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ORIGINAL ARTICLE

Hematological Variables for Detection of Sepsis in neonates: Including C-Reactive Protein/Platelet Ratio and Neutrophil/Lymphocyte Ratio

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ABSTRACT

Keywords: Neonatal Sepsis, NICU, Presepsin, NLR, PCT, CRP and Platelat

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Background: Sepsis is defined as a potentially life-threatening condition that emerges when the host response to infections exceeds normal limits and impairs vital organ functions. **Objectives:** The current study aimed to assess value of different hematological biomarkers in neonates with suspected sepsis in comparison with both of the already identified biomarkers for sepsis. **Methodology:** This cross-sectional study was carried out on 58 neonates with suspected neonatal sepsis, admitted to the Neonatal Intensive Care Unit at Aswan University Hospitals in the period from July 2022 to December 2022. **Results:** Presepsin, procalcitonin, C-Reactive Protein/Platelet ratio and Neutrophil Lymphocyte Ratio were significantly correlated to septic risk factors and signs. While these markers were negatively correlated to oxygen saturation percentage SO2%, weight, length, head circumference, platelet, hemoglobin, and lymphocytes. Strong positive correlation was observed between Neutrophil Lymphocyte Ratio and C-Reactive Protein /platelet ratio and between procalcitonin and persepsin. Reversely, weak positive correlation was present between Neutrophil Lymphocyte Ratio and either of procalcitonin, or persepsin and between C-Reactive Protein /platelet ratio and either procalcitonin or persepsin. **Conclusion:** persepsin, procalcitonin, C-Reactive Protein/Platelet and Neutrophil Lymphocyte Ratio can be used for diagnosis, early detection and monitoring of neonatal sepsis. Further studies are needed to confirm the predictive power of C-Reactive Protein/Platelet and Neutrophil Lymphocyte Ratio.

INTRODUCTION

Sepsis is defined as a potentially life-threatening condition that emerges when the host response to infections exceeds normal limits and impairs vital organ functions. Sepsis is still one of the leading causes of death in the world, as a heavy burden and colossal menace to the critical patients. According to literature reports, more than 750,000 individuals suffered from sepsis and 200,000 deaths are due to sepsis per year in the USA **(1)**.

Although, it reflects the nature of the disease, the precise mechanisms of cell injuries and systemic organ dysfunction induced by sepsis are still not elucidated clearly. As known, the

immune system plays a critical role through the course of sepsis **(2,3)**. Hence,Neutrophil / Lymphocyte ratio is a valuable biomarker significantly associated with the immune status. It only reflects the change in the quantity of immune cells instead of functional change. As a crucial member of inflammatory cytokines, the C reactive Protein-to-Platelet Ratio (C Reactive Protein), based on CRP levels and Platelet counts, indicates not only the inflammation but also the coagulation status. However, no data is currently available regarding the association of CPR with the neonatal sepsis **(3)**.

Many biological markers have been identified, including procalcitonin (PCT), interleukins, pro-vasopressin, C-reactive protein (CRP), and myeloid cells that express triggering receptor-1 (TREM-1). Researchers have attracted extensive attention to the investigations of these biomarkers on sepsis in terms of diagnosis, assessment, antibiotic treatment, and prognosis. The clinical usefulness of the other indicators, with the exception of PCT, is currently unknown or debatable. A novel biomarker, sCD14-subtypes (presepsin), was discovered in 2004, and its significance in the diagnosis and evaluation of sepsis was demonstrated **(4)**.

The use of procalcitonin (PCT), a host-response and blood infection marker, has gotten a lot of attention, and it's already been approved for antimicrobial therapy advice in patients with respiratory infections and sepsis **(5)**. PCT is a calcitonin precursor hormone that is undetectable in healthy people and its production, on the other hand, is elevated in response to bacterial infections and can rapidly decline during recovery. As a result, PCT gives valuable additional information that can be used to support clinical and diagnostic criteria **(6)**.

The current study aimed to assess the value of different hematological biomarkers in neonates with suspected sepsis in comparison with both of the already identified biomarkers for sepsis procalcitonin (PCT) and (presepsin).

PATIENTS AND METHODS

This cross-sectional study was carried out on 58 neonates with suspected neonatal sepsis, admitted to the Neonatal Intensive Care Unit (NICU) at Aswan University Hospitals in the period from July 2022 to December 2022. The required sample size was calculated using the STATCALC module of Epi-Info statistical package program Version 7.2.5 (CDC 2021, Atlanta, GA, U.S.A) using one population proportion formula with the following assumptions: 95% confidence level of 97%; 0.9 design effect; 2.9 % prevalence of neonates with sepsis **(7)**. Considering 10% possible non-response rate 58 neonates were included **(8).**

All cases admitted to NICU with suspected or confirmed neonatal sepsis (from 35-38 weeks gestational age till 28 days of life) with signs and symptoms of neonatal sepsis (feeding intolerance, lethargy, tachypnea, poor perfusion, seizures, respiratory distress, bradycardia, abdominal distention, or vomiting) were included. On the other hand, neonates with hematologic disorders, major congenital anomalies, documented systemic diseases, history of maternal steroid use within the past 3 months, and whose guardians refused to participate were excluded.

