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Assessment of Sepsis Markers in Patients Admitted to the Pediatric Intensive Care Unit in Medical Tobruk Center

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ABSTRACT

Background: sepsis and septic shock continue to be a major cause of mortality and morbidity in infant and children worldwide. **Objective:** To study morbidity and identify the causes of neonatal sepsis among newborn babies. methods: A descriptive case series hospital-based study was conducted from registration files in the neonatal intensive care unit and 123 newborns admitted to neonatal intensive care in Tobruk medical center from January 2024 to November 2025. **Result**: in our study, the studied cases (n = 123). The findings show a predominance of males (61.0%) compared to females (39.0%), Regarding age the wide range (0.03–15 months) and relatively high standard deviation (2.31) suggest variability in age, but the low median confirms that the majority are clustered in early infancy, Hemoglobin levels showed a mean of 13.0 g/dl, which is generally within the normal and elevated hemoglobin levels among some cases, . The mean CRP level (19.41 mg/dl) with a large standard deviation (28.90) and a wide range (0.17–144.0) reflects considerable variability in inflammatory response. **conclusion**: These findings emphasize the importance of close biochemical monitoring in infants with inflammatory or infectious conditions to prevent complications and guide appropriate management.

1. INTRODUCTION

Neonatal sepsis is an infection involving the bloodstream in infants younger than 28 days old and remains a leading cause of morbidity and mortality among neonates, especially in middle and lower-income countries. (Seale AC 2014) Neonatal sepsis is divided into 2 groups based on the time of presentation after birth: early-onset sepsis (EOS) and lateonset sepsis (LOS). EOS refers to sepsis in neonates before 72 hours of life (some experts define it more broadly to include infections developing within the first week of life), and LOS is defined as sepsis occurring at or after 72 hours of life. (Puopolo KM, et al 2017)

Prompt recognition and treatment of neonatal sepsis are crucial, as this infection can rapidly progress to severe complications, including organ failure, septic shock, and death. Management typically includes empiric antibiotic therapy, supportive care, and close monitoring in a neonatal intensive care unit. Delayed initiation of appropriate antibiotic therapy is associated with increased morbidity and mortality. Prevention strategies focus on improving maternal health, implementing infection control measures, and promoting early detection through screening protocols. (Kariniotaki C et al 2024)

1.1. Etiology

EOS is generally caused by the transmission of pathogens from the female genitourinary system or gastrointestinal flora to the newborn or the fetus. (Yu YQ, et al 2022) These pathogens can ascend from the vagina, cervix, and uterus and infect the amniotic fluid. Maternal chorioamnionitis, also known as intra-amniotic infection, is a well-established risk factor for EOS. (Escobar GJ 2000) Neonates can also become infected in utero or during delivery as they pass through the vaginal canal. Maternal colonization with group B *Streptococcus* (GBS) is also a major risk factor. The use of fetal scalp electrodes during deliveries has been associated with a small increased risk of the development of EOS. (Kawakita T, 2016) Other maternal factors that increase the risk of neonatal sepsis include delivery before 37 weeks and prolonged rupture of membranes greater than 18 hours. (Simonsen KA,2014). LOS usually occurs when pathogens are transmitted from the surrounding environment after delivery, eg, through contact with healthcare workers or caregivers. A percentage of LOS may also be caused by a late manifestation of vertically transmitted infection. Infants requiring intravascular catheter insertion or other invasive procedures that disrupt the mucosa are at increased risk for developing LOS. Preterm neonates are at higher risk for sepsis or infection than term neonates. GBS and *Escherichia coli* (*E coli*) are the most common pathogens causing both EOS and LOS, responsible for approximately two-thirds of early-onset infections. (Stoll BJ, et al 2020). Gram-negative bacteria, eg, *Klebsiella, Enterobacter, Citrobacter* spp., and *Pseudomonas aeruginosa*, are commonly associated with LOS, particularly among neonates admitted to neonatal intensive care units. (Gordon A, et al 2006) Coagulase-negative staphylococcal species, particularly *Staphylococcus epidermidis*, are often the cause of hospitalassociated neonatal infections in preterm and term infants with intravenous catheters that remain in place for prolonged periods. Other bacterial pathogens that cause neonatal sepsis include *Staphylococcus aureus, Listeria monocytogenes*, and *Enterococcus*. A recent systematic review and meta-analysis examining the current bacterial pathogens responsible for EOS and LOS found that gram-negative bacteria are the leading cause of both conditions in low- and lower-middle-income countries. (Harrison ML et al 2024)

Pathogens associated with neonatal infections vary by the source of infection, including:

• **Meningitis**: This infection is most commonly caused by GBS and *E coli*, as well as other gram-negative enteric bacilli. Other less common pathogens include coagulase-negative staphylococci (CoNS), *Enterococcus faecalis*, *Listeria monocytogenes*, *Neisseria meningitidis*, nontypeable *Haemophilus influenzae, Staphylococcus aureus, Streptococcus pneumoniae*, and other streptococcal species, eg, groups A, C, or G and viridans streptococci. • **Pneumonia**: This condition is most commonly caused by GBS. Other pathogens include *Chlamydia trachomatis, Citrobacter, Enterobacter, group A streptococci, Klebsiella, Pseudomonas, S aureus, S pneumoniae*, and *Serratia.*

• **Urinary tract infections**: Infections involving the urinary tract are most frequently due to *E coli*, but may also involve *Citrobacter, Enterobacter, Enterococcus, Klebsiella*, and *Proteus.*

• **Skin and soft tissue infections**: These infections commonly arise from *S aureus*, GBS, and group A streptococci.

