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A Clinical Study on the Diagnostic Significance of Sepsis Markers in Neonatal Sepsis in a Tertiary Care Center

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Aims & Objective: To know the sensitivity, specificity, positive predictive value and negative predictive value of sepsis markers in a neonate.

Materials & Methods: All babies< 28 days of life with sepsis risk factors, and clinical features suggesting sepsis were included in this study.

Results: A total of 100 neonates admitted to NICU were enrolled in the study. 32% of the cases had abnormal WBC levels, 44% of cases had thrombocytopenia and CRP was positive in 89% of the cases.18% of the cases had culture-proven sepsis, 29% cases had probable sepsis and 53% cases had suspected sepsis.

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A Clinical Study on the Diagnostic Significance of Sepsis Markers in Neonatal Sepsis in a Tertiary Care Center

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Conclusions: No single individual test is better than others in detecting neonatal sepsis. The conjunction of tests like Total WBC, Platelets, and CRP are to be utilized for better sepsis screening.

Keywords: neonatal sepsis, sepsis markers, platelet count, CRP.

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I. Introduction

The neonatal period is vulnerable to infections and its impact can have long term effects. In this period more than 50% of deaths are reported among under five children. [1]NNPD 2002 -2003 report had showed incidence of neonatal sepsis as 30/1000 live births. [2]Sustainable Developmental Goals (SDG) 3 aims to reduce neonatal mortality to less than 12 deaths for 1000 live births by 2030. W. H. Ohas given guidelines that can be utilized to achieve SDG 3.[3]

After prematurity, sepsis is considered as the second leading cause of mortality. Incidence of clinical sepsisis very high in India. [4]Presence of signs and symptoms of infection within one month of birth are considered as neonatal sepsis.[5]

Neonatal sepsis can be divided into Early-onset sepsis (EONS), and Late-onset sepsis (LONS). Early-onset sepsis occurs within the first 72 hours of life. Late-onset sepsis generally occurs after 3 days of birth. Mortality is more with EONS than LONS.[6]

On time diagnosis and management of neonatal sepsis is very essential to prevent mortality. Blood culture is the confirmatory method of neonatal sepsis. But among all the neonatal sepsis, only 25 to 40% have culture positivity.[7] In developing countries like India, with the resource-limited setting and the delay in obtaining culture positivity report (up to 48 hrs), confirmation of neonatal sepsis can be done based on the clinical presentation, and use of sepsis markers. Hence, this study was taken up to prove the diagnostic significance of sepsis markers in neonatal sepsis.

II. Materials & Methods

This is an observational study done from May 2020 to November 2021 at GEMS NICU, Ragolu, Srikakulam.

a) Inclusion Criteria

All babies< 28 days of life with sepsis risk factors and clinical features suggesting sepsis were included in this study.

b) Exclusion Criteria

Babies with birth asphyxia, with birth weight <1500 grams, with gestational age <32 weeks and

neonates who had taken antibiotics were excluded from the study.

In this observational study, neonates clinically suspected to have sepsis were enrolled. On meeting the inclusion criteria, prior informed, written parental consent was obtained before enrollment in the study. The study has been cleared by Hospital Ethics Committee and Hospital Research Committee. During the study, a pre-designed and pre-tested proforma was implemented.

On admission, as per the hospital protocol, detailed information was noted in the medical case sheet. When sepsis was suspected, clinical features were noted. Investigations like complete blood picture, CRP, and blood culture were done. Various biomarkers are used as diagnostic tools for neonatal sepsis. But the gold standard for the detection of sepsis is blood culture, but blood culture takes 2-3 days for a diagnosis. This study evaluates the Sensitivity, specificity, positive predictive value, and negative predictive value of the sepsis markers i.e., Total Leukocyte Count, CRP, Platelet count. Data was analyzed with Microsoft Excel and SPSS (Statistical package for social sciences) version 25. Statistical analysis was done by using the Chi-square test and ANOVA. Results were expressed in terms of mean, percentages, and depicted as tables, graphs. P-value <0.05 was considered statistically significant.

III. Results

All the 100 neonates enrolled were survived without any mortality.

