International Journal of Science and Research (IJSR)
ISSN: 2319-7064
ResearchGate Impact Factor (2018): 0.28 | SJIF (2018): 7.426

# Early Diagnosis of Neonatal Sepsis using Hematological Scoring System in Resource limited Set Up

**Dr Priyanka Gupta[1], Dr Sanjay Khare[2], Dr Pramod Mishra[3]**

[1]MD Pathology, District Hospital, Vidisha (MP), India

[2]MD Medicine, District Hospital, Vidisha (MP), India

[3]DCH, District Hospital, Vidisha (MP), India

**Abstract:** ***Background: Over past two decades neonatal morbidity associated with sepsis has increased due to changing microbial spectrum. To establish early diagnosis of neonatal sepsis is a challenge because of varied clinical presentations. For definite diagnosis of sepsis, culture results are gold standards which are time taking process. The other recent available markers are sensitive but expensive. Hence they have limited use in financially constrained setup. Therefore there is always a need for a cost effective test to detect infection that could be easily performed in our set up. Objective: Present study has been undertaken mainly to detect neonatal sepsis and to emphasis the fact that hematological scoring system of Rod well suggested in 1988 which was based on CBC report should be established as a part of routine protocol for examination in neonates suspicious for sepsis in order to prevent morbidity due to late diagnosis of sepsis. Material and methods: A prospective study was conducted in NICU of district hospital Vidisha (MP) from March 2019 to April 2019.All neonates with clinical suspicion for sepsis were enrolled in the study. A baseline CBC and blood culture were sent. The HSS were analysed according to the HSS of Rod well et al, score of more than 2 out of 7 consider to be indicative of sepsis. Conclusion: Rod well hematological scoring system is a feasible and cost effective method in detecting neonatal sepsis for resource limited set up.***

## 1. Introduction

Over past 2 decades neonatal morbidity associated with sepsis has increased due to changing microbial spectrum. This is because the newborn especially the premature are prone to serious infections by organisms and partly because the signs of these infections may be absent or minimal and hard to detect. Early diagnosis of neonatal septicemia is a vexing problem because of its non specific clinical picture (1, 2). Neonatal sepsis is a systemic infection occurring in infants at ≤28 days of life and is an important cause of morbidity and mortality of newborns. Early onset neonatal sepsis has been variably defined based on the age at onset, with bacterimia or bacterial meningitis occurring at ≤72 hr in infants hospitalized in the NICU versus <7days in term infants. In preterm infants, EOS is most consistently defined as occurring in the first 3 days of life and is caused by bacterial pathogens transmitted vertically from mother to infant before or during delivery (6).Hence the timely diagnosis of sepsis in neonates is critical as the illness can be rapidly progressive (3).For definite diagnosis of sepsis culture result are gold standard which are time consuming, yield is low (7, 8, 9) and other recent available tests are sensitive but expensive. In my set up there is always a need for a cost-effective test to detect septicemia that could be quick, simple and easily performed. Here, in this study, we undertake to evaluate the performance of hematological scoring system (HSS) of Rod well et al (1988)11 based on complete blood count for early detection of sepsis.Therefore aim of this study is to evaluate the diagnostic accuracy of HSS.

## 2. Material and Methods

The present study is a prospective analysis of the hematologic profiles of 50 neonates admitted in the neonatal care unit of our hospital in the year 2019. Infants were enrolled in the study if there were predisposing perinatal factors or if there was clinical suspicion of sepsis.

The study included three groups:

Group A—infants with sepsis with positive blood cultures. Group B—infants with probable infection with strong clinical history but negative blood cultures. Group C—normal infants without any evidence of sepsis. The blood samples were collected in EDTA as an anticoagulant. Peripheral blood smears were made within 2hour of collection stained with Leishman stain and examined under oil immersion light microscopy at a final magnification of ×1000. The sepsis work up included blood culture and routine blood counts along with the hematologic score. Total leukocyte count was obtained using mindray/BC-5150 autoanalyzer and corrected for nucleated red blood cells. Differential counts were performed on Leishman stained smears and about 200 cells were counted.

The peripheral blood smears of all neonates were analysed for early diagnosis of neonatal sepsis using the hematological scoring system of Rodwell et al. The HSS assigns a score of one for each of the seven criteria found to be significantly associated with sepsis (Table 1) with one exception, an abnormal total count is assigned a score of 2 instead of 1, if no mature polymorphs are seen on the peripheral smear to compensate for the low I:M ratio. Sensitivity, specificity, positive and negative predictive values were evaluated for each of the seven criteria of HSS.

**Table 1:** Hematological scoring system

| Criteria | Abnormality | Score |
|---|---|---|
| Total WBC count | ≤5000/mm$^3$ | 1 |
| | ≥25, 000, 30, 000 and 20, 000/mm$^3$ at birth, 12-24 hr and day2 onward respectively. | 1 |
| Total PMN count | 1800-5400 | 0 |
| | No mature PMN seen | 2 |
| | Increased/decreased | 1 |
| Immature PMN count | 600 | 0 |
| | Increased | 1 |
| Immature/Total PMN ratio | 0.120 | 0 |
| | Increased | 1 |
| Immature/Mature PMN ratio | ≤0.3 | 0 |
| | ≥0.3 | 1 |
| Degenerative changes in PMN toxic granules/v | | 1 |
| Platelet count | ≤150000/mm$^3$ | 1 |

Immature neutrophils include promyelocyte (Fig. 1), metamyelocyte (Fig. 2) and band forms in (Fig.3)