• **Intestinal infections**: Infections from an intestinal source, including necrotizing enterocolitis (NEC), often involve *E coli*, *Klebsiella*, other enteric gramnegative bacilli, *Clostridium* species, and anaerobes, eg, *Bacteroides*.

Viruses and fungi can also cause neonatal sepsis. Viral etiologies are less common but can lead to severe infections, with herpes simplex virus (HSV) being a significant concern.(Fernandes ND et al 2024) HSV transmission often occurs during delivery from mothers with active genital lesions. Other viral pathogens include cytomegalovirus (CMV), enteroviruses, adenoviruses, influenza viruses, para influenza viruses, and respiratory syncytial virus (RSV).

Fungal infections, primarily caused by Candida species, are more prevalent in preterm infants and those with prolonged hospital stays. Risk factors for fungal sepsis include the use of broad-spectrum antibiotics, the presence of central venous catheters, and the administration of parenteral nutrition. Candida albicans and Candida parapsilosis are the most common fungal pathogens in neonatal sepsis. (Molla A .et al 2024)

1.2. Epidemiology

The epidemiology of neonatal sepsis has been changing with time. (Bizzarro MJ 2005) The incidence of EOS has decreased since the 1990s, primarily due to the introduction of universal screening for GBS in pregnant women and intra partum antibiotic prophylaxis. (Van Dyke MK 2009) However, rates of LOS have remained relatively the same.

E coli now accounts for more cases of EOS.(Shane AL,2013) Current evidence suggests that approximately 2,200 per 100,000 live births develop neonatal sepsis, with a mortality rate of 11% to 19%, translating to about 3 million cases each year.(Fleischmann-SC2018) The incidence of neonatal sepsis rises as gestational age decreases. The incidence of EOS with positive blood cultures in the United States is estimated to be 0.77 to 1 per 1,000 live births.(Stoll BJ et al 2011). Due to the nonspecific neonatal presentation for sepsis and the high risk of mortality and morbidity without treatment, many asymptomatic neonates undergo a sepsis workup if risk factors are present or clinically indicated. Although approximately 7% to 13% of all neonates are treated for sepsis, only 3% to 8% have positive cultures.(Simonsen KA,2014)Maternal administration of antibiotics and the low blood volume obtained for blood culture could explain the low rate of positive blood cultures. The incidence of sepsis is significantly higher in premature infants, as well as those with very low birth weight (<1500 g). African American infants have an increased risk of GBS and LOS, likely secondary to the higher rate of GBS carrier rates i African American females. Males have a higher risk of sepsis and meningitis, especially with gram-negative enteric bacilli.(Nordberg V 2021)

1.3. Pathophysiology

The immature immune system of infants is the primary factor contributing to increased neonatal susceptibility to sepsis. The immature function of polymorph nuclear neutrophils, macrophages, and T lymphocytes renders these cells unable to mount a complete inflammatory response in neonates. Furthermore, neonates have limited immunoglobulins at birth and cannot mount an adequate, quantitative, or qualitative immune response against infectious agents. The limited duration that premature infants spend in the uterus results in a reduced transfer of immunoglobulins to the fetus. This deficiency in immunoglobulin's significantly increases the susceptibility of premature infants to sepsis compared to term infants. Additionally, the innate immune system of preterm neonates is compromised by an immature epithelial barrier, which provides inadequate defense against microbial invasion (True H, et al 2022) Beyond these intrinsic vulnerabilities, premature infants often require multiple invasive devices, including vascular access lines, endotracheal tubes, and feeding tubes to support their survival and manage comorbidities associated with prematurity. While lifesaving, these devices serve as potential entry points for pathogens, further amplifying the risk of severe infections. Collectively, these factors create a confluence of immunologic and iatrogenic challenges, rendering preterm neonates particularly susceptible to sepsis and related complications.

1.4. Neonatal Sepsis Clinical Features

Clinical features of neonatal sepsis can range from nonspecific symptoms to hemodynamic instability. Early symptoms may include irritability, lethargy, or poor feeding. Signs of neonatal sepsis may develop rapidly, including respiratory distress, apnea, hypotonic, fever, hypothermia, tachycardia or bradycardia, and hypotension with poor perfusion. Furthermore, seizures can occur as the presenting manifestation in approximately 20% to 50% of cases of bacterial meningitis. (pong A et al 199). Therefore, the presence of seizures or a bulging fontanel in a neonate should raise concern for meningitis. (Puopolo KM et al 2019). Other less common findings include diarrhea, vomiting, abdominal distension, and hepatomegaly. Occasionally, the diagnosis of neonatal sepsis may only be suspected based on laboratory findings, which may reveal hyperglycemia or hypoglycemia, acidosis, or hyperbilirubinemia.