Of the 100 neonates, males were 63%, and females were 37%.

Table 1: Birth Weight Wise Distribution of Study Population

Birth weight	No. of Cases	Percentage
≤2.5kg	71	71
>2.5kg	29	29
Total	100	100

The average birth weight of preterm neonates was 2336.76 ± 148.23 grams, and term neonates were 2661.03 ± 129.16 grams. The average birth weight of all (100) neonates was 2430.80 ± 205.238 grams.

Table 2: Gestational Age-Wise Distribution of Study Population

Gestational age	No. of Cases	Percentage
≤ 37 weeks	62	62
>37 weeks	38	38
Total	100	100

The average gestational age of the preterm neonates was 34.29±0.67 weeks, term neonates were 37.88±0.73 weeks, and the average gestational age of total neonates was 35.65±1.88 weeks.

Of the total neonates, 57% were delivered by caesarean section and 43% were delivered by normal vaginal delivery (NVD).

In this study, regarding indication for caesarean section, foetal distress was the most often reason (16%), followed by meconium stained liquor (12%), CPD (10%), Non-reactive NST (9%), non-progression of labour (8%), and compound presentation (2%) were the other causes for indication of caesarean section.

In this study regarding the distribution of risk factors for sepsis, 20% of the cases had single unclean or more than 3 Vaginal Examinations, 34% of cases had PROM more than 18 hrs, 21% of cases had meconium-stained liquor, 17% of cases had a febrile illness in mother, and 8% of the cases had foul Smelling Liquor.

Table 3: Manifestation of Sepsis

Manifestations of Sepsis	No. of Cases	Percentage
Shock	82	82
Congenital Pneumonia	9	9
Necrotizing enterocolitis (NEC)	5	5
Meningitis	4	4
Total	100	100

In this study, the majority (82%) of the neonates had a shock, followed by congenital pneumonia (9%).

In this study, early onset of neonatal sepsis (EONS) was observed among 56% of the neonates, and late-onset of neonatal sepsis (LONS) was observed among 44% of neonates.

The average duration of EONS was 18 ± 9.12 hrs, and LONS was 168.1 ± 74.35 hrs.

Table 4: Distribution of Cases based on Blood Culture

Blood Culture Positive	No. of Cases	Percentage
Yes	18	18
No	82	82
Total	100	100

Table 5: Distribution of Cases based on Organisms in Culture

Organisms	No. of Cases	Percentage
Actinobacter species	1	1
E.coli	4	4
Haemophilus	1	1
Klebsiella	3	3
Methicillin-resistant staphylococcal aureus	1	1
Pseudomonas aerugonsia	1	1
Staphylococcal species	7	7
Total	18	18

In this study, of all the neonates, 68% of the neonates had normal WBC levels and 32% of cases had abnormal WBC levels.

In this study, of the total neonates, 56% of the neonates had >1.5 Lakhs platelets and 44% of neonates had ≤1.5 Lakhs platelets.

Table 6: Distribution of Cases based on CRP

CRP Positive	No. of Cases	Percentage
Yes	89	89
No	11	11
Total	100	100

Among the total neonates, CRP was positive in 89% of the cases and was negative in 11% of cases.

Table 7: Distribution of Sepsis

Category	No. of Cases	Percentage
Suspected sepsis	53	53%
Probable sepsis	29	29%
Culture proven sepsis	18	18%
Total	100	100

Of the total cases, only 18% of the cases had culture-proven sepsis, 29% of cases had Probable sepsis, and 53% of the cases had suspected sepsis.

Table 8: Gender wise Distribution of Neonatal Sepsis

Gender	Suspected Sepsis	Probable Sepsis	Culture Proven Sepsis	Total
Male	35(55.6%)	15(23.8%)	13(20.6%)	63(63%)
Female	18(48.6%)	14(37.8%)	5(13.5%)	37(37%)
Total	53(53%)	29(29%)	18(18%)	100(100%)

Pearson chi square 2.448; P value 0.294(No significance)

The association between gender and sepsis was statistically not significant (P-value 0.294).