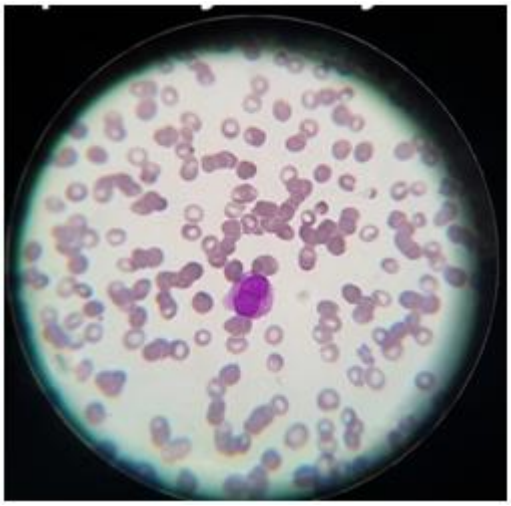


**Figure 1:** Photomicrograph showing immature neutrophil-Promyelocyte

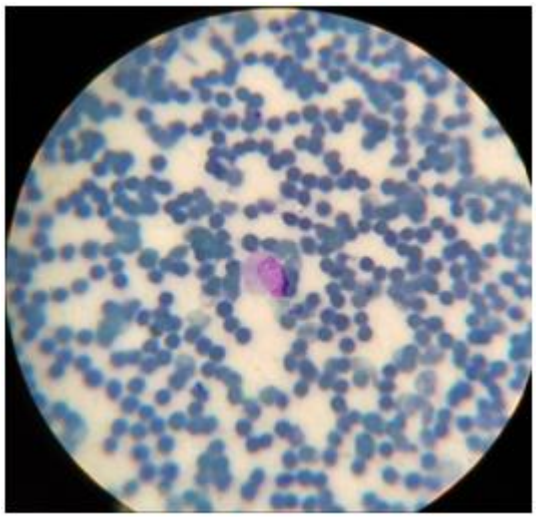


**Figure 2:** Photomicrograph showing Immature neutrophil —Metamyelocyte

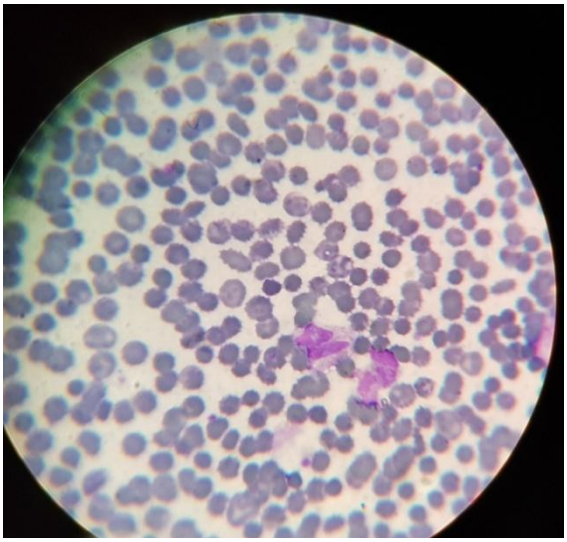


**Figure 3:** Photomicrograph showing Band form

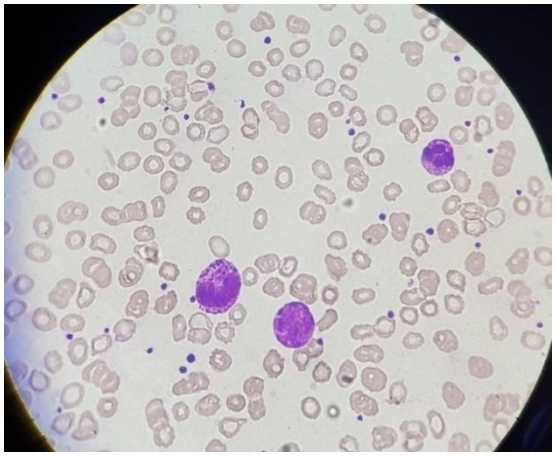


**Figure 4:** Photomicrograph showing toxic changes

**Table 2:** Interpretation of hematological scoring system

| | |
|---|---|
| ≤2 | Sepsis is unlikely |
| **3-4** | Sepsis is possible |
| **≥5** | Sepsis is very likely |

Interpretation is shown in **Table 2.** Scores are: minimum score is 0 and maximum score is 8.

**Statistical Analysis**

To test the statistical significance of three different groups, we employed the Chi Square test and a P value < 0.05 was considered as significant.

## 3. Result

The study included 50 cases divided into three groups represented in Table 3.

**Table 3:** Group distribution of cases

| Groups | Number of Cases (%) |
|---|---|
| Group A-Sepsis | 3 (6%) |
| Group B- Probable infection | 19 (38 %) |
| Group C- Normal | 28 (56 %) |

The diagnosis of sepsis was made when there were positive findings on blood culture. Infants were classified as having probable infection when the blood culture was negative but

there was a strong clinical history of infection. Infants were considered to be normal when the blood culture was negative and there was no strong clinical evidence of infection. In my study period of 1 month, I got 3 (6%) infants with positive blood culture classified them as Group A, 19 (38%) infants with blood culture came negative but they have clinical features of infections like respiratory distress, irritability, and temperature instability classified them as Group B and third group 28 (56%) infants admitted with complaints other than infections, most cases presented with complaints of low birth weight, convulsions, feeding difficulties classified them as Group C.

**Table 4:** Age and sex distribution of cases

| Age | Males (%) | Females (%) |
|---|---|---|
| 0-24hr | 1 (2 %) | 2 (4%) |
| 24-48hr | 7 (14 %) | 6 (12%) |
| 48-72hr | 14 (28 %) | 12 (24%) |
| 72-96hr | 3 (6 %) | 4 (8%) |
| >96hr | - | 1 (2 %) |
| | 25 | 25 |

Table 4 implies equal distribution of males (50%) as well as females (50%), most of cases 14 (28%) males and 12 (24%) females were 2-3 days old in my study period. We had 33 (66%) term infants and 17 (34%) pre-term infants with the age ranging from 24 h to 8 days. Males were predominant in our study which is consistent with other studies, in study by munaza saleem attributed male predominance to globulin synthesising factors on X chromosome thus making males more susceptible to infections. (13)

