Health AffairsISSN - 0278-2715 Volume 13 ISSUE 9 page 4337-4344
Journal link: https://health-affairs.org/
Abstract Link: https://health-affairs.org/

INDICATORS OF NEONATAL SEPTICICEMIA: "PREDICTIVE VALUES OF CERTAIN BIOMARKERS AND ITS RELATIONSHIP WITH ELECTORLYTES".

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Submission: 18 January 2026 | **Acceptance:** 19 February 2026 | **Publication**: 14 March 2026,

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ABSTRACT

Background

Septicemia is one of the leading causes of neonatal mortality globally,apotentially fatalillness. It is a life threatening condition in which the body responds to infection improperly leading to inflammation and damage to bodyorgans. It can cause serious consequences in newborns due to weak immunity.Early diagnosis and swift action are necessary to improve clinical outcomes.

Aim

The main goal is to investigate how electrolyte imbalances and important inflammatory biomarkers including procalcitonin, Total Leukocyte Count (TLC),C-Reactive Protein(CRP), and Erythrocyte Sedimentation rate (ESR) contribute to the onset and course of newborn septicemia. Electrolyte imbalances,particularly hyponatremia and hyperkalemia,are frequently associated with metabolic dysfunction related to sepsis. Additionally, elevated procalcitonin and CRP levels,along with abnormal ESR and TLC readings,are significant indicators of systemic inflammation and bacterial infection.

Methodology

Samples of 50 neonates were collected to evaluate the role of the inflammatory biomarkers with electrolytes using special chemistry analyzers. Results were interpreted using SPPS software tools and the relevant relations in results were administrated by using Pearson correlations.

Results

The findings revealed that out of various biomarkers CRP and Procalcitonin are most sensitive and specific tests for diagnosing septicemia (r= +1.00) indicating its efficiency. Electrolytes imbalances were quitely seen in every nenonates with fluctuations.

Conclusions

The study underscores the importance of early diagnosing and intervention to mitigate the risks ofsevere outcomes and enhance neonatal care in clinical settings.

Keywords

Inflammatory biomarkers of newborn septicemia, hyponatremia, hyperkalemia, metabolic dysfunction,

Pearson correlations.

Introduction

Neonatal sepsis is a potentially fatal infection that can cause major side effects and complications, even in those who survive. There are two types of neonatal sepsis: late- onset neonatal sepsis and early-onset neonatal sepsis (**Oyato et al., 2025**). For newborns, especially those born before their due dates, early-onset sepsis is still a prevalent and dangerous issue. Sepsis that develops within the first 72 hours after birth is referred to as early-onset. For better results and early treatment, it is critical to diagnose sepsis at an early stage. Since the clinical signs and symptoms of sepsis are like those typically seen in neonates as they transition from intrauterine to extrauterine life, diagnosing the condition at an early stage is still difficult. Both preterm and term neonates are susceptible to early onset sepsis. Maternal factors that raise the risk of neonatal sepsis include premature birth and prolonged membrane rupture. There are several negative consequences associated with postponing treatmentof neonatal sepsis. Consequences, such as long- term lung disease and issues with neurodevelopment. However, overusing antibiotics as a preventative measure to avoid sepsis can increase the risk of developing multidrug-resistant organisms and severe candidiasis. The transmission of infections to the fetus or infant from the female genitourinary system. These infections may ascend the vaginal canal, cervix, and uterus, or they may contaminate the amniotic fluid. Neonates may become contaminated during pregnancy or during delivery as they pass through the vaginal canal. Compared to full-term babies, premature babies are more likely to die from infection or sepsis. The main factor contributing to the increased risk of neonatal sepsis is the immature immune system. Because of their immature function, neutrophils, macrophages, and T lymphocytes are unable to execute a full inflammatory response in newborns (**Chen et al., 2023**).An infection that develops after the first 72 hours of birth is commonly referred to as late- onset sepsis (LOS); it is linked to infants who stay in the hospital for an extended period of time and/or have weakened immune systems. Among very preterm newborns, late-onset sepsis is a major cause of morbidity and mortality. Infants with late-onset sepsis are more likely to die, have poor neurodevelopmental outcomes among survivors, and experience in-hospital morbidities. As a result, during the past three decades, significant efforts have been made to prevent late-onset sepsis. Despite these initiatives, up to one-third of antibiotic use in NICUs is driven by the administration of antibiotics for suspected or confirmed late-onset sepsis (Flannery, Edwards, Coggins, Horbar, & Puopolo, 2022).The main causes of late-onset sepsis are exposures to hospital or community settings, as well as nosocomial or

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rizontal pathogen acquisition. Contact with healthcare professionals, contamination or colonization of indwelling invasive medical devices, and additional surfaces and sources of the environment. Given their corresponding requirements for central catheters, mechanical ventilation, prolonged parenteral nutrition, and surgical procedures, preterm birth and critical illness are significant risk factors for late onset sepsis. Predisposing factors also include length of hospital stay, comorbidities, and maternal and perinatal risk factors like preeclampsia, chorioamnionitis, and intrauterine growth restriction. The infectious burden is highest among the most immature infants; LOS rates are 1.6% for term neonates and 12–50% for very preterm and/or very low birth weight infants. The most vulnerable, lowest-gestation infants may have LOS- associated mortality of up to 35%, which varies by organism and by gestation (Coggins & Glaser, 2022).The monitoring of EOS has been demonstrated to benefit from a low- cost, sustainable serum C-reactive protein (CRP) assay,24 despite its limited sensitivity and specificity, especially in the early stages of the infection (>12 hours after the onset of clinical symptoms). It's unlikely that a single biomarker or test can identify neonatal sepsis (Sands et al., 2022).The clinical syndrome known as neonatal sepsis is typified by infection-related signs and symptoms, typically linked to bacteremia.