Table 9: Gestational Age-Wise Distribution of Neonatal Sepsis

Gestational Age	Suspected Sepsis	Probable Sepsis	Culture Proven Sepsis	Total
≤ 37 weeks	26(41.9%)	20(32.3%)	16(25.8%)	71(71%)
>37 weeks	27(71.1%)	9(23.7%)	2(5.3%)	29(29%)
Total	53(53%)	29(29%)	18(18%)	100(100%)

Pearson chi-square 9.89; P value 0.007(Significant)

The association between Gestational Age and sepsis was statistically significant (P-value 0.007).

Table 10: Birth Weight Wise Distribution of Neonatal Sepsis

Birth weight	Suspected Sepsis	Probable Sepsis	Culture Proven Sepsis	Total
≤2.5kg	32(45.1%)	23(32.4%)	16(22.5%)	71(71%)
>2.5kg	21(72.4%)	6(20.7%)	2(6.9%)	29(29%)
Total	53(53%)	29(29%)	18(18%)	100(100%)

Pearson chi square 6.675; P-value 0.036 (Significant)

The association of birth weight with sepsis was statistically significant (P-value 0.036).

Table 11: Mean Total Leucocyte Count (TLC) vs Neonatal Sepsis

		N	Mean ± SD	95% Confidence Interval for Mean		P-value
				Lower Bound	Upper Bound	
Mean TLC	Suspected Sepsis	53	12515.09±2554.73	11810.92	13219.27	0.0001 (Highly sig.)
	Probable Sepsis	29	7855.17± 4868.6	6003.26	9707.09	
	Culture Proven Sepsis	18	7805.56 ± 5534.11	4953.50	10557.6	
	Total	100	10316.00±4571.64	9408.89	11223.1	

In the above table, lower bound values were lowest in the Culture Proven Sepsis and higher bound values were observed in Suspected Sepsis. Thus Leucopenia, an adverse marker of sepsis, was observed in the study had differentiated the Culture Proven Sepsis and Suspected Sepsis. This difference reached levels of the highest statistical significance (p=0.0001).

Table 12: Mean Platelet Count (PLT) VS Neonatal Sepsis

		N	Mean ± SD	95% Confidence Interval for Mean		P-value
				Lower	Upper	
Mean PLT	Suspected Sepsis	53	202113.21 ± 39406.003	191251.57	140359.60	0.0001 (Highly significant)
	Probable Sepsis	29	99172.41 ± 31399.578	87228.65	111116.17	
	Culture Proven Sepsis	18	95833.33 ± 42726.559	74585.92	117080.75	
	Total	100	153130.00 ± 64359.887	140359.60	165900.40	

In the above table, lower bound values were lowest in the Culture Proven Sepsis and higher bound values were observed in Suspected Sepsis. Thus thrombocytopenia was a significant marker in diagnosing proven and probable sepsis. This trend reached levels of the highest statistical significance (p <0.0001).

Table 13: Mean CRP levels VS Neonatal Sepsis

		N	Mean ± SD	95% Confidence Interval for Mean		P-value
				Lower Bound	Upper Bound	
Mean CRP	Suspected Sepsis	53	14.47±6.863	12.58	16.36	0.0001 (Highly significant)
	Probable Sepsis	29	48.00±28.864	37.02	58.98	
	Culture Proven Sepsis	18	78.17±35.499	60.51	95.82	
	Total	100	35.66± 33.019	29.11	42.21	

In the above table, lower bound values were lowest in the Suspected Sepsis and higher bound values were found in Culture Proven Sepsis. Thus raised CRP levels was a significant marker in diagnosing proven and probable Sepsis. This trend reached levels of the highest statistical significance (p <0.0001).

Table 14: Total leucocyte Count VS Blood Culture Positivity

		Blood Culture				Total	
		Positive		Negative			
		No.	%	No.	%	No.	%
Total leucocyte Count	5000-20000	6	3.3	62	75.6	68	68
	<5000/>20000	12	66.7	20	24.4	32	32
Total		18	18	82	82	100	100

Pearson chi-square 12.123, P-value 0.0001 (Highly significant)

In the above table, abnormal total leucocyte count was observed in 66.7% of the culture-positive sepsis and 24.4% of culture-negative cases. This abnormal trend of total leucocyte count in Proven Sepsis showed highly statistical significance (P-value 0.0001).