**Table 5:** Scores of each of the groups

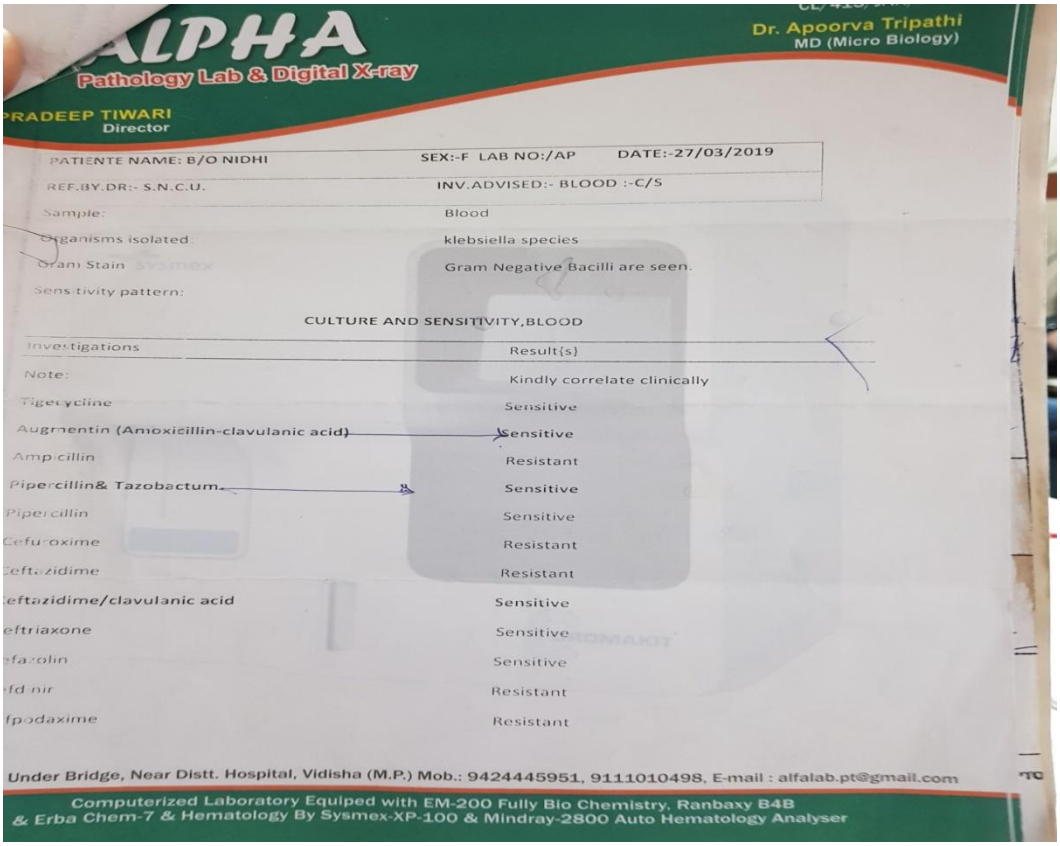
| Groups | Score ≤2 (%) | Score3-4 (%) | Score ≥5 (%) | |
|---|---|---|---|---|
| Sepsis | - | - | 3 (100%) | $X^2$ =48.314, df=4, P-Value=0.000 |
| Probable infection | 4 (21%) | 14 (73.68%) | 1 (5.2%) | |
| Normal | 20 (71.4%) | 8 (28.57%) | - | |

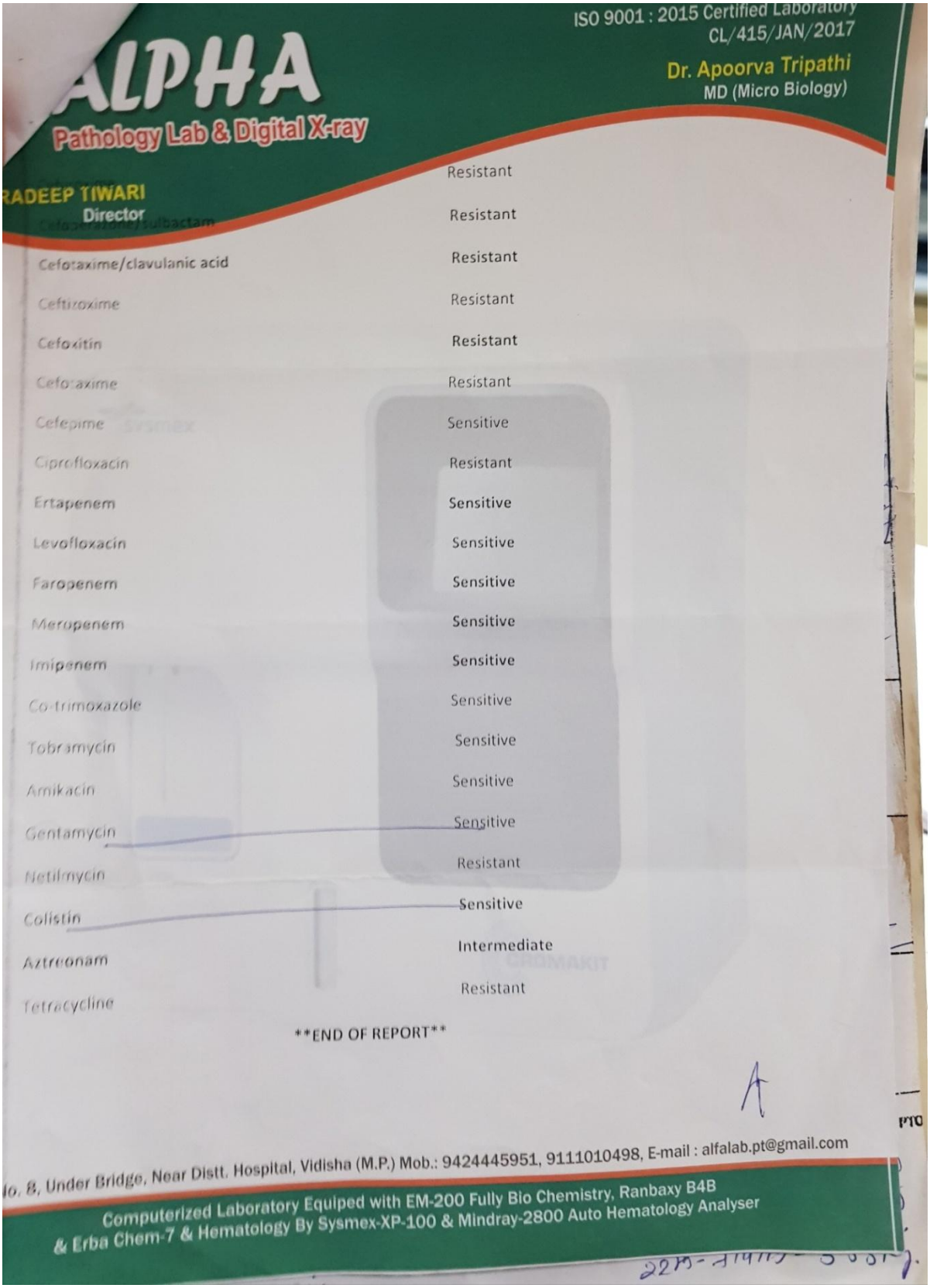
Table 5 shows scores of each group: 3 (100%) infants history of sepsis had score >5 with positive blood culture, 1 (5.2%) infant with history of probable infection had score 5, 14 (73.68%) infants had score 3-4 suggestive the possibility of sepsis. None normal infants had score 5 exclude the certainty of infection, 8 (28.57%) normal infants had score 3-4 suggested the possibility of infection, 20 (71.4%) normal infants and 4 (21%) infants with probable infection had score <2 which implies sepsis was unlikely.