Neonatal risk factors include congenital dermatological abnormalities, fetal immune system prematurity, and birth asphyxia, which weakens the host's defenses and makes them more vulnerable to infection. Furthermore, it has been demonstrated that preterm infants are exposed to bacteria while still in the womb, whereas term infants are most likely exposed to bacteria in the birth canal during labor. While the innate immune system serves as a defense and host immunity plays a significant role in pathogenesis during the early stages of sepsis, adaptive immunity still needs to mature. Although neonatal sepsis symptoms can vary, some common early indicators include fever or hypothermia, tachypnea(increased breathing), tachycardia (increased heart rate), poor feeding, an uneasy child, and lethargy, all of which should raise the possibility of sepsis (Mahmoud et al., 2023).Regardless of age, antibiotics are the preferred medication for treating sepsis. There is a significant overuse of antibiotics in neonates for both prevention and treatment due to the lack of trustworthy criteria for a definitive diagnosis and the belief that early antibiotic administration could prevent sepsis development in children at risk. Large spectrum antibiotics have been administered to all neonates at risk of infection, including many preterm infants, in hospitals since the dawn of the antibiotic era, even when there is no clinical sign of an infectious disease. Antibiotic overuse in neonates continues to occur and is linked to a few pertinent issues,

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spite the fact that prescriptive attitudes have been somewhat lessened by the implementation of stewardship programs, at least in certain hospitals. Neonatal sepsis symptoms in their early stages are mild, nonspecific, and usually shared with other illnesses. While respiratory issues, bradycardia, cyanosis, and temperature instability are common in sepsis-affected infants, they can also be indicators of a non- infectious disease or a poor adjustment to life outside the womb in neonates (Boscarino et al., 2023).When neonates are ill, electrolyte imbalances are common. Regardless of the underlying illness, they can arise in a few settings, including neonatal sepsis, and go undiagnosed, resulting in morbidity and death. Thus, prompt identification, a high level of suspicion, and a comprehensive comprehension of common imbalances to guarantee their correction. One of the most frequent abnormalities seen in critically ill newborns is electrolyte disorder Regardless of the underlying issue, they might go unnoticed, resulting in morbidity and death. The most prevalent electrolyte abnormality, hyperkalemia, was detected in 14.4% of cases. The study found that mixed electrolyte imbalance was present in 7.9% of cases, and hyponatremia was the second most common electrolyte abnormality, occurring in 9.5% of cases (Khan, Alauddin, Amman, & Uddin, 2022).

Preserving the exact equilibrium of Cellular homeostasis, ideal neuromuscular function, and general organ health all depend on electrolytes. These levels being out of balance can have negative effects, particularly on critically ill newborns. Neonatal kidney function can be directly impacted by electrolyte imbalances. Since acute kidney injury (AKI) is linked to higher morbidity and longer hospital stays in neonatal cardiac patients after surgery, its occurrence is cause for serious concern. The relationship between abnormalities in sodium or chloride levels and AKI after pediatric heart surgery has not received much attention. Dysnatremia, which is characterized by sodium imbalances, is one of the most prevalent electrolyte disorders observed in hospitalized patients. Although dysnatremia has been linked to higher hospital mortality, coronary events, and infection complications in adults after heart surgery, little is known about how it affects young patients with heart disease(Ozalp et al., 2025) Although hyperkalemia, or an elevated potassium level, is uncommon in children, it can indicate a few illnesses. Additionally, hyperkalemia is one of the indications for emergency medical care since it is acknowledged as one of the main risk factors causing potentially fatal cardiac arrhythmic complications. Many childhood diseases and conditions, both congenital and acquired, are associated with an electrolyte imbalance. One of the most crucial microelements in the human body, potassium is involved in preserving the water-salt balance, osmotic pressure, intercellular and intracellular fluid water balance, and blood acid-base balance. A serum or plasma pota

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m concentration greater than 5.5 mmol/L is referred to as hyperkalemia; however, in premature and young children, the upper limit may attain 6.5 mmol/L. Due to decreased glomerular filtration rate and relative insensitivity to aldosterone, infants have a higher normal blood potassium level because their urine excretes less potassium. (Boyarchuk, Mudryk, Borys, & Volianska, 2021).The liver produces the acute-phase protein known as C- reactive protein (CRP), which rises when the body is infected or inflammatory. Research has indicated that CRP is a risk factor and determines predictors for sepsis in both adults and neonates. As a biomarker for neonatal sepsis, CRP, an acute phase reactant produced in the liver in response to inflammatory cytokines, has garnered extensive and sustained interest. Sensitivities of 50% to 70% with unacceptable false positives have been regularly reported in studies assessing the CRP for the diagnosis of EOS. During the first one to two days of life, CRP levels naturally rise to levels that are almost abnormal.

During the first three days of life, CRP naturally rises in many healthy newborns or in infants with non-infectious conditions such as prolonged labor, stressful delivery, meconium aspiration syndrome, delayed postpartum transition, prolonged membrane rupture, hemolysis, intraventricular hemorrhage, or perinatal asphyxias [45,47,116]. According to Perrone et al., children in good health had mean CRP values (Boscarino, et al., 2023). Monocytes and hepatocytes produce procalcitonin, a prohormone of calcitonin, in reaction to cytokine stimulation. It rises after delivery until the postnatal day. The commonly produced interferon-γ downregulates PCT. in viral infections, cytokine. In order to distinguish between bacterial and viral etiologies, PCT has become a promising biomarker for the diagnosis of bacterial infections. PCT levels quickly increase within 2-4 hours and peak within 6-8 hours following exposure to bacterial endotoxins, making it a more sensitive marker than CRP for the early detection of neonatal sepsis. This rise frequently corresponds with mortality and disease severity. However, PCT measurements at birth may initially be normal in cases of early-onset neonatal sepsis. At 24 hours of age, a serial PCT measurement might be more beneficial. for a prompt diagnosis. Additionally, in term and near-term infants with suspected early-onset sepsis, serial PCT determinations enable the reduction of the duration of antibiotic therapy. However, a larger cohort of neonates must confirm the safety and reliability of this PCT-guided approach before it can be suggested (Celik, Hanna, Canpolat, & Pammi, 2022).C-reactive protein (CRP) and procalcitonin (PCT) are examples of acute-phase reactants that can help detect neonatal sepsis. Though in trace amounts, procalcitonin is a precursor of calcitonin that the thyroid gland produces. In cases of sepsis and serious bacterial infections, the biomarker is also released by other