Table 15: Prediction of Sepsis with Total Leucocyte Count

Sensitivity	33.3%
Specificity	24.4%
PPV	8.8%
NPV	62.5%

The total leucocyte count of this study had a moderate Negative predictive value (62.5%) with low Sensitivity (33.3%), low Specificity (24.4%), and low Positive predictive value (8.8%).

Table 16: Platelet Count (PLT) VS Blood Culture Positivity

		Blood Culture				Total	
		Positive		Negative			
		No.	%	No.	%	No.	%
PLT	≤1.5L	13	72.2	31	37.8	44	44
	>1.5L	5	27.8	51	62.2	56	56
Total		18	18	82	82	100	100

Pearson chi square 7.096; P value 0.008 (significant)

In this study, thrombocytopenia occurred in 72.2% of the culture-positive sepsis, and 37.8% of culture-negative cases. This increased trend of thrombocytopenia in Proven Sepsis showed statistical significance (P-value 0.008).

Table 17: Prediction of Sepsis with Platelets

Sensitivity	72.2%
Specificity	62.2%
PPV	29.5%
NPV	91.1%

In this study, Platelets had a high negative predictive value (91.1%), and moderate Sensitivity (72.2%) with moderate Specificity (62.2%), and a low positive predictive value (29.5%).

Table 18: CRP levels VS Blood Culture Positivity

		Blood Culture				Total	
		Positive		Negative			
		No.	%	No.	%	No.	%
CRP	Positive	15	83.3	74	90.2	89	89
	Negative	3	16.7	8	9.8	11	11
Total		18	18	82	82	100	100

Pearson chi-square 0.72, P-value 0.396 (No significance)

In the above table, increased CRP levels was observed in 83.3% of the culture-positive sepsis and 90.2% of culture-negative cases. This association between CRP levels and culture did not show statistical significance (P-value 0.396).

Table 19: Prediction of Sepsis by CRP

Sensitivity	83.3%
Specificity	9.8%
PPV	16.9%
NPV	72.7%

In this study, CRP levels had high Sensitivity (83.3%), moderate Negative predictive value (72.7%) with low Specificity (9.8%), and low positive predictive value (16.9%).

IV. Discussion

In this study, males were more (63%) compared to females (37%) which showed a male preponderance with a male to female ratio of 1.7:1. Similar male preponderance was reported by studies done by Bhalodia MJet al. [8] (66.7%), Vinay BS et al. [9](66.6%), Emad A. Morad et al.[10] (66%), Abebe Sorsa[11] (65.3%), Mittal A et al.[12] (58.8%), Arnab Sengupta et al.[13] (58.2%), Flora Chacha et al.[14] (51.2%).

In the present study, low birth weight was reported in the majority (71%) of the study population. Similar reports were obtained in the study by Vinay BS et al.[9] (70%), Mittal Aet al.[12] (56.1%), Arnab Sengupta et al.[13] (56.6%), Emad A. Morad et al.[10] (54%). Contrast findings were seen in Flora Chacha et al.[14] (29.8%), Abebe Sorsa study[11] (24.1%).

In this study, more (62%) preterm babies were seen than term babies (38%). Similar to this finding preterm babies were more in Vinay BS et al.[9] (68.4%), Choudhary D.K et al.[15](76%) studies, whereas preterm babies were less in the study by Flora Chacha et al.[14] (22.6%), Abebe Sorsa study[11] (22.9%), Bhalodia MJet al.[8] (26.7%), Emad A. Morad et al.[10] (38%).

Of the total babies, 57% of the neonates were delivered by caesarean section (57%) and 43% were delivered by normal vaginal delivery (NVD). Whereas study by Flora Chacha et al.[14] (22%), Abebe Sorsa study[11] (24.1%), and Emad A. Morad et al.[10] (46%) caesarean sections was less compared to normal deliveries.