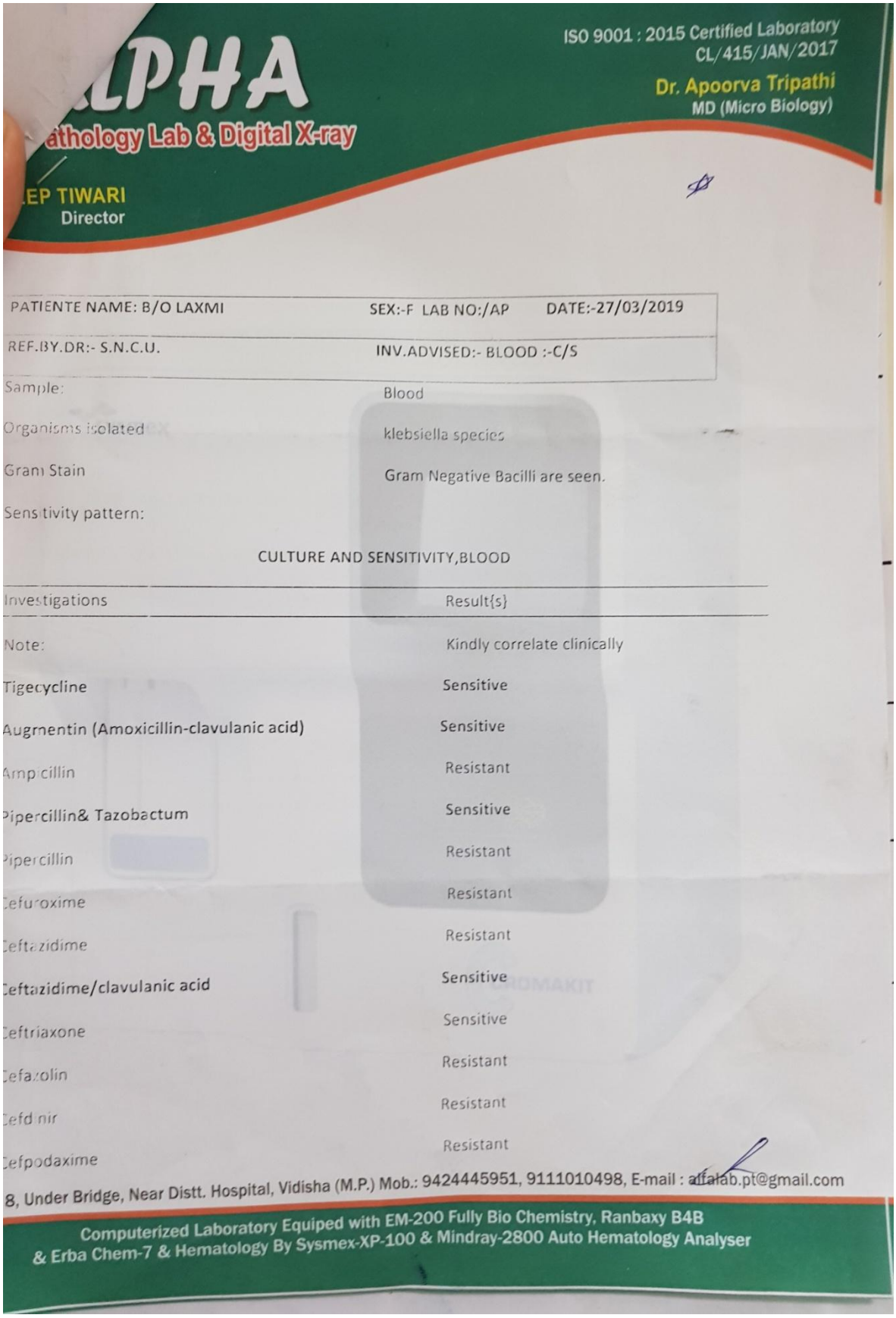
**Table 6:** Performance of individual hematological findings

| Total WBC counts | Sensitivity (%) 100 | Specificity (%) 72.3 | Positive predictive value (%) 18.75 | Negative predictive value (%) 100 |
|---|---|---|---|---|
| Total PMN counts | 100 | 53.2 | 12 | 100 |
| Immature PMN counts | 100 | 80.8 | 25 | 100 |
| I/T PMN ratio | 100 | 78.7 | 23 | 100 |
| I/M PMN ration | 100 | 78.7 | 23 | 100 |
| Degenerative changes | 66.66 | 100 | 100 | 97.9 |
| Platelets counts | 100 | 78.7 | 23 | 100 |

Culture Reports
Only 3 cases (Group A) had blood culture positive with HSS score 5.