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lls, such as monocytes and macrophages. The liver, on the other hand, produces CRP, and inflammation causes its levels to rise. Prenatal conditions like maternal fever, stress delivery, and fetal distress can raise CPR, which reduces its specificity. Furthermore, CRP is a good predictor of late-onset neonatal sepsis but an unreliable marker for early-onset neonatal sepsis because it takes 10–12 hours to react to an infection. On the other hand, PCT levels rise in 2-4 hours and remain elevated up to 30 hours [7]. Furthermore, PCT is a reliable indicator of early-onset neonatal sepsis because its concentrations and response are unaffected by gestational age. When these two biomarkers are combined, the diagnostic efficacy is improved (Tum, Ngeranwa, Maiyoh, & Onyambu, 2025).

The ESR is a nonspecific tissue damage test. It has been linked to increased collagenases, infection, infarction, and cancer. The only one of these that frequently results in illness or death in the neonatal stage is infection. Because the micro or mini-ESR method only needs a few drops of capillary blood, it is used on newborns. Landau was the first to describe micro-ESR determination, and Smith Evans et al. later conducted the first evaluation of micro-ESR in newborn infants. They discovered that while the range was roughly the same for both groups, the normal values seemed to be slightly higher in the female infants. For both sexes, the ninety-fifth percentile was 6.0 mm/h. Low birth-weight infants and full-term infants both fell within the same range of normal values. Eight of the nine infants with severe infections that were part of their study had elevated micro- ESR values. Furthermore, idiopathic respiratory distress syndrome was distinguished from the infectious process by a normal ESR value (Kaur & Singh, 2021).In clinical practice, CRP and ESR measurements are commonly ordered together with the goal of identifying and tracking systemic inflammation. Patients with a range of illnesses have been included in ESR and CRP in both primary care and hospital settings. CRP and ESR are equally accurate at diagnosing acute inflammation; however, because CRP levels fluctuate more quickly than ESR and are less impacted by patient age, CRP is typically more dependable for disease monitoring. Although there may be discrepancies, CRP and ESR provide comparable information in patients with chronic inflammatory diseases. Since CRP and ESR are frequently requested as part of blood screening tests for people who are asymptomatic, mildly symptomatic, or exhibit vague clinical manifestations, the fact that they produce unselected samples from general adult populations without any discernible inflammatory disease is a significant concern. Furthermore, interpreting reference values requires knowing how CRP concentrations and ESR are distributed in general populations (Alende-Castro et al., 2021).In sepsis, WBC counts, such as leukocytosis or leukopenia, are commonly reported. Leukopenia, also known as neutropenia, is a particularly risky sign of the severity of sepsis. Although a high WBC count can indicate an infection, it is not a reliable indicator and could be changed under various conditions, reducing its diagnostic potential. Analyzing the differential counts, particularly the percentages of neutrophils and lymphocytes, may provide information about the inflammatory response linked to sepsis. Higher neutrophil-to-lymphocyte ratios (NLRs) have been linked to worse outcomes and the seve rity

of sepsis, suggesting that they may be used as prognostic biomarkers. Blood loss, hemolysis, and inflammation are some of the causes of anemia, a common symptom in septic patients. Monitoring hemoglobin levels can help guide transfusion and assess the severity of the illness options for patients with sepsis (SB et al., 2025).

MATERIALS AND METHODS

In this context, the study design selected for this research is a descriptive cross-sectional study. The study was conducted in District Faisalabad which is one of the most industrialized cities in Punjab Pakistan. The data collection exercise was conducted from April 2024 to June 2024. Venous blood samples (5 mL) were collected aseptically from each neonate, Samples were divided as follows: 2 mL in EDTA tubes for hematological analysis and 3 mL in gel separator tubes for serum separation for liver function tests. All samples were processed within 2 hours of collection in the hospital laboratory. The sample size for this study was estimated using standard statistical procedures with a view of making the study both reliable and valid. The sample 50 neonates were obtained to perform testing on them. Newborns with the age of 3-28 days irrespective of gender and Only neontaes with late onset of sepsis were included in this study. Newborns with the age more than 28 days and Neonates with early onset of sepsis were exluded from the study. Participants for this study were neonates attending healthcare facilities in Saad Medical Complex and Rabia Trust Hospital, Faisalabad. They include the current patient's records, test results and data obtained from a direct interview with the patient.The data gathered encompass patient's age, gender, and medical records of patients with the Neonatal Jaundice. Some of the demographic information gathered from the patients included patient's age, gender, social class, level of education and occupation. The diagnostic testing data was collected using Mini Vidas, I Chroma 2 and ACCRE 8 speciaized chemistry analyzer were used in this study. Using Mini Vidas, I Chroma 2 and ACCRE 8 various tests are performed such as Procalcitonin, CRP, sodium, potassium and chloride to diagnose septicemia. The data used in this study was analyzed using Statistical Package for the Social Sciences (SPSS) Version 25. SPSS is one of the most common statistical software that offers a powerful and sophisticated data analysis that can be used to examined most of the relationships and trends within the data set. It was used to conducting both frequency and inferential statistical analyses to make sure that the results accrued are valid.