Early-onset of neonatal sepsis was observed among 56% of the neonates, and late-onset of neonatal sepsis was observed among 44% of neonates. Similar to this finding in Abebe Sorsa study[11], early onset of neonatal sepsis was seen in 61.2% of cases, and in 38.8% of cases late-onset of neonatal sepsis was reported, and Vinay BS et al.[38] also reported early-onset sepsis in 90% of cases.

In contrast to this study finding in the study by Choudhary D.K et al.[15] early-onset sepsis was present in 27% of cases, while late-onset neonatal sepsis was present in 73% of cases.

In this study, Blood culture was positive in only 18% of the cases and was negative in 82% of cases. Similar findings were reported by Choudhary D.K et al.[15] (17%), Harshitha M. Swamy et al.[16] (20%), Flora Chacha et al.[14] (20.3%), Bhalodia MJ et al.[8] (38%), whereas the higher incidence of positive blood culture was reported in the studies by Sriram R. [17] (50.4%), Vinay BS et al.[9](80%).

In this study regarding culture, Staphylococcal species were present in 7% of the cases, followed by E.coli (4%), Klebsiella (3%), whereas Actinobacter species, Haemophilus, Methicillin-resistant staphylococcal aureus, and Pseudomonas aerugonsia was observed in each one percent of the cases. Staphylococcal species were the predominant organism. Similar to this study, S. aureus was the commonest organism in the studies by Karthikeyan G et al.[18], Misquith R et al.[19], Jaswal RS et al.[20], Tushar Priyanka et al.[21]

CRP was positive in 89% and was negative in 11% of cases. Similar to this finding in Sriram. R study[17], CRP was positive in 88.7% cases and negative in 11.3% cases. In contrast to this finding Gurpreet Singh Chhabra et al.[22] studies had 3% CRP positivity.

a) Total WBC Count vs Blood Culture Positivity

In this study, abnormal total leucocyte count was observed in 66.7% of the culture-positive sepsis and 24.4% of the culture-negative cases. The total leucocyte count of this study had reported 33.3% Sensitivity, which was in accordance with studies by Tushar Priyanka et al.[21] (23.63%), Harshitha M. Swamy et al.[16](20%), and Makkar M et al. [23] (43.18%).

In this study total leucocyte count had shown specificity of 24.4%, which was lower than other studies by Tushar Priyanka et al.[21] (71.27%), Bhalodia et al.[8] (74.5%), and Majumdar A et al.[24] (85%).

This variation might be due to different selection criteria adapted while selecting the participants, and different levels of infections in neonates.

In this study total leucocyte count had a low positive predictive value (8.8%), which was similar to the study by Hiral PS [25](15.38%). Contrast results were obtained in the studies by Punyashetty KB et al.[26] (87.5%), Makkar M et al. [23] (86.36%), and Narasimha A et al. [27](80%).

The total leucocyte countof this study had a moderate Negative predictive value (62.5%), which was in accordance with Makkar M et al. [23] (56.89%), Majumdar A et al.[24] (87%), and Bhalodia et al.[8] (87%) studies.

b) Platelet Count vs Blood Culture Positivity

This study had high Sensitivity (72.2%) for platelets which was in accordance with Makkar M et al.[23] (70.45%), Majumdar A et al.[24] (70%), Hiral PS [25] (73.68%), Mittal Aet al.[12] (83.08%).

For platelets, moderate Specificity (62.2%) was observed in this study which was in line with studies by Bhalodia et al.[8] (55.9%), Hiral PS [25] (53.09), and Narasimha A et al. [27] (75%). Low Positive predictive value (29.5%) was reported which was in concordance with Khair BK et al. [28] (31%), Hiral PS [25](26.92%), Mittal Aet al.[12](35.53%), and Harshitha M. Swamy et al.[16] (21.4%).

In this study, Platelets had a high negative predictive value (91.1%), which was similar to studies of Hiral PS [25](89.58%), Punyashetty KB et al.[26] (93.5%), Khair BK et al. [28] (94%), Majumdar A et al.[24] (95%), and Narasimha A et al. [27] (85.71%)

c) CRP vs Blood Culture Positivity

In this study in 83.3% of the culture-positive sepsis and 90.2% of culture-negative cases increased CRP levels were reported. This increased CRP levels in culture-proven sepsis did not show statistical significance (P-value 0.396).