ALPHA
Pathology Lab & Digital X-ray
DEEP TIWARI
Director

ISO 9001 : 2015 Certified Laboratory
CL/415/JAN/2017
Dr. Apoorva Tripathi
MD (Micro Biology)

PATIENTE NAME: B/O LAXMI SEX:-F LAB NO:/AP DATE:-27/03/2019
REF.BY.DR:- S.N.C.U. INV.ADVISED:- BLOOD :-C/S

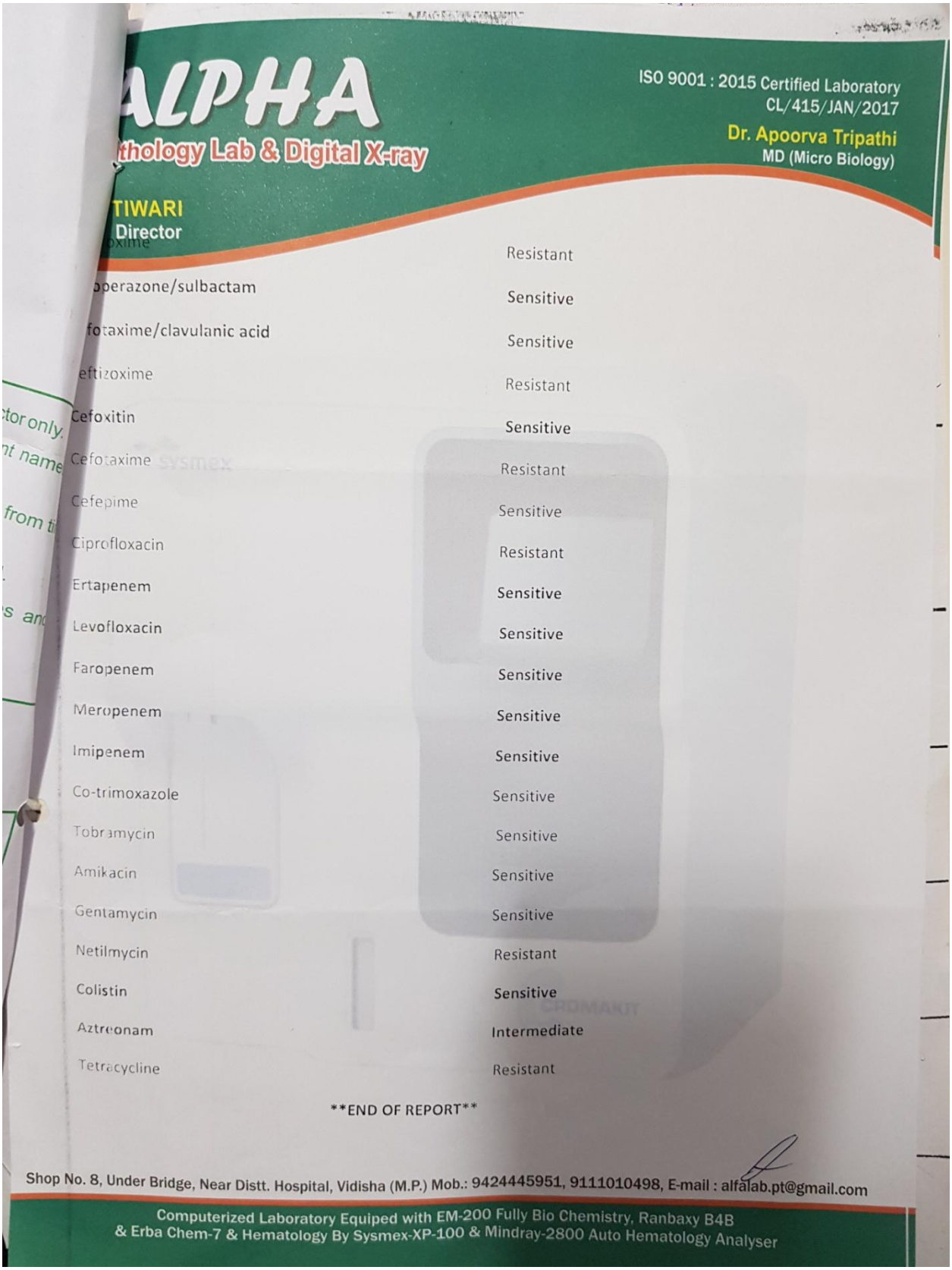
Sample: Blood
Organisms isolated: klebsiella species
Gram Stain: Gram Negative Bacilli are seen.
Sensitivity pattern:

CULTURE AND SENSITIVITY,BLOOD

| Investigations | Result{s} |
|---|---|
| Note: | Kindly correlate clinically |
| Tigecycline | Sensitive |
| Augmentin (Amoxicillin-clavulanic acid) | Sensitive |
| Ampicillin | Resistant |
| Piperacillin& Tazobactum | Sensitive |
| Piperacillin | Resistant |
| Cefuroxime | Resistant |
| Ceftazidime | Resistant |
| Ceftazidime/clavulanic acid | Sensitive |
| Ceftriaxone | Sensitive |
| Cefazolin | Resistant |
| Cefdinir | Resistant |
| Cefpodaxime | Resistant |

8, Under Bridge, Near Distt. Hospital, Vidisha (M.P.) Mob.: 9424445951, 9111010498, E-mail : alfalab.pt@gmail.com

Computerized Laboratory Equiped with EM-200 Fully Bio Chemistry, Ranbaxy B4B
& Erba Chem-7 & Hematology By Sysmex-XP-100 & Mindray-2800 Auto Hematology Analyser