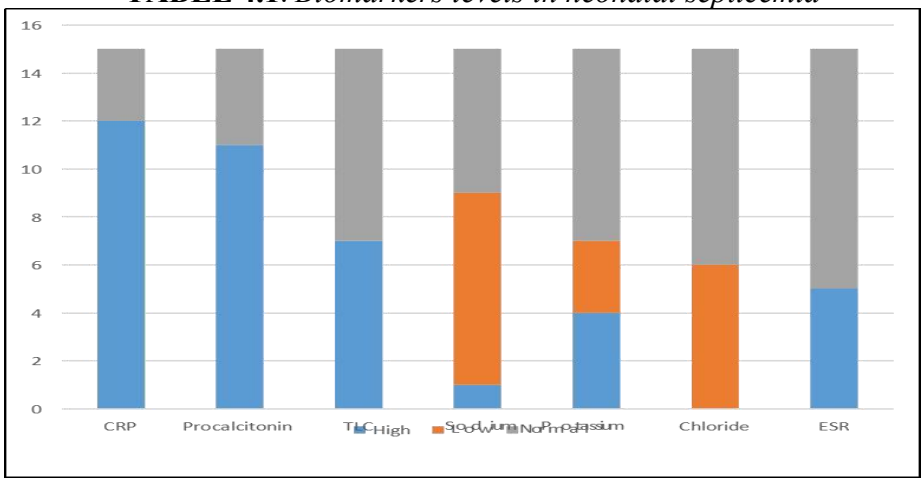
RESULT AND DISCUSSION

The statistical analysis of inflammatory biomarkers (CRP, ESR, Procalcitonin, TLC) and electrolyte levels (Sodium, Potassium, Chloride) in neonates diagnosed with septicemia. Samples of

neonates were collected from NICU. Out of 50, 35 are those whose history showed that they were carrying infection from their mother and were catagorized in early onset of sepsis, therefore these were excluded from the samples. The Data from remaining 15 neonatal patients were analyzed using SPSS-equivalent methods in Python focusing on descriptive statistics, group comparisons, and correlation analysis to evaluate associations and patterns related to the condition.

BIOMARKER	HIGH	LOW	NORMAL
CRP	12	0	03
Procalcitonin	11	0	04
TLC	07	0	08
Sodium	01	08	06
Potassium	04	03	08
Chloride	0	06	09
ESR	05	0	10

TABLE 4.1. *Biomarkers levels in neonatal septicemia*



Out of 15 neonates, 12 showed elevated CRP levels (>10 mg/L), indicating a strong inflammatory response. CRP is an acute-phase protein that increases rapidly in response to infection, especially bacterial. Its high levels in most neonates suggest that it is a highly sensitive marker for diagnosing sepsis. Only 3 neonates had CRP within the normal range, showing that false negatives are relatively rare. CRP levels typically rise within 6–8 hours of infection and peak around 48 hours, making it useful for both early detection and monitoring of sepsis. In this study, CRP outperformed TLC and ESR in sensitivity, proving it to be a reliable diagnostic tool in neonatal septicemia.

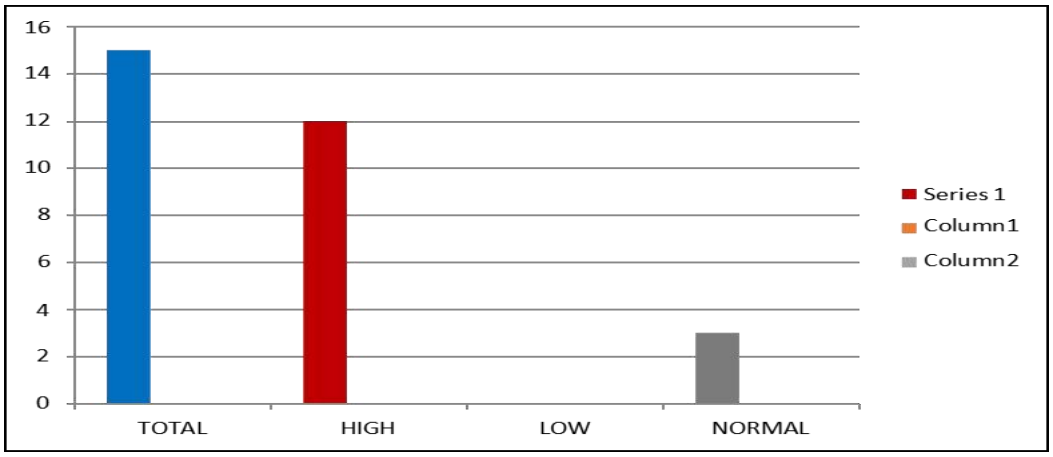


Figure 4.2 *Level of CRP (n=1)*

This is consistent with Jain et al. (2021) who reported over 85% sensitivity of CRP in detecting neonatal sepsis. Vouloumanou et al. (2011) also found CRP to be a useful early-phase marker in bacterial infections. As CRP rises within 6–8 hours of infection and peaks around 48 hours it is valuable for both early detection and monitoring**.** Ghosh et al. **(**2015) highlighted CRP's role in tracking treatment progress in neonates with sepsis.In the study 11 out of 15 neonates had elevated Procalcitonin levels (>0.5 ng/ml), indicating a strong inflammatory or bacterial response. This marker rises significantly in response to systemic bacterial infections and is known to be more specific than CRP. Only 4 neonates showed normal levels, reinforcing Procalcitonin's value in identifying sepsis. It reacts quickly to infection, often rising within 2–6 hours, making it useful for early detection. The high frequency of elevated Procalcitonin confirms its high sensitivity and specificity in diagnosing neonatal septicemia. Therefore, it is considered a reliable biomarker in clinical decision-making.

