir S, Hassan KA. Neonatal Sepsis: Accuracy of Hematological Scoring System for Diagnosing Neonatal Sepsis. **J Neonatal Intensive Care**. 2020;11(4):203-210.
12. Makkar M, Gupta C, Pathak R, Garg S, et al. Performance evaluation of hematological scoring system in early diagnosis of neonatal sepsis. J Clin Neonatol. 2013;2(1):25-9.
13. Supreetha MS, Sathyavathi RA, Shivendra VS, Kariappa TM. Evaluation of neonatal septicemia using hematological parameters. Int J Recent Sci Res. 2015;6(2):2775-8.
14. Ghosh S, Mittal M. Early diagnosis of neonatal sepsis using a hematological system. Indian J Med Sci. 2001;55(9):495-500.
15. Narasimha A, Kumar HML. Significance of hematological scoring system (HSS) in early diagnosis of neonatal sepsis. Indian J Hematol Blood Transfus. 2011;27:14-7.
16. Zawar MP, Tambekar RG, Deshpande NM, Gadgil PA, Kalekar SM. Early diagnosis of neonatal septicemia by sepsis screen. Indian J PatholMicrobiol. 2003;46:610-2.
17. Singh M. Care of the Newborn. 7th ed. New Delhi: Sagar Publications; 2010. p. 223-9.
18. Hiral PS, Bharti M J. Early diagnosis and evaluation of neonatal septicemia by hematological scoring system. International Journal of Medical Science and Public Health.2019;Vol.8(6):409-14.