ALPHA
thology Lab & Digital X-ray
TIWARI
Director

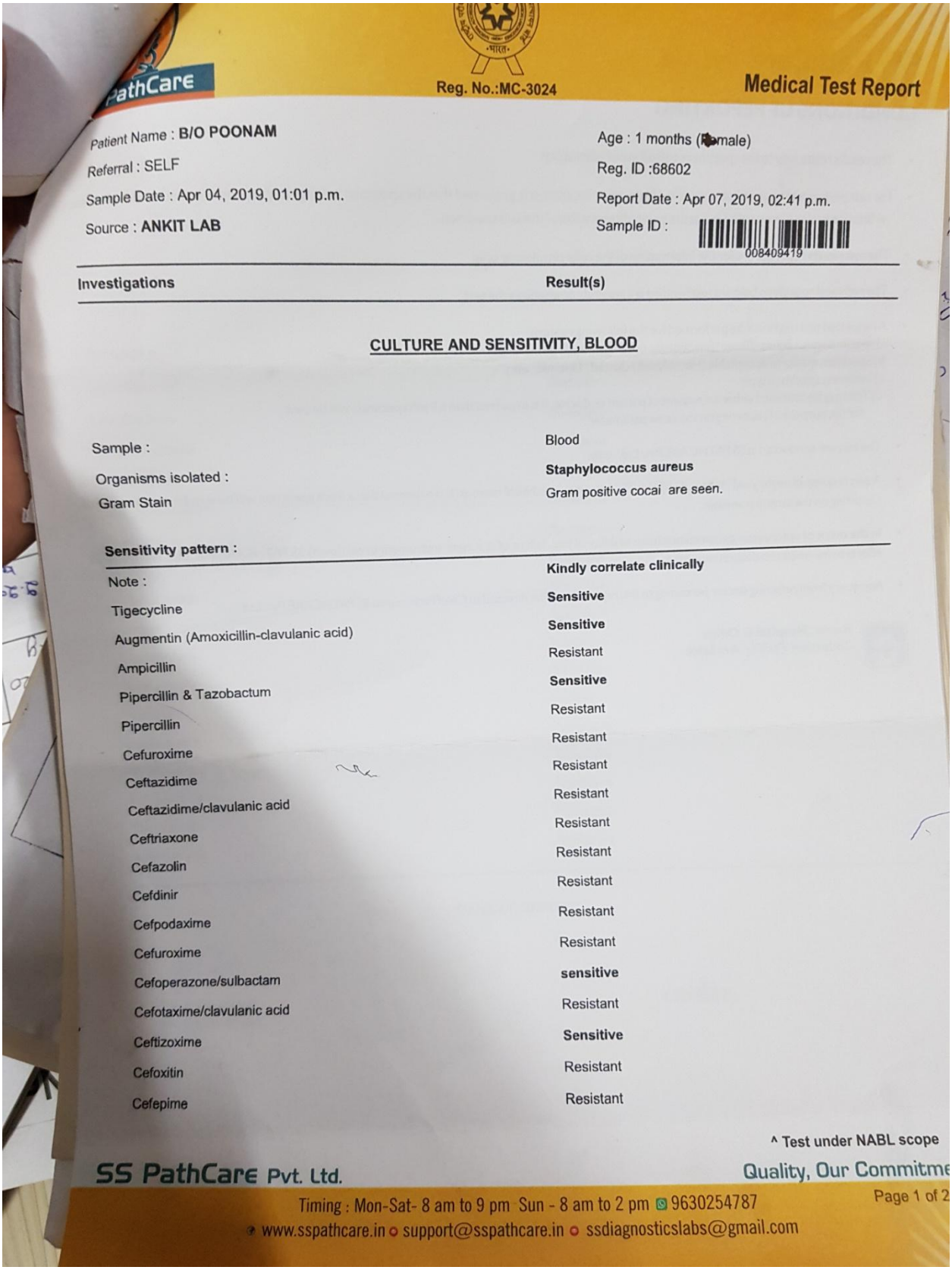
ISO 9001 : 2015 Certified Laboratory
CL/415/JAN/2017
Dr. Apoorva Tripathi
MD (Micro Biology)

| | |
|---|---|
| oxime | Resistant |
| operazone/sulbactam | Sensitive |
| fotaxime/clavulanic acid | Sensitive |
| eftizoxime | Resistant |
| Cefoxitin | Sensitive |
| Cefotaxime | Resistant |
| Cefepime | Sensitive |
| Ciprofloxacin | Resistant |
| Ertapenem | Sensitive |
| Levofloxacin | Sensitive |
| Faropenem | Sensitive |
| Meropenem | Sensitive |
| Imipenem | Sensitive |
| Co-trimoxazole | Sensitive |
| Tobramycin | Sensitive |
| Amikacin | Sensitive |
| Gentamycin | Sensitive |
| Netilmycin | Resistant |
| Colistin | Sensitive |
| Aztreonam | Intermediate |
| Tetracycline | Resistant |

**END OF REPORT**

Shop No. 8, Under Bridge, Near Distt. Hospital, Vidisha (M.P.) Mob.: 9424445951, 9111010498, E-mail : alfalab.pt@gmail.com

Computerized Laboratory Equiped with EM-200 Fully Bio Chemistry, Ranbaxy B4B
& Erba Chem-7 & Hematology By Sysmex-XP-100 & Mindray-2800 Auto Hematology Analyser



PathCare

Reg. No.:MC-3024

Medical Test Report

Patient Name : B/O POONAM
Age : 1 months (Female)
Referral : SELF
Reg. ID :68602
Sample Date : Apr 04, 2019, 01:01 p.m.
Report Date : Apr 07, 2019, 02:41 p.m.
Source : ANKIT LAB
Sample ID : 008409419

| Investigations | Result(s) |
|---|---|

CULTURE AND SENSITIVITY, BLOOD

| | |
|---|---|
| Sample : | Blood |
| Organisms isolated : | **Staphylococcus aureus** |
| Gram Stain | Gram positive cocai are seen. |
| **Sensitivity pattern :** | |
| Note : | **Kindly correlate clinically** |
| Tigecycline | **Sensitive** |
| Augmentin (Amoxicillin-clavulanic acid) | **Sensitive** |
| Ampicillin | Resistant |
| Pipercillin & Tazobactum | **Sensitive** |
| Pipercillin | Resistant |
| Cefuroxime | Resistant |
| Ceftazidime | Resistant |
| Ceftazidime/clavulanic acid | Resistant |
| Ceftriaxone | Resistant |
| Cefazolin | Resistant |
| Cefdinir | Resistant |
| Cefpodaxime | Resistant |
| Cefuroxime | Resistant |
| Cefoperazone/sulbactam | **sensitive** |
| Cefotaxime/clavulanic acid | Resistant |
| Ceftizoxime | **Sensitive** |
| Cefoxitin | Resistant |
| Cefepime | Resistant |