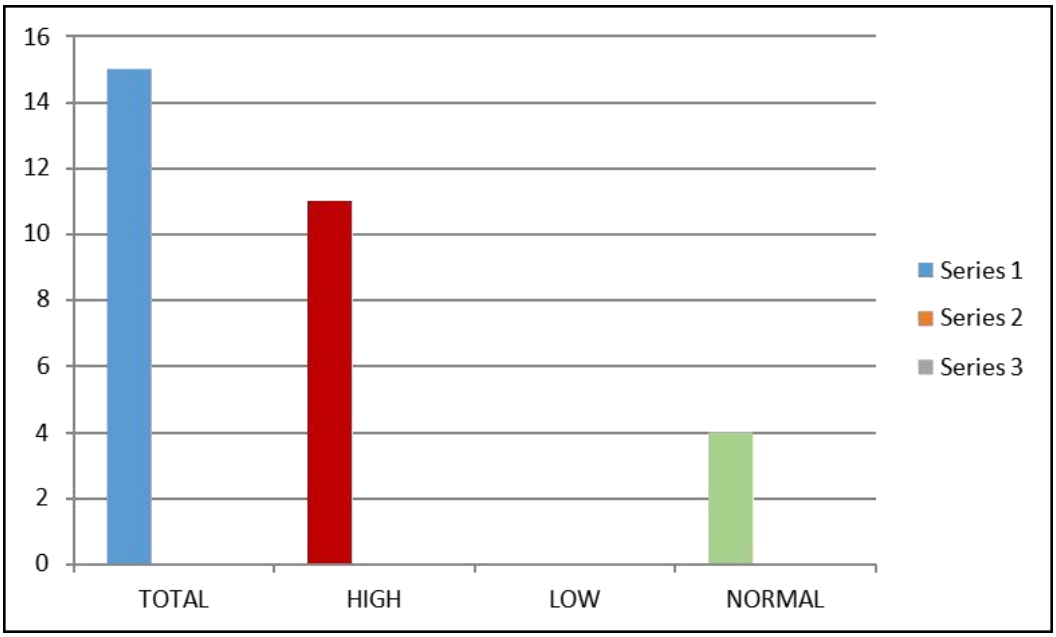


Figure 4.3 *Level of Procalcitonin (n=15)*

Procalcitonin was elevated in 11 out of 15 neonates, reflecting 73% sensitivity in this study. Assink et al. (2015) emphasized that PCT is more specific to bacterial infections compared to CRP. Chiesa et al. (2004) found that PCT rises within 2–4 hours of infection onset and stays elevated, making it reliable for early and specific diagnosis. These findings support PCT as a strong and sensitive biomarker for identifying bacterial sepsis in neonates.Out of 15 neonates 7 had elevated TLC levels while 8 had values within the normal range. An increased TLC usually indicates an immune response to infection, particularly bacterial infections. In the Study less than half of the neonates showed high TLC, suggesting that it is a moderately sensitive marker for sepsis. Some septic neonates may even have normal TLC due to immature immune systems. This makes TLC less reliable as a sole indicator of sepsis in neonates. It is more useful when combined with other markers like CRP and Procalcitonin. The findings indicate that TLC has limited specificity and sensitivity for neonatal sepsis diagnosis.