All the studied cases were subjected to complete history tacking, clinical examination, and routine investigation (complete blood count (CBC), CRP, CRP/Platelet Ratio, Neutrophil/Lymphocyte ratio (NLR), renal function tests (urea and creatinine), electrolytes (sodium, potassium, and calcium), random blood sugar, PCT and presepsin).

Statistical analysis

Data was analyzed using descriptive statistical tools, including frequencies for discrete variables or means and standard deviations (SD) for continuous variables. Data analysis includes a bivariate correlation analysis using the Pearson’s correlation in search for

significant correlations between NLR and serum CRP, age, admission PaO2/FiO2, days of hospitalization, and the sepsis severity scores (SOFA, APACHE II, and SAPS II). The significance level was set at 0.05. All data analysis was conducted using the IBM-SPSS Statistics version 23.0 software package **(9)**.

Ethical considerations

Approval for this study was obtained from the Institutional review board, Faculty of Medicine, Aswan University (IRB No 645\7\22) prior to study execution. All caregivers received a written consent form. The informed consent was clear and indicated the purpose of the study, and their freedom to participate or withdraw at any time without any obligation. Further, participants' confidentiality and anonymity were assured by assigning each participant with a code number for the purpose of analysis only. The study was not based on any incentives or rewards for the participants and was abided by the guidelines of Helsinki Declaration **(10)** and the STROBE guidelines for observational studies **(11)**.

RESULTS

Table 1 showed the baseline characteristics of the studied sample. Out of 58 cases, 31 (53.4%) were males. Half of neonates (n=29) showed positive consanguinity. Regarding residence, the majority lived in rural areas (97%). Also, most of neonates were full-term (93.1%), while three cases (5.1%) were preterm and only one case was near-term. About 5% (n=3) needed resuscitation at birth. For the history of maternal disease, about one-third (n=19) had a fever in the prenatal period, about one-quarter (n=15) were hypertensive, 30 cases (52%) had PROM and 9 cases (15.5%) had a history of diabetes.

Fig. 1 presented the findings of the neonatal examination of the studied group, including fever, hypothermia, pallor, cyanosis, feeding intolerance, jaundice, poor perfusion and Convulsions, with a different percentage of distribution of these findings among cases. Also, about two-thirds of cases had disturbed conscious level, and about one-fifth of cases (n=11) had abdominal distension.

Table 2 illustrated the general examination of neonates with sepsis, as regard to the birth weight, 3 patients (5.2%) had low birth weight (<2.5kg), 3 patients (5.2%) were macrocosmic ≥4kg, while the majority (n=52) had normal birth weight. Regarding length, the mean value was (49.6 ± 1.87). Also, two cases (3.5%) had microcephaly (<32 cm), two (3.5%) had macrocephaly >35.5 cm), and 54 neonates (93.1%) had normal head circumference (HC) (32-36 *cm).* As well, only one patient (1.7%) had bradycardia, while 10 cases had tachycardia (17.2%). For the respiratory rate (RR), 34 patients (58.6%) had tachypnea (RR>60), while 10 patients (17.2%) had bradypnea (RR<25). Respecting temperature, five cases (6.4%) were Hypothermic (<36), 15 (32.4%) had Hyperthermia (>37.5). Regarding oxygen therapy, about 55% of patients (55.2%) were on mechanical ventilation (MV), 12 (21%) were on nasal oxygen and 14 patients (24%) were off oxygen. Moreover, about one-third (n=34) had low abnormal oxygen saturation (<92%) while 24 neonates (13.1%) had normal saturation (92%-95%).

Table 3 showed the systematic affection of patients, only one patient had Hyalin membrane disease, half of patients had pneumonia and two (3.4%) had pneumothorax. For the cardiovascular system, 20 patients (34%) had Patent ductus arteriosus (PDA) and 8 cases (13.8%) had an atrial septal defect (ASD). Regarding gastrointestinal system, 16 patients (27.6%) had necrotizing enterocolitis (NEC), 4 (6.9%) had pneumoperitoneum and one case had Jejunal atresia. Also, 8 cases (13.8%) had neurological disorders (one had hypoxic ischemic encephalopathy (HIE), one had hydrocephalus, and 1 patient (1.7%) had meningocele.

Furthermore, the main laboratory findings (Neutrophil, Lymphocyte, NLR, Platelet, Hemoglobin, CRP, CRP/Platelet Ratio, PRESEPSIN, PCT), Random blood glucose Sodium, Potassium, Urea, Creatinine) were demonstrated in **table 4**.