In this study, CRP levels had high sensitivity (83.3%), which was similar to Chandna A et al.[29](83%), Patel U et al.[30] (81.7%), Vinay BS et al. study[9] (81.2%), Sharma CM et al.[31] (80%), Harshitha M. Swamy et al.[16] (90%).

CRP levels in this study had low specificity (9.8%), which was less than studies of Chandna A et al.[29] (42%), Harshitha M. Swamy et al.[16] (47.5%). This variation could be because of the different methodologies used to measure CRP and the cut off used.

CRP levels in this study had low PPV (16.9%), which was similar to studies of Flora Chacha et al.[14] (37.5%), Harshitha M. Swamy et al.[16] (30%).

In this study, CRP levels had moderate NPV (72.7%), which was similar to studies of Sucilathangam G et al.[32] (78.1), Flora Chacha et al.[14](84.5%), Harshitha M. Swamy et al.[16] (95%).

Table 21: Comparison of Sensitivity, Specificity, PPV, NPV with other Studies

Test	Authors	Sensitivity	Specificity	PPV	NPV
Total WBC count	Khair KB et al. [28] (2010)	50%	91%	43%	93%
	Narasimha A et al. [27] (2011)	10.5%	91.66%	80%	24.4%
	Makkar M et al. [23] (2013)	43.18%	86.36%	86.36%	56.89%
	Majumdar A et al.[24] (2013)	45%	85%	40%	87%
	Bhalodia et al.[8] (2017)	66.7%	74.5%	48%	87%
	Punyashetty KB et al.[26] (2016)	100%	90.62%	87.5%	100%
	Hiral PS [25] (2019)	10.53%	86.42%	15.38%	80.46%
Total WBC count <5000/ >20000	Harshitha M. Swamy et al.[16] (2020)	20%	90%	33.3%	81.8%
	Tushar Priyanka et al.[21] (2018)	23.63%	71.27%	35.83%	-
	Present Study	33.3%	24.4%	8.8%	62.5%
Platelets ≤1.5L	Narasimha A et al. [27] (2011)	47.36%	75%	85.71%	31%
	Khair BK et al. [28] (2010)	60%	82%	31%	94%
	Makkar M et al.[23] (2013)	70.45%	93.9%	93.9%	72.3%
	Majumdar A et al.[24] (2013)	70%	80%	40%	95%
	Bhalodia et al.[8](2017)	56.3%	55.9%	56%	58%
	Punyashetty KB et al.[26] (2016)	91.3%	100%	100%	93.5%
	Mittal Aet al.[12]	83.08%	20.33%	35.53%	69.4%
	Hiral PS [25](2019)	73.68 %	53.09%	26.92%	89.5%
	Harshitha M. Swamy et al.[16](2020)	60%	45%	21.4%	81.8%
	Tushar Priyanka et al. [21](2018)	34.6%	78.7%	52.5%	63.9%
	Present study	72.2%	62.2%	29.5%	91.1%
CRP levels (>6mg/dl)	Patel U et al.[30] (2014)	81.7%	88%	95.7%	59.5%
	Vinay BS et al. study[9] (2015)	81.2%	50%	86.6%	40%
	Flora Chacha et al.[14] (2014)	40.4%	82.7%	37.5%	84.5%
	Chandna A et al.[29] (1988)	83%	42%	57%	-
	Sharma CM et al.[31] (2103)	80%	93%	-	-
	Harshitha M. Swamy et al.[16]	90%	47.5%	30%	95%
	Sucilathangam G et al.[32] (2012)	50%	69.4%	38.8%	78.1%
	Sriram R study[17]	52.0%	61.5%	91.4%	14%
	Present study	83.3%	9.8%	16.9%	72.7%

Table 22: Comparison of Sensitivity, Specificity, PPV, NPV of Total WBC with Other Studies