1.5. Neonatal Sepsis Risk Factors

A high index of suspicion is therefore necessary for a timely diagnosis. Physicians must be aware of any factors that may increase an infant’s risk of developing sepsis. Prematurity and very low birth weights are also significant risk factors to consider. Maternal risk factors for EOS include GBS colonization, chorioamnionitis, preterm labor, or prolonged rupture of membranes.(.(Escobar GJ 2000)For LOS evaluation, consideration should be given to the presence of indwelling devices, eg, central venous catheters or endotracheal tubes, as well as dependence on parenteral nutrition.

1.6. Laboratory Studies

Neonates with bacteremia can be asymptomatic and have a normal physical examination. Thus, laboratory testing plays a crucial role in diagnosis, and the threshold for performing lab tests should be low.

1.7. Blood and urine culture

Bacteremia represents the predominant presentation, accounting for 82.9% of documented infections, whereas pneumonia and meningitis occur less frequently at 5% and 4.2%, respectively.[13] Therefore, collecting at least 1 mL of blood is recommended, as low-level bacteremia may not be detected with smaller aliquots(pong A et al 199). Urine studies are generally not obtained during EOS evaluations, as urinary tract infections in this age group are usually secondary to hematogenous dissemination to the kidneys; however, they should be performed to evaluate LOS.(Visser VE , et al 1979).

1.8. Lumbar puncture

Notably, approximately 23% of neonates with bacteremia have concurrent meningitis, and up to 38% of those with meningitis may have negative blood cultures.(Benitz WE , et al 2010)Lumbar puncture with cerebrospinal fluid (CSF) analysis and culture should be performed in any neonate with a positive blood culture, a clinical presentation that suggests central nervous system involvement (eg, bulging fontanelles, seizures), an ill-appearing neonate, or infants who deteriorate or fail to improve while on antibiotic therapy.(Aleem S, et al 2019). In term infants who appear clinically well and are being assessed for EOS solely on the basis of maternal risk factors, lumbar puncture is not routinely indicated.(.(Benitz WE , et al 2010)).Lumbar puncture is usually performed in neonates being evaluated for LOS. CSF should be analyzed for cell count and differential, protein, and glucose levels. Gram stain, culture, and molecular assays should be performed. CSF findings suggestive of meningitis include pleocytosis (CSF white blood cell [WBC] count ≥16 WBCs/mm³) with neutrophilic predominance, elevated protein levels, and reduced glucose levels.(Fleischer E, et al 2019)

1.9. Complete blood count

A complete blood count with differential and C-reactive protein (CRP) are important lab tests, often collected serially. These indices are poor at identifying neonatal sepsis but are more effective at ruling it out.(Visser VE , et al 1979).) Neutropenia has better specificity thanneutrophilia as a marker of neonatal sepsis.(.(Fleischer E, et al 2019)

An elevated immature-to-total neutrophil ratio of more than 0.2 has high sensitivity and negative predictive value for predicting neonatal sepsis.(Jethani S, et al 2022) WBC and absolute neutrophil count are usually high in the first 6 hours of birth. Therefore, performing a complete blood count 12 to 24 hours after birth improves its sensitivity and negative predictive value for detecting sepsis compared with testing performed within the first 7 hours of life.(Rozycki HJ,et al 1987)

1.10. Additional Diagnostic Studies

An elevated neutrophil-to-lymphocyte ratio has been shown to aid in the diagnosis of neonatal sepsis.(Chen J, et al 2023) CRP levels begin to rise within 6 to 8 hours of infection and peak at approximately 24 hours. (Gabay C , et al 1999).Persistently normal CRP levels have a 99.7% negative predictive value for neonatal sepsis.(Visser VE , et al 1979).Other inflammatory markers, including procalcitonin, haptoglobin, and cytokines, can also be obtained to support the diagnosis or evaluate treatment efficacy. A chest radiograph should be performed in a neonate with respiratory symptoms or signs.