^ Test under NABL scope

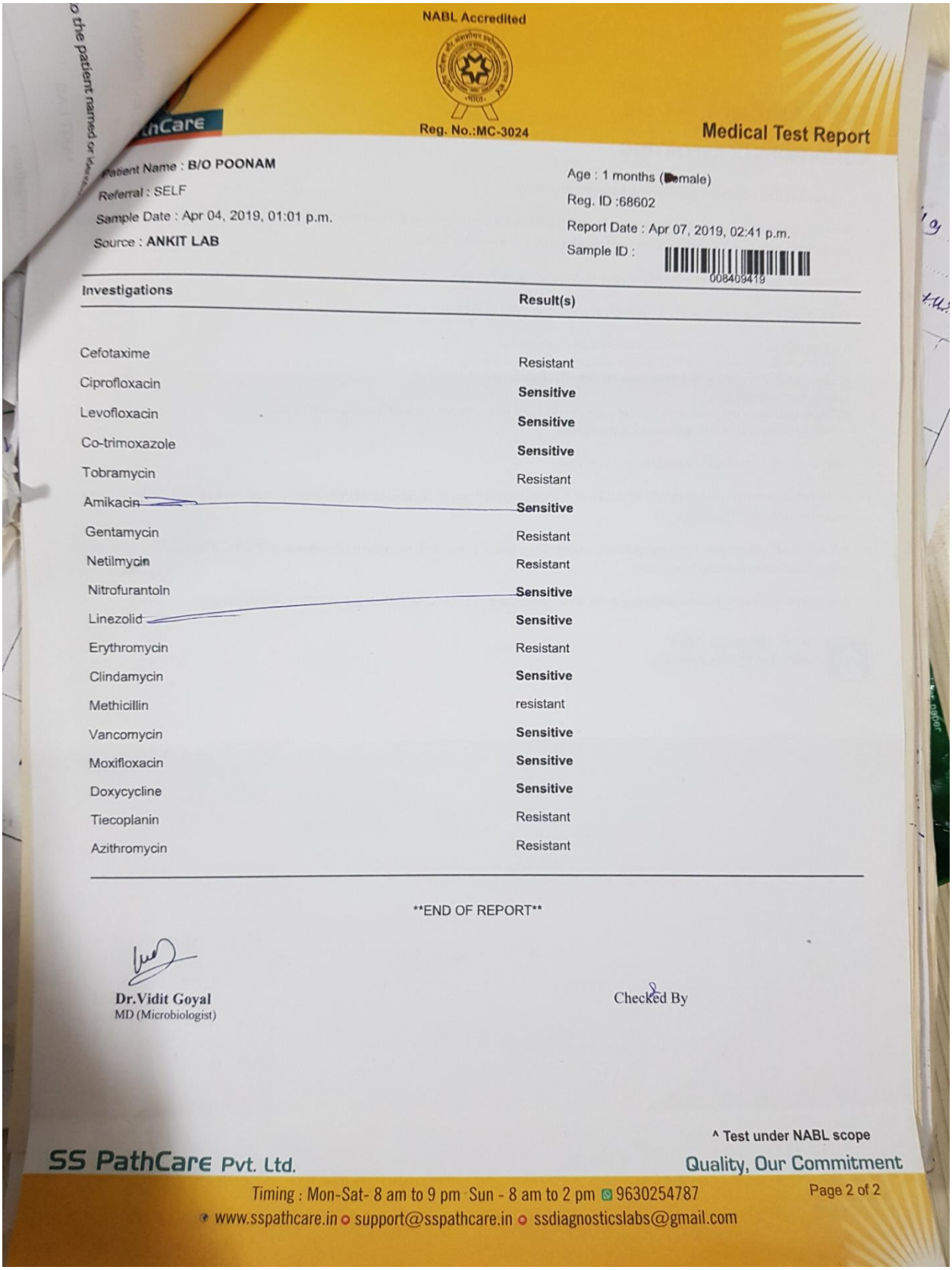
SS PathCare Pvt. Ltd.

Quality, Our Commitme

Timing : Mon-Sat- 8 am to 9 pm Sun - 8 am to 2 pm 9630254787

www.sspathcare.in support@sspathcare.in ssdiagnosticslabs@gmail.com

Page 1 of 2



NABL Accredited

Reg. No.:MC-3024

Medical Test Report

Patient Name : B/O POONAM
Referral : SELF
Sample Date : Apr 04, 2019, 01:01 p.m.
Source : ANKIT LAB

Age : 1 months (Female)
Reg. ID :68602
Report Date : Apr 07, 2019, 02:41 p.m.
Sample ID : 008409419

| Investigations | Result(s) |
|---|---|
| Cefotaxime | Resistant |
| Ciprofloxacin | **Sensitive** |
| Levofloxacin | **Sensitive** |
| Co-trimoxazole | **Sensitive** |
| Tobramycin | Resistant |
| Amikacin | **Sensitive** |
| Gentamycin | Resistant |
| Netilmycin | Resistant |
| Nitrofurantoin | **Sensitive** |
| Linezolid | **Sensitive** |
| Erythromycin | Resistant |
| Clindamycin | **Sensitive** |
| Methicillin | resistant |
| Vancomycin | **Sensitive** |
| Moxifloxacin | **Sensitive** |
| Doxycycline | **Sensitive** |
| Tiecoplanin | Resistant |
| Azithromycin | Resistant |

**END OF REPORT**

Dr.Vidit Goyal
MD (Microbiologist)

Checked By

^ Test under NABL scope

SS PathCare Pvt. Ltd.