Table 5 showed the correlation between hematological biomarkers and disease determinants in neonates with sepsis. It was found that presepsin was significantly positively correlated with maternal fever, PROM, neonatal fever, pallor, cyanosis, disturbed Conscious levels, poor perfusion, abnormal chest, abdominal, heart, and neurological examinations, feeding intolerance, hypoactivity, resuscitation, jaundice, and CRP. Conversely, it was negatively correlated with crying, SO2%, weight, length, HC, platelet, hemoglobin, RBG, and lymphocyte.

For PCT, it was significantly positively correlated with maternal fever, PROM, neonatal fever, pallor, cyanosis, disturbed conscious levels, poor perfusion, abnormal chest, abdominal, heart, neurological examinations, feeding intolerance, hypoactivity, abdominal distension, RR, CRP, and blood urea. Inversely, negative correlation with platelet, hemoglobin, weight, and SO2%. Regarding CRP/Platelet ratio, there was a positive correlation with HR, CRP, RR, maternal fever, PROM, neonatal fever, pallor, cyanosis, disturbed conscious levels, poor perfusion, abnormal chest, abdominal, heart examinations, feeding intolerance, hypoactivity, abdominal distension and negative correlation with hemoglobin, platelet, potassium, and SO2%. Respecting NLR, there was a positive correlation with HR, Neutrophil, CRP, creatinine, fever maternal, PROM, jaundice, poor perfusion, abnormal heart and abdominal examinations and negatively correlated with hemoglobin, platelet, and lymphocyte.

Figures 2 and 3 depict the intercorrelation between the different hematological parameters. NLR was strongly correlated with CRP/Platelet ratio and weakly correlated with both, presepsin and PCT. Also, presepsin was strongly correlated with PCT. As well, CRP/Platelet ratio was correlated to PCT and presepsin weakly.

DISCUSSION

Based on a greater understanding of sepsis, it reflects the nature of the disease. However, the precise causes of cell damage and systemic organ failure caused by sepsis remains unknown. The immune system plays a vital role throughout the course of sepsis, which is defined by a systemic dysregulated immunological response to infection that leads to microvasculature and endothelial dysfunction **(3)**. This observational study included 58 neonates with suspected sepsis, Attending to NICU at Aswan University Hospital, during the period from July 2022 to Decembre 2022, to evaluate the efficacy of different hematological biomarkers.

The current study revealed that males represented 53.4%. This was in line with a study done by Can et al. (2018), as they had a larger percentage of male patients with sepsis 64% while only 36% of patients were females **(12)**. Also, it agreed with Ghrahani et al. (2019) whom study had more males admitted with sepsis 59.1%% than females 40.9%% **(13)**. Another study by Iskandar et al. (2019) found male neonates with sepsis 65.2% were much more than female neonates. Additionally, Tosson et al. (2021) study had 80% male patients while 20% were females **(14)**. On the other hand, Abed et al. (2023) study had 40% % male patients while 60% % were females **(15)**. This may be due to the different inclusion and exclusion criteria between the studies.

The present study revealed that most of cases were full-term, this agrees with Tosson et al. (2021), whom study had 100% full term neonates and that was because the exclusion criteria from this study were pre-term neonates **(14)**. Also, a study by Rashwan et al. (2019) found that the mean gestational age of the patients included in their study was 38.03 weeks ± 0.60 SD, which agrees with our study **(16).** Contrarily, the current results disagreed with other studies as Simonsen et al. (2014), who reported that many factors that could be

linked to the incidence of neonatal sepsis, have been attributed more to prematurity **(17)**. Also, A study by Iskandar et al. (2019) found that the characteristics of neonatal maturity (gestational age) and birth weight seems to differ within their study groups, although it had not been significant **(18)**.

It was found that 5.2% of cases had low birth weight (<2.5kg). These results disagreed with other studies like Simonsen et al. (2014) who stated that contributors to the incidence of neonatal sepsis have been attributed to low birth weight **(17)**. Another study by Ghrahani et al. (2019) found that infants from septic group showed lower birth weight and gestational age when compared to infants in the control group **(13)**. This was in agreement with the physiology of neonates, that infants with lower gestational age and birth weight are more susceptible to sepsis.

Regarding the correlation between septic markers (presepsin, PCT, CRP /Platelet ratio and NLR) with risk factors, signs, and symptoms of sepsis in neonates with sepsis, it was found that these markers have significant correlation with septic risk factors and signs, as they increase with the Prescence of these factors. In this study, septic markers (presepsin, PCT, CRP /Platelet and NLR) were negatively correlated to SO2%, weight, length, HC, platelet, hemoglobin, RBG, and lymphocyte. Simonsen et al. (2014) **(17)**, Hedegaard et al. (2015) **(19)**, Ozdemir and Elgormus (2017) **(20)** reported a sensitivity range of 41 to 96% and a specificity range of 72 to 100% for CRP in the diagnosis of neonatal sepsis.