1.11. Sepsis Calculator

The EOS Kaiser sepsis calculator is a key resource for diagnosing and managing neonatal sepsis, particularly EOS in newborns.(Kuzniewicz MW ,et al 2017)The American Academy of Pediatrics (AAP) endorses this calculator for risk stratification in neonates ≥35 weeks' gestational age with suspected bacterial sepsis. Kariniotaki C et al 2024)

1.12. Treatment / Management

1.13. Empiric Antibiotic Therapy Empiric antibiotic treatment should be initiated when sepsis is clinically suspected, even in the absence of confirmatory laboratory data. In general, antimicrobial resistance patterns of common bacteria in the neonatal intensive care unit should guide the initial choice of antibiotics. Typical treatment regimens include intravenous (IV) ampicillin and aminoglycosides (gentamicin or amikacin) to cover the most common pathogens in EOS (GBS, *E coli, Enterococcus*, and *Listeria monocytogenes*).[29] Neonates who are critically ill and are at risk of resistant pathogens, ampicillin combined with a thirdor fourth-generation cephalosporin (eg, cefotaxime, ceftazidime, or cefepime), is recommended. Cephalosporins lack antimicrobial activity against Listeria monocytogenes.

Empiric therapy in neonates with suspected LOS includes intravenous (IV) ampicillin and aminoglycosides (gentamicin or amikacin) or ampicillin combined with a third- or fourth-generation cephalosporin (eg, cefotaxime, ceftazidime, or cefepime). A combination of nafcillin (or, in severe cases, vancomycin) and an aminoglycoside can be used in neonates with LOS who have been hospitalized since birth. (Cortese F, et al 2016) Neonates with severe infection or hemodynamic instability should receive vancomycin and third- or fourthgeneration cephalosporin (eg, ceftazidime or cefepime) to provide coverage for methicillin-resistant *Staphylococcus aureus* (MRSA) and gram-negative bacteria. Aminoglycosides have poor central nervous system (CNS) penetration; for that reason, a thirdgeneration cephalosporin should be considered if CNS infection is suspected.(Sullins AK,et al 2013)However, ceftriaxone should be avoided, as it can lead to hyperbilirubinemia and the serious precipitation of calcium-ceftriaxone crystals. Additionally, increasing antibiotic resistance is a concern for neonatal sepsis. Antibiotic stewardship teams play a crucial role in preventing the unjustified and prolonged use of antibiotics.(Shane AL,et al 2017) In neonates with culture-proven sepsis, empiric antibiotic therapy should be adjusted according to the identified pathogen and its antimicrobial susceptibility profile.

1.14. Neonatal Viral Sepsis Treatment

Neonatal sepsis caused by viral pathogens presents a significant challenge in neonatal care. Treatment typically involves targeted antiviral agents, eg, acyclovir for HSV infections or ganciclovir for CMV infections. However, the efficacy of antiviral therapy in neonatal viral sepsis can vary depending on the specific pathogen, timing of intervention, and the overall health status of the neonate. Early diagnosis and prompt initiation of antiviral treatment are crucial for improving outcomes, as delayed therapy can lead to increased morbidity and mortality.

1.15. Antifungal Therapy

Antifungal therapy plays a vital role in the management of neonatal fungal infections, significantly improving survival rates and clinical outcomes. The choice of antifungal agent depends on factors, eg, the severity of infection, gestational age, and potential adverse effects. Amphotericin B deoxycholate remains a first-line treatment option due to its broad spectrum of activity and extensive clinical experience. However, lipid formulations of amphotericin B are increasingly preferred due to their reduced nephrotoxicity. Fluconazole is another commonly used antifungal, especially for prophylaxis in highrisk preterm infants. Prompt initiation of antifungal therapy, along with supportive care and removal of central venous catheters when possible, is essential for improving survival rates and reducing complications associated with neonatal fungal sepsis.

1.16. Differential Diagnosis

Given the nonspecific signs of neonatal sepsis, several differentials must be considered, including:

- Infection due to other agents (virus, fungal, or parasite)
- Congenital heart disease
- Metabolic disease
- Neonatal vascular encephalopathy
- Prematurity and associated complications (respiratory distress syndrome, intraventricular hemorrhage, apnea of prematurity, and others)
- Hypo or hyperthyroidism
- Transient tachypnea of the newborn
- Meconium aspiration

1.17. Treatment Planning

The treatment regimen for neonatal sepsis varies based on various risk factors and conditions. The duration of therapy can vary based on the isolated organisms, the type of infection, and the presence of any neonatal complications. Most symptomatic neonates with culture-confirmed sepsis improve clinically within 24 to 48 hours. For neonates with uncomplicated bacteremia and no evidence of meningitis, antibiotic therapy is typically administered for 7 to 10 days.(Rohatgi S,2017-. Islam K,et al 2023). In neonates with bacteremia, a follow-up blood culture should be performed 24 to 48 hours after starting treatment to assess treatment response. Continued signs of bloodstream infection suggest either inadequate antimicrobial activity against the pathogen or the presence of an undetected infectious focus, eg, infected central venous access devices, cardiac vegetations, abscesses, or osteomyelitis, which requires targeted management.