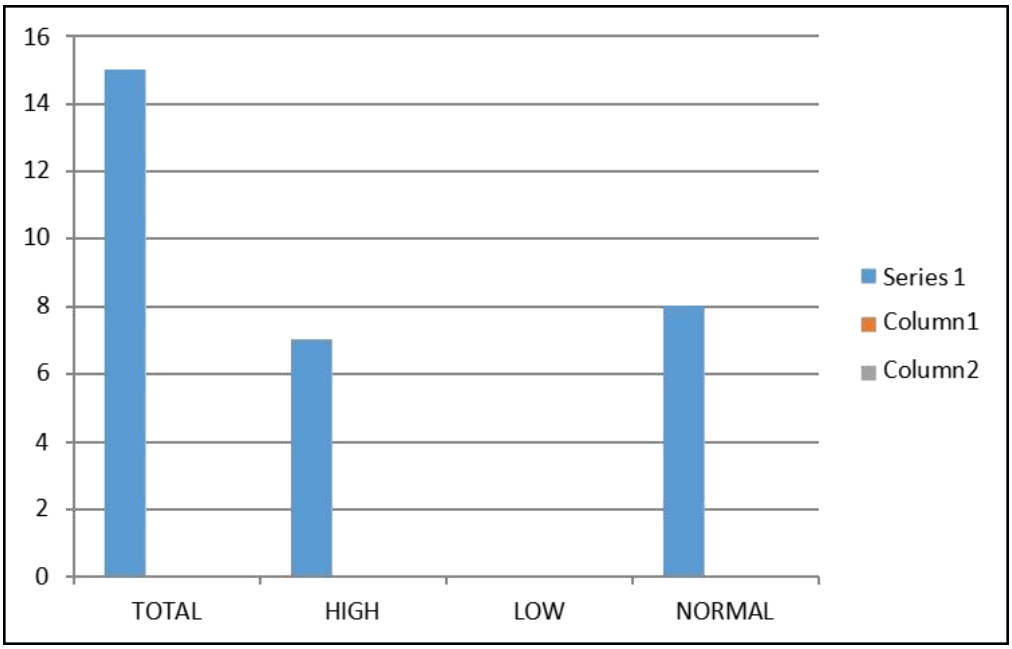


Figure 4.4 *Level of Leukocytes TLC (n=15)*

Only 7 neonates showed elevated TLC suggesting moderate sensitivity**.** Davis et al. (2016) reported that TLC is not very specific for neonatal sepsis due to variability in immune responses. Kocabas et al. (2007) also stated that TLC can be within normal range even in severe infections. This confirms that TLC should be used in combination with other markers like CRP and PCT for better diagnostic accuracy.In the study only 5 out of 15 neonates showed elevated ESR levels, while the remaining had normal values. ESR increases in response to inflammation, but it is a non-specific marker meaning it can be elevated in many other conditions besides sepsis. The low number of elevated ESR cases in septic neonates indicates that ESR is not a very sensitive or reliable test for neonatal sepsis. Moreover, ESR tends to rise slowly and may not reflect early stages of infection. Due to its delayed response and lack of specificity, ESR alone is not sufficient for sepsis diagnosis and should be used in combination with more sensitive markers like CRP and Procalcitonin. In this study, its diagnostic value was found to be limited.

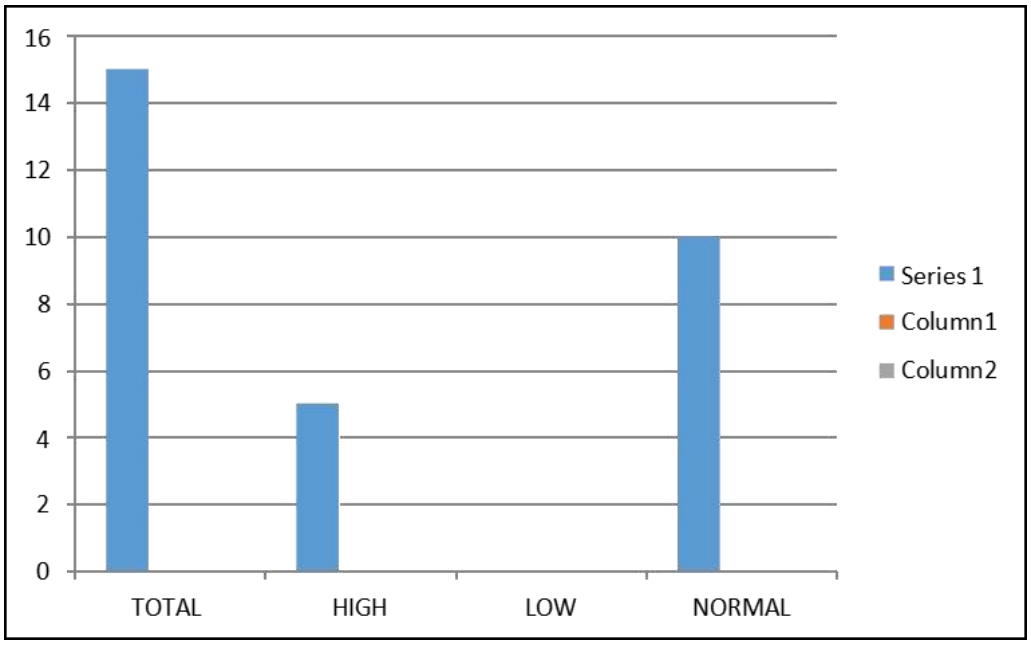


Figure 4.5 *Level of erythrocyte sedimentation rate (n=15)*

Only 5 out of 15 neonates had elevated ESR levels, showing its limited sensitivity in neonatal sepsis. Sharma et al. (2012) explained that ESR rises slowly and is often elevated in various non-infectious conditions as well. Nuntnarumit et al. (2002) found ESR to be a non-specific marker that should not be used alone for diagnosis. Thus, ESR is better used as a supportive indicator, not a primary tool in sepsis evaluation.Out of 15 neonates 8 showed low sodium levels a condition known as hyponatremia**.** This suggests that more than half of the neonates experienced sodium imbalance. Hyponatremia is commonly associated with sepsis due to fluid shifts, capillary leakage and impaired renal function. Only 1 neonate had high sodium, while 6 had normal levels. This imbalance can affect blood pressure regulation and cellular functions. The frequent drop in sodium levels highlights its role as an indicator of systemic infection or dehydration in septic neonates. However, it is not highly specific**,** as it may also occur in other neonatal conditions.