According to a study done by Kamel et al. (2021), the lower the neonate's weight, the more impacted the levels of Hb, PLT, TLC, and CRP. Also, higher presepsin, TLC, CRP, and PCT levels, which coincides with our findings. In their study, they discovered a substantial increase in serum Presepsin in preterm groups, with the lowest levels in the full-term group and the highest in the ELBW group, indicating that the lower the neonate's weight, the higher the levels of presepsin **(21)**.

Regarding Correlation between presepsin, PCT, CRP/Platelet and NLR; NLR was strongly correlated to CRP/Platelet, showed mild correlation to presepsin, and mild correlated to Procalcitonin. Presepsin was strongly correlated to PCT and CRP/Platelet mildly correlated to procalcitonin. This is in line with a study by Kamel et al. (2021) as they found that a positive correlation was observed between serum presepsin **(21)**, Procalcitonin (PCT) and CRP levels, also this is in agreement with Miyosawa et al. (2018) who found the same results **(22)**.

A prior study by Dursun et al. (2018) discovered that PCT was used as a reference control and that elevated PCT levels were associated with CRP, NLR, and MPV. They discovered that CRP had a stronger relationship with PCT than NLR and MPV. Furthermore, their findings revealed that increases in CRP levels were associated to NLR and MPV **(23)**. Moreover, Gurol et al. (2015) discovered associations between PCT and WBC, CRP, and NLR in persons with suspected bacteremia and sepsis who were divided into groups based on PCT levels. The strongest association was discovered between PCT and NLR **(24)**.

Moreover, Rashwan et al. (2019) discovered substantial positive relationships between CRP, presepsin and procalcitonin. There was also a strong positive relationship between presepsin and procalcitonin. The findings of their study revealed significantly higher serum levels of PCT and presepsin among non-survivor neonates with sepsis versus the survivor group, with non-significant differences in the other measured biomarkers between the two groups, indicating that PCT and presepsin are the best prognostic markers for neonatal sepsis among the studied biomarkers **(16)**.

The current investigations found substantial positive relationships between PCT and both CRP and presepsin, as well as between CRP and presepsin. This was also consistent with the findings of Abdollahi et al. (2012) **(25)**, Spanuth et al. (2012) **(26)**, Maurice et al. (2014) **(27)**, Sabry et al. (2016) **(28)**.

Presepsin levels were observed to be high in neonates with sepsis in our study. CRP and PCT levels are comparable. Because our findings were consistent with earlier research, we believe that presepsin could be employed as an accurate marker for both the diagnosis and follow-up of neonatal sepsis. Results of our study showed that NLR and CRP\platelet ratio were high but they were not significantly correlated to procalcitonin and presepsin. So, they can be used as markers for diagnosis and early detection of sepsis but not as much significant as presepsin and procalcitonin. and further studies need to confirm our results.

Strengths and Limitations

In this study, there were some limitations that should not be overlooked when interpreting the findings, such as the lack of a control group of healthy babies. Also, peripartum antibiotics are widely used in mothers for obstetric indications that are much broader than our guidelines for sepsis evaluation, and the use of antibiotics in newborns raises the possibility of obscuring some cases of neonatal bacteriuria and bacteremia that were eradicated by transfer of these antibiotics from the mother to her infant prior to delivery. Though, from a clinical standpoint, such occurrences should not modify our approach toward the newborn's required assessment.

However, the current findings emphasize the need for early detection of sepsis among newborns in the NICU, as infections remain widespread and life-threatening in neonates admitted to NICU despite advances in neonatal care over the past decades. Because of the diverse and non-specific clinical manifestations, early recognition and diagnosis of newborn sepsis is difficult. It is critical to make an early diagnosis of sepsis since timely antibiotic therapy improves outcomes.

Conclusion and Recommendation

In conclusion, sepsis was more common in males than females. The majority of patients (57 patients) were living in rural areas. No significant risk was related to gestational age or birth weight.

Presepsin, PCT, CRP/Platelet ratio and NLR were significantly correlated to septic risk factors and signs, as they increase with the Prescence of these factors. While these markers were negatively correlated to oxygen saturation percentage SO2%, weight, length, HC, platelet, hemoglobin, and Lymphocytes. Strong positive correlation was observed between NLR and CRP/platelet ratio and between PCT and persepsin. Reversely, weak positive correlation was present between NLR and either of PCT or persepsin and between CRP/platelet ratio and either PCT or persepsin.

Further, CRP/Platelet and NLR were high in neonates with sepsis, but they were not much significant as procalcitonin and presepsin. CRP had the highest correlation coefficient of any of the indicators studied.

In recommendation, serum persepsin and PCT, as biomarkers, can be used for diagnosis, early detection and monitoring of sepsis. Also, CRP/Platelet and NLR can also be used for diagnosis and early detection as their values were high and significantly correlated to different risk factors in neonates with sepsis. Also, CRP had the highest correlation coefficient of any of the indicators studied. There may be reasons to measure PCT and CRP in acute medical patients. Further studies are needed in the near future to confirm the efficacy of use of CRP/Platelet and NLR in the diagnosis, early detection, follow up and monitoring sepsis in neonates.