Test	Authors	Sensitivity	Specificity	PPV	NPV
Total WBC count <5000/ >20000	Khair KB et al. [28] (2010)	50%	91%	43%	93%
	Narasimha A et al. [27](2011)	10.5%	91.66%	80%	24.4%
	Makkar M et al. [23] (2013)	43.18%	86.36%	86.36%	56.89%
	Majumdar A et al.[24] (2013)	45%	85%	40%	87%
	Bhalodia et al.[8] (2017)	66.7%	74.5%	48%	87%
	Punyashetty KB et al.[26](2016)	100%	90.62%	87.5%	100%
	Hiral PS [25] (2019)	10.53%	86.42%	15.38%	80.46%
	Harshitha M. Swamy et al.[16] (2020)	20%	90%	33.3%	81.8%
	Tushar Priyanka et al.[21] (2018)	23.63%	71.27%	35.83%	-
	Present study	33.3%	24.4%	8.8%	62.5%

Table 23: Comparison of Sensitivity, Specificity, PPV, NPV of Platelets with Other Studies

Test	Authors	Sensitivity	Specificity	PPV	NPV
Platelets ≤1.5 Lakhs	Narasimha A et al. [27] (2011)	47.36%	75%	85.71%	31%
	Khair BK et al. [28] (2010)	60%	82%	31%	94%
	Makkar M et al.[23] (2013)	70.45%	93.9%	93.9%	72.3%
	Majumdar A et al.[24] (2013)	70%	80%	40%	95%
	Bhalodia et al.[8] (2017)	56.3%	55.9%	56%	58%
	Punyashetty KB et al.[26](2016)	91.3%	100%	100%	93.5%
	Mittal Aet al.[12] (2018)	83.08%	20.33%	35.53%	69.44%
	Hiral PS [25] (2019)	73.68 %	53.09%	26.92%	89.58%
	Harshitha M. Swamy et al.[16](2020)	60%	45%	21.4%	81.8%
	Tushar Priyanka et al. [21](2018)	34.6%	78.7%	52.5%	63.9%
	Present study	72.2%	62.2%	29.5%	91.1%

Table 24: Comparison of Sensitivity, Specificity, PPV, NPV of CRP Levels with Other Studies

Test	Authors	Sensitivity	Specificity	PPV	NPV
CRP levels (>6mg/dl)	Patel U et al.[30] (2014)	81.7%	88%	95.7%	59.5%
	Vinay BS et al. study[9] (2015)	81.2%	50%	86.6%	40%
	Flora Chacha et al.[14] (2014)	40.4%	82.7%	37.5%	84.5%
	Chandna A et al.[29](1988)	83%	42%	57%	-
	Sharma CM et al.[31] (2103)	80%	93%	-	-
	Harshitha M. Swamy et al.[16]	90%	47.5%	30%	95%
	Sucilathangam G et al.[32] (2012)	50%	69.4%	38.8%	78.1%
	Sriram R study[17] (2011)	52.0%	61.5%	91.4%	14%
	Present study	83.3%	9.8%	16.9%	72.7%

In conclusion, it is proved that no single individual test is better than others in detecting neonatal sepsis. So, the conjunction of tests like Total WBC, Platelets and CRP can be utilized for better sepsis screening, timely management and to reduce the duration of hospital stay and to improve appropriate antibiotic utilization.

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Author's Contribution:

Vamseekrishna Polepalli: Definition of intellectual content, Literature survey, Prepared first draft of manuscript, implementation of study protocol, data collection, data analysis, manuscript preparation and submission of article;

Rohini Reddy Vanukuri: Concept, design, clinical protocol, manuscript preparation, editing, and manuscript revision;

Nayan Baba Pelala: Design of study, statistical Analysis and Interpretation;