The recommended duration of antibiotic therapy for neonates with an uncomplicated bacterial urinary tract infection is 10 to 14 days. The treatment for suspected EOS with negative cultures is variable. According to the AAP's recommendation, if blood cultures show no bacterial growth, antibiotics should be stopped within 36 to 48 hours of incubation unless definitive evidence of an infection at a specific site is obtained. (Puopolo KM et al 2018). A 14-day antibiotic course is sufficient for neonates with meningitis caused by GBS or other gram-positive organisms; however, a 3-week course is necessary for neonates with meningitis caused by *E coli* or other gram-negative organisms. Prolonged therapy sometimes extending up to 8 weeks may be necessary for neonates with ventriculitis, abscesses, or subdural empyema. The duration of therapy in pretreated neonates is guided by the following CSF findings and culture results:

• Therapy for 10 days for gram-positive and 14 days for gram-negative infection when CSF pleocytosis and a positive blood culture are present

• Therapy may be discontinued after 48 hours if the CSF results are normal and all cultures remain negative.

• Individualized meningitic-dose therapy when CSF pleocytosis is present, but cultures are negative, based on clinical assessment and alternative infectious or noninfectious causes.

1.18. Prognosis

Mortality rates are inversely proportional to gestational age, such that preterm or younger neonates have higher mortality rates than term neonates. (Stoll BJ,et al 2010)

1.19. Complications

Neonatal sepsis remains a significant contributor to morbidity and mortality in neonates. Prematurity and delayed treatment are commonly associated with adverse outcomes. Very low birth weight infants have been found to have a higher risk of chronic lung disease, and extremely low birth weight infants are at a greater risk of neurodevelopmental risks, eg, hearing and visual deficits, cerebral palsy, and impaired psychomotor and mental development. (Wynn JL, et al 2010)

2. METHOD

Design, sample size, and setting of the study

A descriptive case series hospital-based study was conducted from registration files in the neonatal intensive care unit and 123 newborns admitted to neonatal intensive care in Tobruk medical center from January 2024 to November 2025.

Statistical analysis of the data

Data were fed to the computer and analyzed using IBM SPSS software package version 20.0. **(**Armonk, NY: IBM Corp**)**. Categorical data were represented as numbers and percentages. Quantitative data were expressed as range (minimum and maximum), mean, standard deviation, median and interquartile range (IQR). Significance of the obtained results was judged at the 5% level

3. Ethical approval

Ethical approval for the study was obtained from the Faculty of Health Sciences, University of Tobruk. The study was conducted using an onymized laboratory records collected retrospectively from the hospital laboratory database. No patient names, personal identifiers, or confidential information were accessed or recorded during data collection. All data were handled with strict confidentiality and were used exclusively for scientific research purposes. Since the study relied solely on existing laboratory records and did not involve direct contact with patients, individual informed consent was not required. Data security and privacy were maintained throughout the study in accordance with accepted ethical research principles.

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4.RESULT

4.1 Sociodemographic Characteristics of the Studied Cases

A total of **123 pediatric cases** admitted to the pediatric intensive care unit at Tobruk Medical Centre were included in the study. Male patients represented the majority of the sample, with **75 cases (61.0%)**, while female patients accounted for **48 cases (39.0%)**. The age of the studied cases ranged from **0.03 to 15 months**, with a mean age of **0.88 ± 2.31 months** and a median age of **0.37 months**. This finding indicates that most cases were concentrated in the neonatal and early infancy period.

Table 1. Distribution of the Studied Cases by Sex and Age

Variable	Category / Statistic	Value
Sex	Male	75 (61.0%)
	Female	48 (39.0%)
Age (months)	Minimum–Maximum	0.03–15.0
	Mean ± SD	0.88 ± 2.31
	Median (IQR)	0.37 (0.17–0.79)

4.2 Hematological and Inflammatory Markers

Hemoglobin levels ranged from **1.60 to 20.90 g/dl**, with a mean value of **13.0 ± 3.68 g/dl** and a median of **13.0 g/dl**. Although the mean hemoglobin level was generally within the expected range for infants, the wide range suggests that some cases had severe anaemia or unusually high hemoglobin values.

C-reactive protein was positive in **114 cases (92.7%)**, while only **9 cases (7.3%)** were CRP negative. CRP levels ranged from **0.17 to 144.0 mg/dl**, with a mean of **19.41 ± 28.90 mg/dl** and a median of **9.44 mg/dl**. These findings indicate a high inflammatory burden among the studied cases.

Table 2. Haemoglobin and CRP Findings among the Studied Cases

Variable	Category / Statistic	Value
Haemoglobin (g/dl)	Minimum–Maximum	1.60–20.90
	Mean ± SD	13.0 ± 3.68
	Median (IQR)	13.0 (10.10–16.05)
CRP	Negative	9 (7.3%)
	Positive	114 (92.7%)
CRP (mg/dl)	Minimum–Maximum	0.17–144.0
	Mean ± SD	19.41 ± 28.90
	Median (IQR)	9.44 (2.50–23.0)

4.3 Glucose, Electrolyte, Liver and Renal Function Findings

Blood glucose levels ranged from **10.0 to 281.0 mg/dl**, with a mean value of **79.76 ± 30.84 mg/dl** and a median of **80.0 mg/dl**. Although most patients had glucose values within an acceptable range, the minimum and maximum values indicate the presence of hypoglycaemia and hyperglycaemia in some cases.