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Tables

Table (1): Demographic data of patients with neonatal sepsis

	n = 58	%
Age at admission (days):		
Range	1 – 28	
Mean ± SD	5.14 ± 4.76	
Median (IQ range)	4 (2.75-5.25)	
Sex:		
Male	31	53.4
Female	27	46.6
Consanguinity: Positive	29	50.0
Residence:		
Rural	57	96.6
Urban	1	3.4
Mode of delivery:		
Cesarian Section (CS)	33	56.9
Vaginal delivery (VD)	25	43.1
Gestational age:		
Range	28 – 40	
Mean ± SD	37.66 ± 2.04	
Median (IQ range)	38(37-39)	
Gestational age categories:		
Full term (≥ 38 wks.)	54	93.1
Near term (35 - <38 wks.)	1	1.7
Preterm (< 35wks)	3	5.2
Need for Resuscitation	3	5.2
Maternal disorders:		
Fever	19	32.8
Hypertension	15	25.9
Premature rupture of membrane (PROM)	30	51.7
Diabetes	9	15.5

Table (2): General examination of neonates with sepsis

	No. (n=58) %	
Weight (kg):		
Mean ± SD	3.33 ± 0.64	
Low birth <2.5kg	*3(5.17%)*	
Normal 2.5-4kg	*52 (89.66%)*	
Macrocosmic ≥4kg	*3(5.17%)*	
Length (cm):		
Mean ± SD	49.6 ± 1.87	
Head circumference (HC):		
Mean ± SD	35.16 ± 2.25	
Microcephaly <32	*2(3.45%)*	
Normal 32-35.5	*54(93.1%)*	
Macrocephaly >35.5	*2(3.45%)*	
Heart rate (HR) (beat /min):		
Mean ± SD	138.31 ± 22.28	
Abnormality		
Bradycardia (<110)	*1(1.7%)*	
Normal (110-160)	*47(81%)*	
Tachycardia (>160)	*10(17.2%)*	
Respiratory rate (RR) (cycle: /min)		
Mean ± SD	63.14 ± 14.75	
Normal (25-60)	*24(41.4%)*	
Tachypnea (>60)	*34(58.6%)*	
Temp:		
Mean ± SD	37.4 ± 1.11	
Hypothermia (<36)	*5(6.4%)*	
Normal (36-37.5)	*38(63.8%)*	
Hyperthermia (>37.5)	*15 (32.8%)*	
Oxygen therapy:		
Mechanical ventilation (MV)	32	55.2 %
Nasal	12	20.7%
Off O_2	14	24.1%
SO_2 (percent):		
Mean ± SD	92.93% ± 6.47%	
Abnormal (<92%)	*34 (33.8%)*	
Normal (92%-95%)	*24(31%)*	

Table (3): Systematic affection of patients with neonatal sepsis

	No. (n=58)	%
Respiratory disorders	**32**	**55.2**
Hyalin membrane disease	1	1.7
Pneumonia	29	50.0
Pneumothorax	2	3.4
Cardiac disorders	**20**	**34.5**
Atrial septal defect (ASD)	12	20.7
Patent ductus arteriosus (PDA)	8	13.8
GIT disorders	**21**	**36.2**
Necrotizing enterocolitis (NEC)	16	27.6
Pneumoperitoneum	4	6.9
Jejunal atresia	1	1.7
Neurological disorders	**10**	**17.2**
Hydrocephalus	1	1.7
Hypoxic ischemic encephalopathy (HIE)	8	13.8
Meningocele	1	1.7

Table (4): Laboratory investigations of cases with neonatal sepsis

	Range	Mean ± SD	Median (IQ range)
Neutrophil 10^3/ul	1.2 - 6.24	2.86±1.26	2.8(1.94-3.7)
Lymphocyte 10^3/ul	1.29 - 5.04	2.83±1.12	2.4(2.07-3.7)
Neutrophil \lymphocyte ratio	0.2 - 7.3	1.65±1.63	1.03(0.66-1.87)
Platelet 10^3/ul	20 – 550	175.52±149.25	96(50-300)
Hemoglobin g\dl	8.8 – 17	13.43±2.41	14(11-15)
MCV fl	79 – 112	97.4±7.14	99(95.5-100)
MCH pg	25 – 53	33.84±3.92	35(32-35)
MCHC g\dl	32 – 53	35.56±2.55	36(35-36)
C reactive protein (CRP) mg\dl	2 – 110	31.9±27.06	24(6-48)
CRP \ platelet ratio	0 - 4.5	0.64±0.86	0.43(0.02-1.02)
Presepsin (pg\ml)	123 - 3591	919.9±779.5	744(387.25-1209.25)
Procalcitonin (ng\ml)	0 – 11	1.51±1.74	1.14(0.1-2.38)
Random blood glucose (RBG)	60 - 120	93.97±10.78	90(88-100)
Sodium (NA) mEql\l	122 - 150	136.83±5.73	135(135-136.25)
Potassium (K) mEq\l	2.5 – 5	3.96±0.65	4(3.5-4)
Urea mg\dl	12 – 65	24.14±8.66	23(19.75-27)
Creatinine mg\dl	0.1 - 0.8	0.39±0.13	0.4(0.3-0.5)