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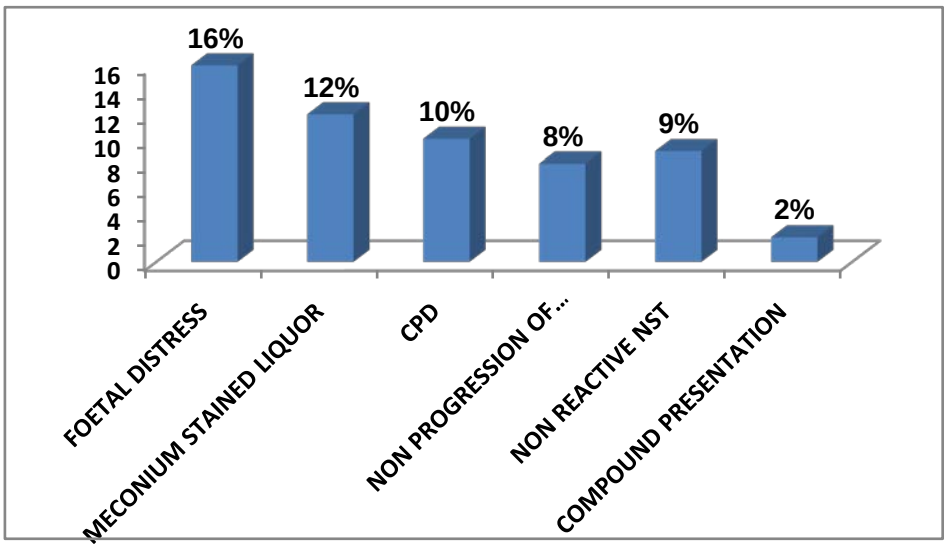

Figure 1: Distribution of Study Population based on Indication for Caesarean

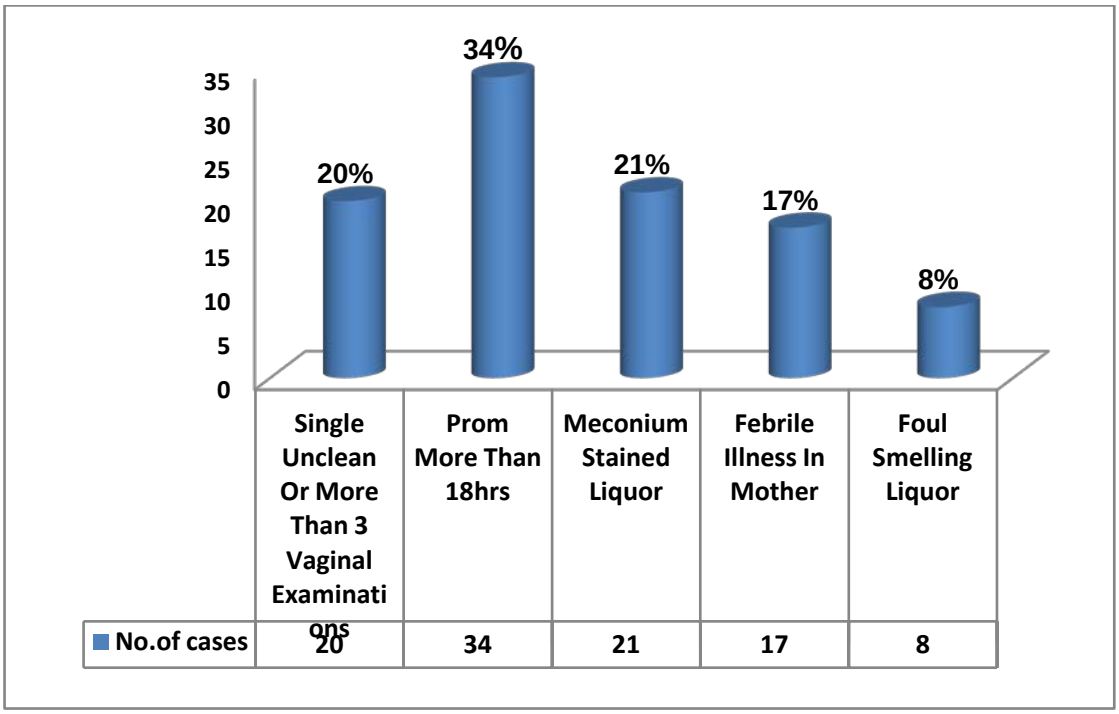

Figure 2: Distribution of Risk Factors for Sepsis