Electrolyte results showed considerable variability. Sodium had a mean of **134.9 ± 23.36 mmol/L**, potassium had a mean of **4.67 ± 1.08 mmol/L**, chloride had a mean of **99.09 ± 25.96 mmol/L**, calcium had a mean of **9.75 ± 12.05 mmol/L**, and magnesium had a mean of **2.80 ± 2.99 mmol/L**. Total bilirubin showed a mean of **11.10 ± 6.98 mg/dl**, while urea and creatinine showed mean values of **26.44 ± 33.03 mg/dl** and **1.43 ± 3.64 mg/dl**, respectively. These results suggest that some patients experienced biochemical disturbance, particularly in inflammatory, renal, hepatic, and electrolyte-related markers

Table 3. Descriptive Biochemical Findings among the Studied Cases

Variable	Minimum–Maximum	Mean ± SD	Median (IQR)
Glucose (mg/dl)	10.0–281.0	79.76 ± 30.84	80.0 (65.0–91.0)
Calcium (mmol/L)	0.10–104.0	9.75 ± 12.05	9.0 (8.25–9.80)
Sodium (mmol/L)	5.05–199.0	134.9 ± 23.36	137.0 (134.0–140.4)
Potassium (mmol/L)	2.56–10.50	4.67 ± 1.08	4.48 (4.10–5.01)
Chloride (mmol/L)	3.70–132.0	99.09 ± 25.96	105.0 (101.0–109.0)
Magnesium (mmol/L)	1.0–22.0	2.80 ± 2.99	2.0 (1.80–2.63)
Total bilirubin (mg/dl)	0.50–41.0	11.10 ± 6.98	10.50 (6.63–12.95)
Urea (mg/dl)	1.0–361.0	26.44 ± 33.03	22.0 (15.0–29.97)
Creatinine (mg/dl)	0.10–23.0	1.43 ± 3.64	0.53 (0.39–0.81)

4.4 Rewritten Study Hypotheses

Main Hypothesis

Paediatric patients admitted to the intensive care unit with suspected sepsis show abnormal inflammatory and biochemical markers, particularly elevated CRP and variable electrolyte, renal, liver, and glucose values.

Specific Hypotheses

H1: Male infants are more frequently represented among paediatric intensive care cases with suspected sepsis than female infants.

H2: Most paediatric intensive care cases with suspected sepsis are concentrated in the neonatal and early infancy period.

H3: CRP positivity is highly prevalent among paediatric intensive care cases with suspected sepsis.

H4: Haemoglobin levels show variability among paediatric intensive care cases with suspected sepsis.

H5: Blood glucose levels show clinically relevant variability among paediatric intensive care cases with suspected sepsis.

H6: Electrolyte, liver function, and renal function markers show biochemical variability among paediatric intensive care cases with suspected sepsis.

4.5 Hypothesis Testing Summary

Table 4. Summary of Hypothesis Findings

Hypothesis	Result from the Study	Decision
H1: Male infants are more frequently represented than female infants.	Male cases were 75 (61.0%), while female cases were 48 (39.0%).	Supported
H2: Most cases are concentrated in the neonatal and early infancy period.	Median age was 0.37 months, with most cases clustered in early infancy.	Supported
H3: CRP positivity is highly prevalent.	CRP was positive in 114 cases (92.7%) and negative in 9 cases (7.3%).	Supported
H4: Haemoglobin levels show variability.	Haemoglobin ranged from 1.60 to 20.90 g/dl, with a mean of 13.0 ± 3.68 g/dl.	Supported
H5: Blood glucose levels show clinically relevant variability.	Glucose ranged from 10.0 to 281.0 mg/dl, indicating both low and high values.	Supported
H6: Electrolyte, liver, and renal markers show biochemical variability.	Wide ranges were observed in sodium, calcium, chloride, urea, creatinine, and bilirubin.	Supported

Summary of Results

The study findings indicate that the admitted cases were mainly male and predominantly within the neonatal or early infancy period. CRP positivity was very high, affecting **92.7%** of the cases, suggesting a strong inflammatory or infectious profile. Although mean haemoglobin and glucose values were generally acceptable, the wide ranges indicate clinically important abnormalities in some patients. Electrolyte, liver, and renal function parameters also showed marked variability, supporting the need for close biochemical monitoring in paediatric intensive care patients with suspected sepsis.