Table (5): Correlation between Hematological Biomarkers and other Parameters

	Presepsin	PCT	CRP/P	NLR
	rho (P-value)*			
Sex	0.107 (0.422)	0.162 (0.224)	0.085 (0.527)	-0.094 (0.482)
Consanguinity	0.110 (0.410)	0.199 (0.135)	0.238 (0.072)	-0.021 (0.878)
Fever maternal	**.559 (<0.001)**	**.475 (<0.001)**	**.591 (<0.001)**	**.271 (0.040)**
Neonatal fever	**.492 (<0.001)**	**.408 (0.001)**	**.423 (0.001)**	-0.066 (0.622)
PROM	**.494 (<0.001)**	**.443 (<0.001)**	**.651 (<0.001)**	**.318 (0.015)**
Crying	**-.274 (0.038)**	0.254 (0.054)	**.536 (<0.001)**	0.011 (0.933)
Cyanosis	**.665 (<0.001)**	**.612 (<0.001)**	0.083 (0.535)	-0.187 (0.159)
Jaundice	**.427 (0.001)**	0.254 (0.054)	-0.068 (0.614)	**.276 (0.036)**
Convulsions	0.087 (0.516)	0.036 (0.791)	**.690 (<0.001)**	-0.159 (0.234)
Resuscitations	**.302 (0.021)**	**0.254 (0.022)**	**.676 (<0.001)**	0.058 (0.664)
Active or not	**.609 (<0.001)**	**.601 (<0.001)**	**.280 (0.033)**	**.322 (0.030)**
In-tolerance feeding	**.701 (<0.001)**	**.715 (<0.001)**	-0.121 (0.364)	-0.201 (0.404)
Hypothermia	-0.182 (0.172)	-0.150 (0.259)	**.698 (<0.001)**	-0.048 (0.721)
Perfusion poor	**.720 (<0.001)**	**.702 (<0.001)**	**.615 (<0.001)**	**.354 (0.006)**
Abdominal distention	-0.233 (0.079)	**.280 (0.033)**	**.560 (<0.001)**	-0.174 (0.192)
Disturb. Conscious levels	**.559 (<0.001)**	**.613 (<0.001)**	**.396 (0.002)**	**.411 (0.001)**
Pallor	**.372 (0.004)**	**.464 (<0.001)**	**.369 (0.004)**	-0.179 (0.178)
Abnormal Chest exam.	**.486 (<0.001)**	**.462 (<0.001)**	**.613 (<0.001)**	-0.082 (0.541)
Abnormal Heart exam.	**.303 (0.021)**	**.341 (0.009)**	0.113 (0.397)	**.380 (0.003)**
Abnormal Exam.	**.427 (0.001)**	**.441 (0.001)**	0.085 (0.527)	**.365 (0.005)**
Abnormal Neuro. exam	**.260 (0.048)**	**.259 (0.049)**	0.054 (0.689)	-0.015 (0.911)
Age at admission	0.181 (0.175)	0.089 (0.508)	0.146 (0.275)	0.201 (0.130)
Gestational age	-0.258 (0.050)	-0.048 (0.721)	0.077 (0.275)	0.163 (0.220)
HR (beat /min)	0.146 (0.276)	-0.029 (0.832)	**.399 (0.002)**	**.299 (0.023)**
RR (cycle /min)	0.186 (0.162)	**.417 (0.001)**	**.291 (0.027)**	0.235 (0.076)
SO_2 (percent)	**-.550 (<0.001)**	**-.438 (0.001)**	**-.329 (0.012)**	-0.217 (0.101)
Weight (kg)	**-.470 (<0.001)**	**-.338 (0.009)**	-0.203 (0.126)	-0.077 (0.565)
Length (cm)	**-.354 (0.006)**	-0.125 (0.349)	-0.025 (0.852)	0.055 (0.685)
HC (cm)	**-.283 (<0.031)**	-0.168 (0.207)	-0.104 (0.439)	-0.029 (0.831)
Neutrophil 10^3/ul	0.123 (0.358)	0.172 (0.196)	0.164 (0.219)	**.364 (0.005)**
Lymphocyte 10^3/ul	**-.262 (0.047)**	-0.256 (0.053)	-0.186 (0.163)	**-.297 (0.024)**
Platelet 10^3/ul	**-.436 (0.001)**	**-.518 (<0.001)**	**-.590 (<0.001)**	**-.387 (0.003)**
Hemoglobin	**-.273 (0.038)**	**-.369 (0.001)**	**-.557 (<0.001)**	**-.347 (0.008)**
MCH	0.040 (0.763)	**.375 (0.004)**	0.083 (0.534)	-0.013 (0.923)
CRP	**.531 (<0.001)**	**.375 (0.004)**	**.697 (<0.001)**	**.469 (<0.001)**
RBG (mg/dl)	**-.402 (0.002)**	-0.231 (0.082)	-0.224 (0.090)	-0.155 (0.245)
Potassium (K)	-0.013 (0.924)	0.116 (0.388)	**-.293 (0.026)**	-0.197 (0.139)
Urea	0.191 (0.152)	**.352 (0.007)**	0.232 (0.080)	0.208 (0.118)
Creatinine	0.035 (0.797)	0.239 (0.071)	0.182 (0.173)	**.264 (0.046)**