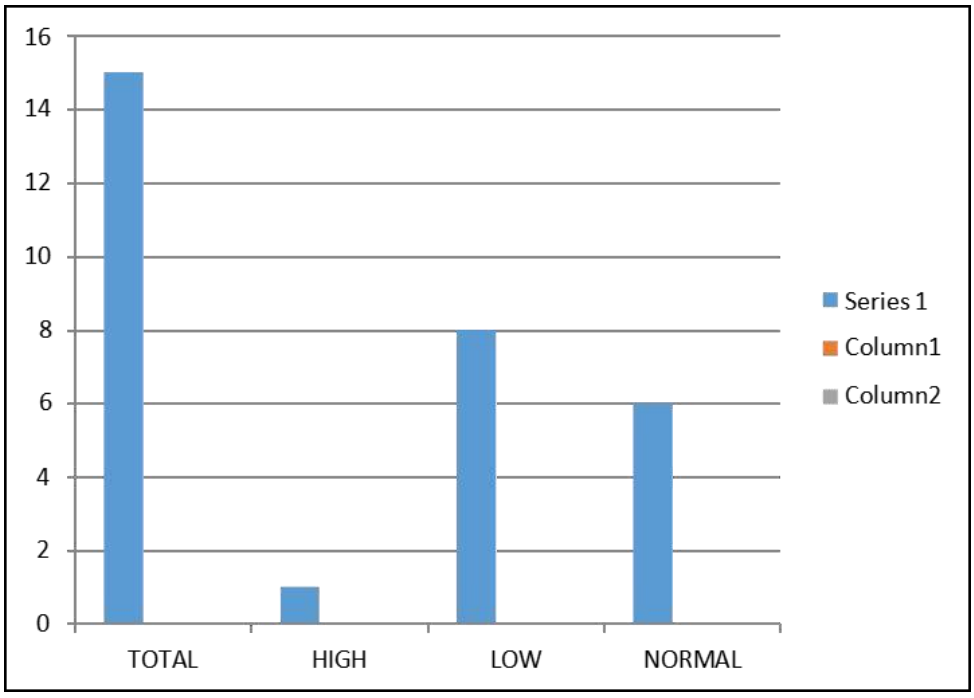


Figure 4.5 *Level of Sodium (n=15)*

Low sodium levels were found in 8 neonates (53%), which suggests hyponatremia is common in neonatal sepsis. Kumar et al. (2014) found similar results, noting that sodium levels decrease due to capillary leakage, inflammation, or renal dysfunction. El-Nawawy et al. (2009) also reported that electrolyte imbalance, especially hyponatremia, often reflects the severity of infection and should not be overlooked in septic neonates.Among the 15 neonates 6 had low chloride levels (hypochloremia) while 9 had normal levels**,** and none had high levels. Hypochloremia in neonates with sepsis may be linked to fluid loss, metabolic alkalosis, or renal dysfunction. It often occurs alongside hyponatremia and can worsen acid-base imbalances in the body. The moderate frequency of chloride imbalance shows it is commonly affected**,** though not as severely or frequently as sodium. Chloride may serve as a supportive indicator when evaluating electrolyte balance in septic neonates.

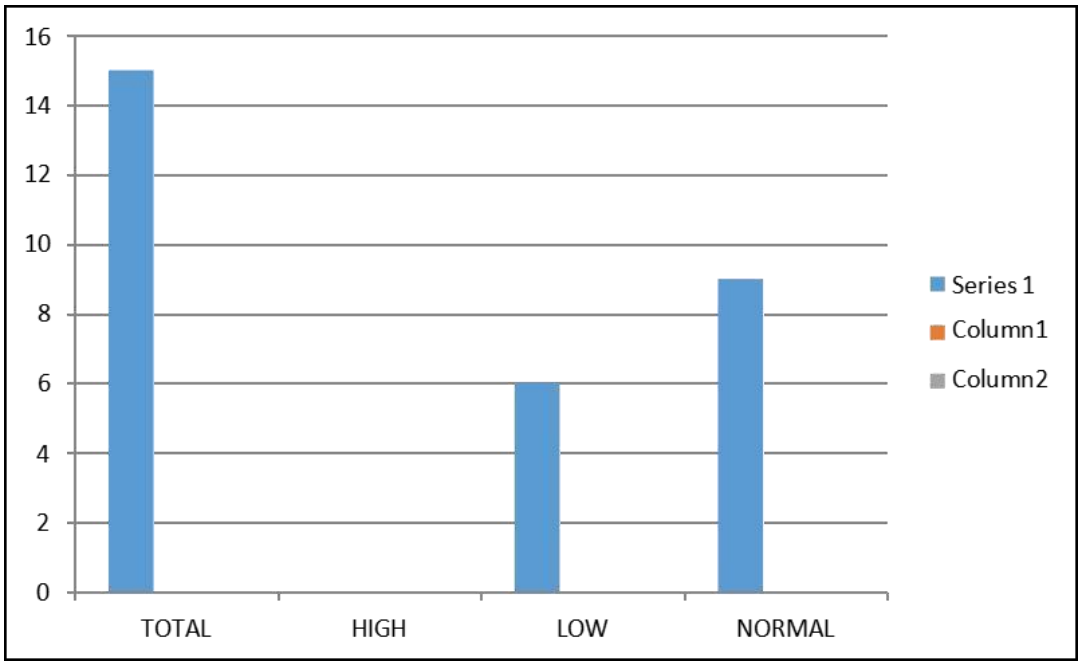


Figure 4.7 *Level of chloride (n=15)*

Six neonates had low chloride levels (hypochloremia), which may suggest fluid or metabolic imbalance**.** Ahmed et al. (2015) noted that hypochloremia in sepsis often occurs alongside hyponatremia or due to overhydration during treatment**.** Mannan et al. (2018) supported this, stating chloride imbalance is common in sepsis and may contribute to metabolic acidosis**,** especially in critical stages of infection.The correlation results showed a strong positive relationship between CRP and Procalcitonin, meaning as one increases the other likely does too. Moderate positive correlations were seen between CRP with ESR and TLC. Negative correlations were observed between CRP and electrolytes (sodium and chloride), suggesting that as inflammation increases, electrolyte levels may drop. This implies an inverse relationship between inflammatory response and electrolyte balance

PARAMETER	R-value	STRENGTH/DIRECTION
CRP & Procalcitonin	0.899	Strong Positive

CRP & ESR	0.680	Moderate Positive
CRP & TLC	0.662	Moderate Positive
CRP & Chloride	-0.670	Moderate Negative
CRP & Sodium	-0.570	Moderate Negative
ESR & Procalcitonin	0.658	Moderate Positive
ESR & Chloride	-0.715	Strong Negative

Table 4.2 *Pearson correlation coefficients were computed among biomarkers and electrolytes to identify significant relationships.*

Out of 15 neonates 3 died during the study, and all were female. This raises concern but the small sample size makes it difficult to draw strong conclusions. The mortality rate of 20% reflects the seriousness of late-onset neonatal sepsis. The deaths indicate the potential severity of the condition, emphasizing the importance of early detection and treatment.