5. DISCUSSION

In our study,the findings show a predominance of males (61.0%) compared to females (39.0%), which may suggest either a higher susceptibility of males to the studied condition or a sampling variation. Similar trends have been reported in pediatric and infectious disease studies, where male predominance is commonly observed. This agree with kanchan Devacota et al 2024 shows , the majority of neonates admitted to NICU were male ,(61.59%)while (38.41) were female , (Devkota K, et al 2024), and don't agree with Zidan et al.,2022, The percentage of males in the study group was (40%) and Vs (60%) were females, which was primarily due to the huge number of cases they screened and did not affect our study results. (Zidan, A., et al 2022)

Regarding age distribution, the studied population is largely composed of very young children, with a mean age of 0.88 months and a median of 0.37 months, indicating that most cases fall within the neonatal period. The wide range (0.03–15 months) and relatively high standard deviation (2.31) suggest variability in age, but the low median confirms that the majority are clustered in early infancy. This highlights the vulnerability of neonates and young infants to the condition under investigation. This agree with Sebastian Born Sepsis incidence and case fatality were highest in children less than 1 year old and declined in older children and adolescents.(Sebastian Born–et al 2021). According to a study done by Sediqi, M. S. et al., it was found that two-month-olds to one-year-olds (37.94%) and one-year-olds to three-year-old (34.98%) had the highest prevalence of sepsis (Sediqi, M. S et al 2023)

Hemoglobin levels showed a mean of 13.0 g/dl, which is generally within the normal range for neonates and infants. However, the wide range (1.60–20.90 g/dl) indicates the presence of both severe anemia and elevated hemoglobin levels among some cases. The median value (13.0 g/dl) suggests that most patients had acceptable hemoglobin levels, but the lower extremes may reflect underlying nutritional deficiencies, infections, or chronic conditions affecting a subset of patients. Minichil Worku *et al.* conducted a similar study aimed at assessing the role of CBC parameters in diagnosing neonatal sepsis. (Mainichi W et al 2022).

C-reactive protein (CRP) levels revealed that the majority of cases were CRP positive (92.7%), indicating a high prevalence of inflammation or infection among the studied group. The mean CRP level (19.41 mg/dl) with a large standard deviation (28.90) and a wide range (0.17–144.0) reflects considerable variability in inflammatory response. The median value (9.44 mg/dl) suggests that while most patients had elevated CRP, a subset exhibited markedly high levels, possibly indicating severe or acute infections. This agree a study of a typical heterogeneous ICU patient population suggested that the CRP concentration is a good marker of infection diagnosis, and that it performs better than body temperature and WCC measurements. (P Póvoa et al 2005) Patel U *et al.* carried out a research study to determine the usefulness of C-reactive protein (CRP) for evaluation of neonatal sepsis in teaching hospital of central India. Of 82 neonates studied, 67 (81.7%) had positive CRP while 58 (70.73%) had positive blood culture. The sensitivity, specificity, positive and negative predictive values and diagnostic accuracy of CRP were 81.7%, 88.0%, 95.7%, 59.5% and 83.2% respectively.(Patel U *et al*2014).

Blood glucose levels showed a mean of 79.76 mg/dl, which falls within the normal range for infants. The median value (80.0 mg/dl) further supports that most patients maintained normal glycemic levels. However, the wide range (10.0–281.0 mg/dl) indicates the presence of both hypoglycemia and hyperglycemia in some cases, which may be associated with stress response, infection, or metabolic disturbances., Yumi Mitsuyama et al . Who found that septic patients who had severe hypoglycemia (blood glucose level ≤ 40 mg/dL) on admission had significantly higher mortality, significantly more severe acidosis as indicated by blood pH level, and significantly higher blood lactate level compared with those who had euglycemia.(Yumi M , et al 2022).

Overall, the findings suggest that the studied population is predominantly composed of young infants with a high prevalence of inflammatory conditions, as evidenced by elevated CRP levels. While most hematological and biochemical parameters fall within normal ranges, the observed variability highlights the presence of clinically significant abnormalities in a subset of patients, warranting careful monitoring and management.

According to Table (2) presents the descriptive analysis of electrolytes, liver function, and renal function among the studied cases. Overall, the results demonstrate considerable variability across most biochemical parameters, which may reflect differences in clinical status, disease severity, and age-related physiological changes in the studied population. The result in our study agree with Gehan Lotfy et al ,(56) who observed the Multiorgan failure group, liver function tests (ALT, AST, TB, and DB) were considerably higher. This outcome supports the findings of Zahmatkeshan et al., 2019 who found a correlation between patient mortality and aberrant aminotransferases (ALT and AST), INR, total bilirubin, and direct bilirubin.**(**Abdel-Hakeem GL 2019).

Regarding electrolytes, calcium (Ca) levels showed a mean of 9.75 mmol/L with a median of 9.0 mmol/L, which lies within the normal physiological range for most patients. However, the extremely wide range (0.10–104.0 mmol/L) and high standard deviation (12.05) suggest the presence of outliers or measurement variability, indicating that some cases experienced significant disturbances in calcium homeostasis.Astudy conducted by .**(** Ershad M, et al 2019)

Sodium (Na) levels had a mean of 134.9 mmol/L and a median of 137.0 mmol/L, which are generally within normal limits. The interquartile range (134.0–140.4 mmol/L) shows that most patients maintained relatively stable sodium levels. Nevertheless, the wide range (5.05–199.0 mmol/L) points to the occurrence of both hyponatremia and hypernatremia in a subset of patients, possibly related to dehydration, infection, or renal dysfunction.