***Spearman's Rank Correlation**

Figures

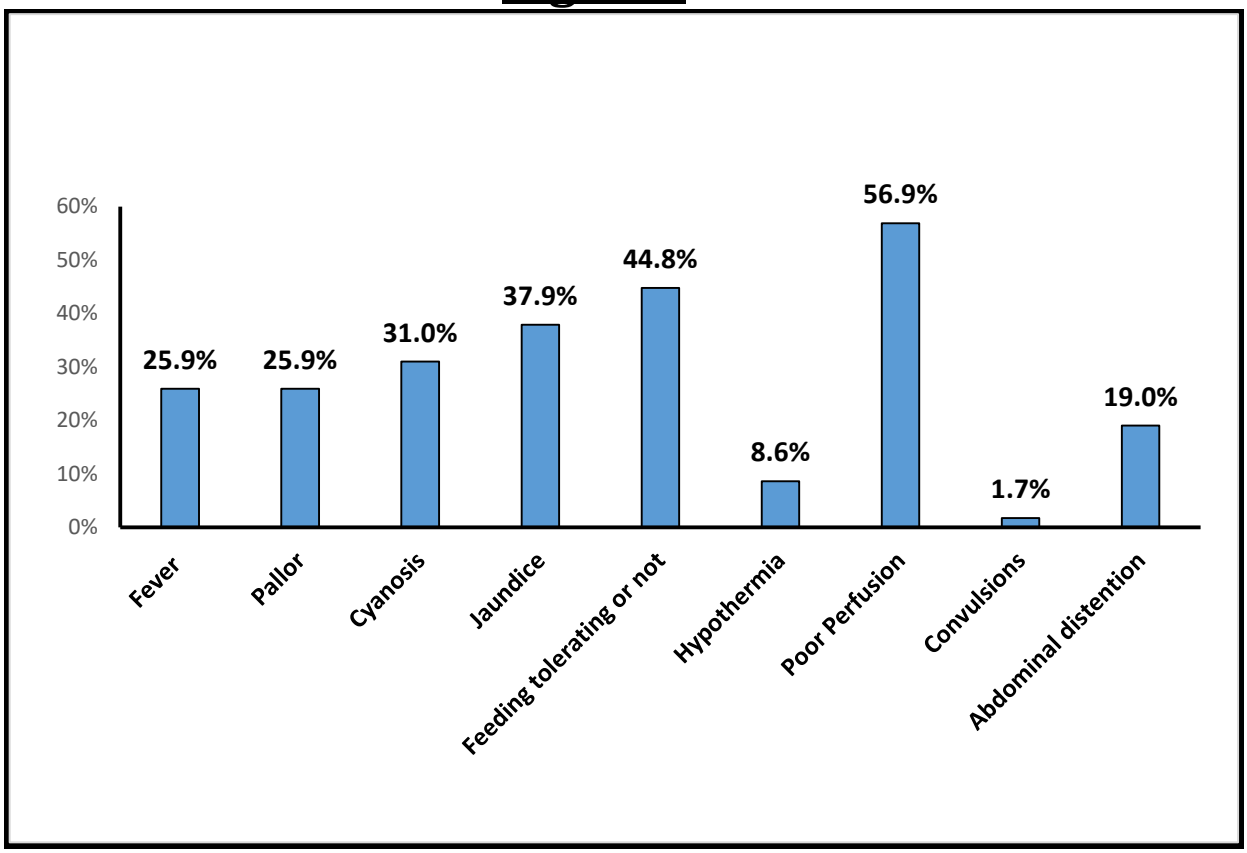

Fig. (1): Neonatal Examination of cases with neonatal sepsis

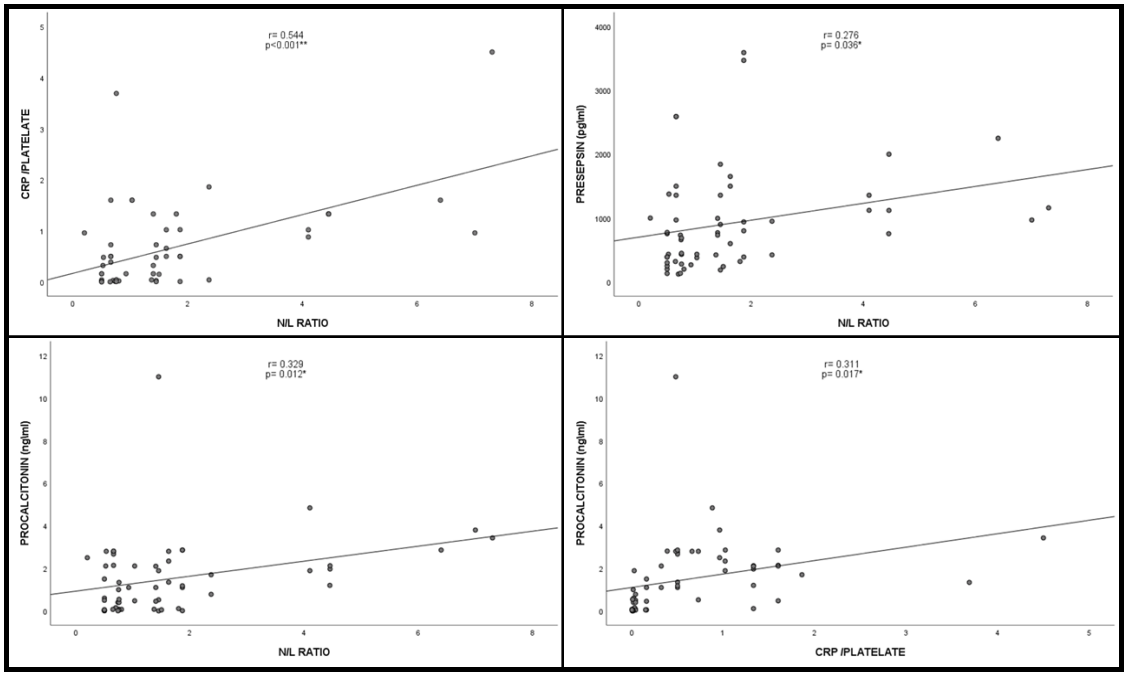