Quality, Our Commitment

Timing : Mon-Sat- 8 am to 9 pm Sun - 8 am to 2 pm 9630254787

Page 2 of 2

www.sspathcare.in support@sspathcare.in ssdiagnosticslabs@gmail.com

## 4. Discussion

Neonatal sepsis is a term that has been used to describe the systemic response to infection in newborn infants. The inability of neonates to completely muster the minimum inflammatory response makes them more susceptible to bacterial invasion of the blood stream than older children and adults and the risks are even higher in preterm infants. Diagnosis of neonatal septicemia may be difficult as the early signs of sepsis may be subtle and different at different gestational ages [5].

In present study considering all four parameters that is sensitivity, specificity, positive predictive value and negative predictive value, degenerative changes were the most reliable tests for diagnosing sepsis in my study.

Degenerative changes in neutrophils were not found as sensitive indicator of sepsis but it has high specificity, high PPV and high NPV. Moreover the presence of toxic granules indicates the production of unusual neutrophils during infection and stress induced leucopoiesis. They never have seen in healthy babies. In my study, total leukocyte counts, total PMN counts, immature PMN, I/T ratio, I/M ratio and platelets counts all have high sensitivity, high specificity, high NPV but low PPV compared with study of Makkar et al (14) except PPV. For decreasing inappropriate use of antibiotics in cases tests must have a reasonably high specificity and better predictive value. In my short span of study with small sample size I got only 3 cultures positive with HSS score 5. Single parameter is not useful to predict sepsis, combination of all parameters should be taken into consideration The higher the score, the greater was the likelihood of sepsis, score ≤2 suggests that sepsis was unlikely.

Though there are several methods for rapid detection of microorganisms in blood cultures of newborn infants using automated blood culture system, DNA probe method [10–12], still HSS can be employed as a useful test to distinguish the infected from the non infected infants. It has high sensitivity and specificity, the certainty of sepsis being present with higher scores. In my set up where it's difficult to afford other expensive methods because of economical conditions of cases this method I found very quick and economical.

## 5. Conclusion

Single individual hematological parameter is not useful in predicting neonatal sepsis, so HSS by a combination of hematological parameters as given in Table1 is considered as an important system for early diagnosis of neonatal sepsis. HSS is a simple, quick, cost effective tool which can be used as a screening test for early diagnosis of neonatal sepsis. HSS is useful for distinguishing the infected infants from non infected infants. Unnecessary exposure of infants to antibiotic therapy can thus be avoided.

## References

[1] Mathur NB, Saxena LM, Sarkar R, Puri RK. Superiority of acridine orange-stained buffy coat smears for diagnosis of partially neonatal septicaemia. Acta Paediatr. 1994; 83 (6):652–655.
[2] Xanthour M. Leucocyte blood picture in healthy full term and premature babies during neonatal period. Arch Dis Child. 1970; 45:242–249. doi: 10.1136/adc.45.2']]\40.242. [PMC free article] [PubMed] [CrossRef]
[3] Speer CP, Gahr M, Schrotter W. Early diagnosis of neonatal infection. Monatsschr Kinderheilkd. 1985;133 (9):665–668. [PubMed]
[4] Rodwell RL, Leslie AL, Tudehope DI. Early diagnosis of neonatal sepsis using a hematologic scoring system. J Pediatr. 1988; 112:761–767. doi: 10.1016/S0022-3476 (88)80699-1. [PubMed] [CrossRef]
[5] Neonatal bacteraemia diagnosis and management (editorial) (1997) Br Med J 2:1385–1386 [PMC free article] [PubMed]
[6] Ghosh S, Mittal M, Jaganathan G. Early diagnosis of neonatal sepsis using a hematological scoring system. Indian J Med Sci. 2001;55 (9):495–500.[PubMed]
[7] Sharma A, Kutty CV, Sabharwal U, Rathee S, Mohan H. Evaluation of sepsis screen for diagnosis of neonatal septicemia. Indian J Pediatr. 1993; 60:559–63.
[8] Misra PK, Kumar R, Malik GK, Mehra P, Awasthi S. Simple hematological tests for diagnosis of neonatal sepsis. Indian Pediatr. 1989; 26:156–60.
[9] Baltimore RS, Huie SM, Meek JI, Schuchat A, O'Brien KL. Early-onset neonatal sepsis in the era of group B streptococcal prevention. Pediatrics. 2001; 108:1094–8.
[10] Gars-Prats JA, Cooper TR, Schneider VF, Stager CE, Hansen TN. Rapid detection of microorganisms in blood cultures of newborn infants utilising an automated blood culture system. Pediatrics. 2000; 105:523–527. doi: 10.1542/peds.105.3.523. [PubMed] [CrossRef]
[11] Hertz D, Fuller D, Davis T, Popile L, Stevenson D, Lemons J. Comparison of DNA probe technology and automated continuous monitoring blood culture systems in the detection of neonatal bacteraemia. J Perinatol. 1999; 19:290–293. doi: 10.1038/sj.jp.7200156. [PubMed] [CrossRef]
[12] Pauli IJ, Lekhawat P, Kehl S, Sasidharan P. Early detection of bacteraemia in the neonatal intensive care unit using the new BALTEC system. J Perinatol. 1999; 19:127–131. doi: 10.1038/sj.jp.7200124. [PubMed] [CrossRef]
[13] Saleem, Munazza et al. "Hematological Scoring System for Early Diagnosis Of Neonatal Sepsis". Journal of Rawalpindi Medical College (JRMC) 18.1 (2014): 68-72.
[14] Makkar M, Gupta C, Pathak R, Garg S, Mahajan NC. Performance evaluation of haematological scoring system in early diagnosis of neonatal sepsis. J Clin Neonatol 2013; 2:25-9.