Potassium (K) levels were relatively stable, with a mean of 4.67 mmol/L and a median of 4.48 mmol/L, both within normal limits. The narrower interquartile range (4.10–5.01 mmol/L) indicates that most patients had balanced potassium levels. However, the range (2.56–10.50 mmol/L) still suggests that some patients experienced hypo- or hyperkalemia, which could be clinically significant, especially in critically ill cases. Our results correspond with those of Sadeghi-Bojd et al., 2019, who found that the k level is normal or slightly raised in early sepsis. In our instances, the mean of serum K was considerably higher among the sepsis group(slam F, et al 2025)

Chloride (Cl) levels showed a mean of 99.09 mmol/L and a median of 105.0 mmol/L, with most values falling within the expected range. Similar to other electrolytes, the wide range (3.70–132.0 mmol/L) reflects variability that may be associated with acid– base imbalances or fluid disturbances.

Magnesium (Mg) levels had a mean of 2.80 mmol/L and a median of 2.0 mmol/L. While the median falls within the normal range. The majority of patients in Table (1) were neonates or young infants, with a high percentage showing positive CRP (92.7%), indicating a strong presence of inflammatory or infectious conditions. This inflammatory status is likely reflected in the biochemical disturbances observed in Table (2).

Electrolyte imbalances reported in Table (2), particularly the wide ranges of sodium, potassium, and chloride, may be explained by the high prevalence of infection and systemic inflammation shown in Table (1). In neonates and infants, infections are commonly associated with fluid imbalance, dehydration, or metabolic disturbances, which can lead to conditions such as hyponatremia or hypernatremia. Despite the mean and median values being within normal ranges, the variability indicates that a subset of patients experienced clinically significant electrolyte abnormalities.in our finding agree with Mirza Sultan Ahmad et al who found Median (IQR [interquartile range]) levels of sodium and chloride were, 140 (7.1), and 100.2 (7.4) mmol/L, respectively. Mean levels of potassium and calcium were 5.07 ±0.76 mmol/L and 2.35 ±0.338 mmol/L, respectively. Hyperkalemia was the commonest electrolyte disorder present in 60 (39.7%) neonates, followed by hypercalcemia in 50 (33.1%) and hypocalcemia in 20 (13.2%). (Chaurasia S, et al 2019)

Similarly, the relatively stable mean hemoglobin level in Table (1) contrasts with the variability in renal and metabolic parameters in Table (2). This suggests that while most patients maintained adequate oxygen-carrying capacity, other systems—particularly renal function—were more affected. Elevated urea and creatinine levels in some cases may be linked to dehydration or impaired renal perfusion, which are common complications of severe infection.

The high CRP levels in Table (1) also correlate with the elevated total bilirubin levels observed in Table (2). Inflammatory and infectious processes in neonates can affect liver function, leading to hyperbilirubinemia. This is especially relevant in early infancy, where liver immaturity combined with infection can exacerbate bilirubin elevation.This outcome supports the findings of Zahmatkeshan et al., 2019 who found a correlation between patient mortality and aberrant aminotransferases (ALT and AST), INR, total bilirubin, and direct bilirubin. ((slam F, et al 2025).

creatinine levels on renal function tests were considerably higher in the multiorgan failure group. All non-survivor children had elevated renal functions, and Huang, L., et al.'s 2020 research demonstrated a statistically significant positive connection between elevated renal functions and risk of mortality. (Mirza S A2018)

Glucose variability in Table (1) (ranging from hypoglycemia to hyperglycemia) may also be connected to the metabolic disturbances seen in electrolytes and renal function in Table (2). Stress response, sepsis, and inadequate feeding in infants can all contribute to fluctuations in glucose levels alongside electrolyte imbalance.

Overall, the comparison between the two tables suggests that the studied population, predominantly composed of young infants with a high rate of inflammation, exhibits notable biochemical variability. While central tendencies (mean and median) appear within normal ranges for many parameters, the wide ranges and high standard deviations highlight the presence of significant clinical abnormalities in a subset of patients. These findings emphasize the importance of close biochemical monitoring in infants with inflammatory or infectious conditions to prevent complications and guide appropriate management

Recommendation

Based on the study finding , create awareness to the community by giving health education to mothers about different risk factor of sepsis . and it must be focus on the prevention of risk factor rather than treating the disease after it occurs by planning necessary training program for health professional also who it work in pediatric and neonatal ward in this hospital

6. CONCLUSION

The studied population, predominantly composed of young infants with a high rate of inflammation, exhibits notable biochemical variability. While central tendencies (mean and median) appear within normal ranges for many parameters, the wide ranges and high standard deviations highlight the presence of significant clinical abnormalities in a subset of patients. These findings emphasize the importance of close biochemical monitoring in infants with inflammatory or infectious conditions to prevent complications and guide appropriate management

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