Fig. 2: Univariate Correlation between Different Hematological Parameters (A)

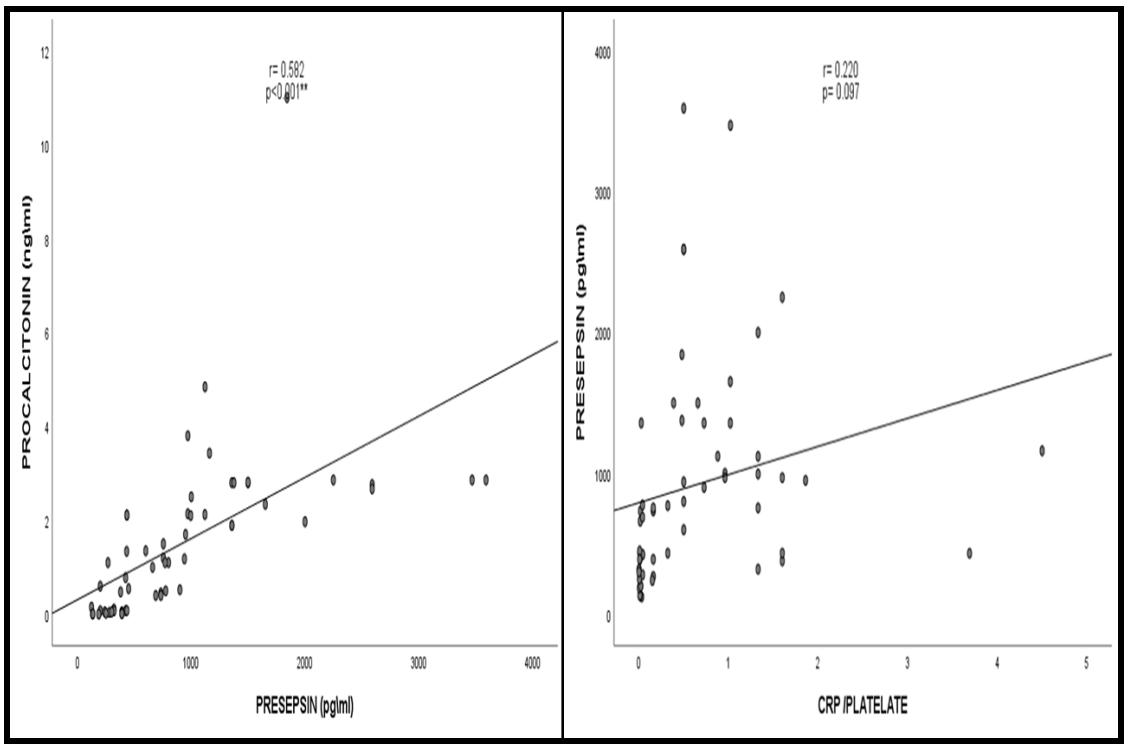

Fig. 3: Univariate Correlation between Different Hematological Parameters (B)