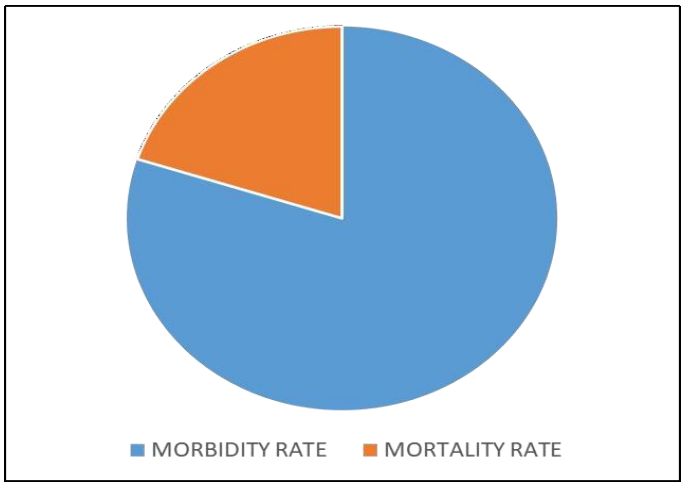


Figure 4.8. *Morbidity and Mortality Rates*

Statistical comparison between male and female neonates showed no significant differences across any biomarker or electrolyte level. Although females had slightly higher mean values in most parameters, the p-values were all greater than 0.05, indicating that the variation was not statistically meaningful. This suggests that gender does not significantly influence the biomarker or electrolyte responses in neonatal sepsis.

Parameter	Mean (M)	Mean (F)	t-statistic	p-value	Interpretation
CRP	48.44	124.15	-1.33	0.222	NS (Not Significant)
Procalcitonin	0.64	12.90	-1.00	0.352	NS
TLC	25.57	24.00	0.97	0.355	NS
ESR	47.71	86.88	-1.71	0.119	NS
Sodium	135.20	137.59	-1.04	0.324	NS
Potassium	4.57	4.75	-0.34	0.738	NS
Chloride	98.73	99.21	-0.23	0.823	NS

Table 4.2 *Gender-Based Comparison (Independent t-tests)*

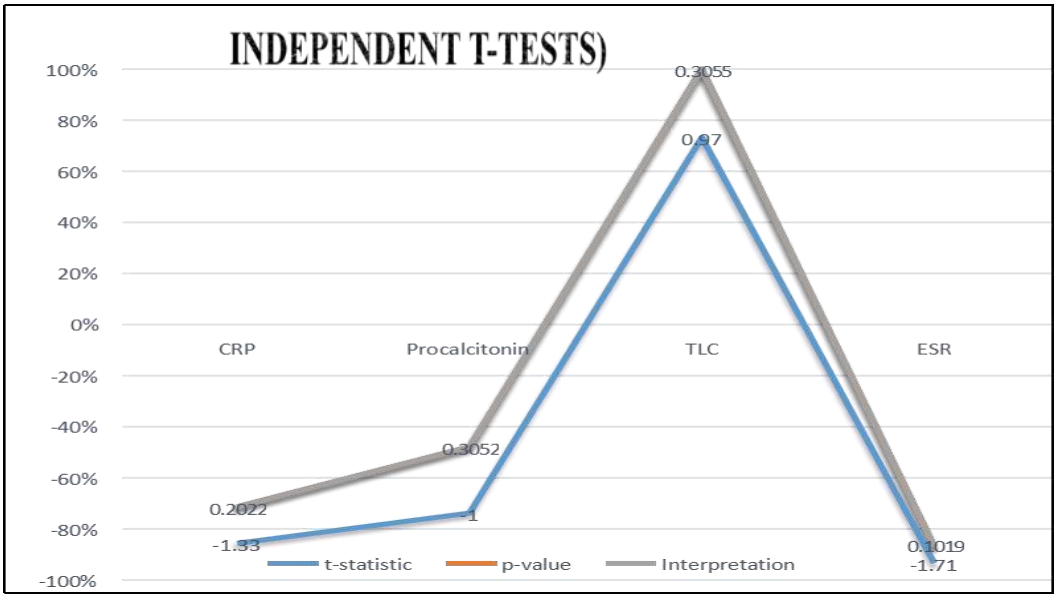


Figure 4.9. *Independent t-tests*

Conclusion

Therefore, it is concluded that CRP and Procalcitonin are the most specific and sensitive tests for diagnosing sepsis in neonates. ESR and TLC were less consistent. Electrolyte imbalances, especially low sodium and chloride levels, were common and support the presence of systemic infection. Potassium remained mostly stable. No gender-based differences were observed in biomarker levels or disease severity. Nenonates irrespective of gender can have exposed to bacteria from environment and can develop serious consiquenses. First cross-sectional study design hinders the researchers capacity to determine the causality between the role of electrolytes in inflamatory markers. As such connections have been established it is also important to find out whether there is causality or just coincidence and more so there is a dire need to have longitudinal studies so as to reveal the manner in which diseases progress. Secondly, the data were restricted to Faisalabad only, therefore its generalization to other parts of Pakistan or to the global environment is quite limited. Socioeconomic, cultural, and the healthcare system might differ from one area to another, which bring about differences in epidemiological features. Future research should focus on longitudinal research because the present findings were cross-sectional and therefore could not establish the causal link between inflammory biomarkers in early and late onset of sepsis. Such studies can give information about the further outcome of the disease and efficacy of early treatment. Increasing study area coverage to other areas of Pakistan and other countries will make the results more generalizable and useful in determining the regional differences in diseases and their risk factors. Furthermore, greater numbers of participants should be included to obtain the greatest variance of those impacted by loss, including rural dwellers and people who have

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stricted access to medical care.Future studies regarding the construct should review the table below and target the socioeconomic factors in relation to health. It is possible to consider the consequences of poverty, education level, and healthcare access for the outcomes of sepsis to develop relevant policy measures. Additionally, public health interventions should be assessed by its impact on increasing awareness, reducing prejudice and improving screening and treatment.

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