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Original Research Article

PREVALENCE OF MENINGITIS IN CLINICALLY SUSPECTED CASES OF EARLY AND LATE ONSET NEONATAL SEPSIS

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ABSTRACT

Background: Neonatal meningitis remains a serious infection globally, leading to significant rates of death and illness. In India, the incidence of neonatal sepsis is reported to be 0.5 per 1000 live births. The greatest impact of neonatal sepsis and meningitis is seen in developing nations. The World Health Organization (WHO) estimates about 5 million neonatal deaths annually. This study aims to evaluate and compare the occurrence of meningitis in suspected cases of early and late onset neonatal sepsis.

Material and Methods: This observational study was carried out at a specialized neonatal intensive care unit (NICU) over a one-year period. A total of **150** newborns were enrolled, and detailed information regarding demographics, maternal health, and obstetric history was collected from consenting participants.

Results: A comparison of patient profiles based on cerebrospinal fluid (CSF) findings was conducted between two groups: group I with normal CSF results (n=108) and group II with CSF indicative of meningitis (n=30). Among the meningitis cases, pathogens identified included S. epidermidis (5.5%), S. hominis (2.5%), other coagulase-negative Staphylococci (CONS) (8%), Enterococcus (5.2%), and group B Streptococcus (2.5%) as gram-positive bacteria, along with Klebsiella pneumoniae (5.5%) and P. aeruginosa (2.5%) as gram-negative bacteria.

Conclusion: The study suggests a heightened risk of meningitis in neonatal sepsis cases. Neonatal bacterial meningitis emerges as a significant contributor to illness and mortality in developing nations such as India.

Keywords: CSF, Meningitis, Neonatal Sepsis, Neonatal Intensive Care Unit.

INTRODUCTION

Neonatal sepsis is a significant contributor to neonatal mortality worldwide, with an especially high prevalence in developing countries. According to global data, neonatal mortality, accounting for approximately 5 million deaths each year, occurs predominantly in developing regions where neonatal sepsis is responsible for 30%–50% of these deaths. The National Neonatal Perinatal Database (NNPD) reports an incidence rate of 30 cases of neonatal sepsis per 1000 live births. Moreover, meningitis, which is more common during the neonatal period, is a major cause of neonatal morbidity and mortality, particularly in regions with limited resources.[1-6]

The incidence of neonatal meningitis varies significantly between regions. In western countries, it ranges from 0.2 to 0.5 cases per 1000 live births, whereas developing countries report higher rates, from 1.1 to 1.9 cases per 1000 live births. Neonatal sepsis is categorized into early onset sepsis (EOS) and late onset sepsis (LOS).[7,8] LOS, which manifests after 72 hours of age, can lead to serious conditions like septicemia, pneumonia, or meningitis.[9] The mortality rate for neonatal meningitis in developing countries is alarmingly high, ranging from 33% to 48%.[10,11]

Specific studies highlight regional differences in the incidence of neonatal meningitis. For instance, in the UK, the incidence in neonates with LOS ranges from 1.3% to 3.5%. In North India, Kaul et al,[9] reported a 22.5% incidence of meningitis among neonates with clinical sepsis in a tertiary care referral unit. Additional studies from North and Central India reported similar findings, with an incidence rate of approximately 17% in neonates with LOS. However, there is limited data from West India.[10,11]

The actual incidence of neonatal bacterial meningitis may be underestimated due to various factors, such as difficulties in diagnosing the condition, disparities between hospital-based and community studies, regional differences, and unregistered deaths in areas with poor access to healthcare services. The empirical relationship between bacterial sepsis and meningitis is well-documented, with estimates suggesting that nearly 20% of EOS and 10% of LOS cases are complicated by meningitis. The risk is higher in preterm neonates, who are two to three times more likely than term neonates to develop late-onset sepsis and its complications.

Morbidity related to neonatal meningitis is often underreported but is considerable. Survivors of neonatal meningitis are at high risk for neurological sequelae and lifelong impairments due to the impact of the infection on their developing brains.[12-16]

The current study aims to evaluate the prevalence of meningitis in neonates clinically suspected of having sepsis. This objective will be achieved by assessing and comparing the prevalence of meningitis in cases of early and late onset neonatal sepsis.

MATERIAL AND METHODS

This descriptive observational study was conducted over a one-year period in a tertiary level neonatal intensive care unit (NICU). Ethical approval was obtained from the institutional ethical committee, and written informed consent was secured from all participants or their guardians.

Inclusion Criteria

Neonates exhibiting clinical features indicative of sepsis were included if presenting conditions such as lethargy, hypotonia, tachycardia, fever, and other signs correlating with sepsis (e.g., abdominal distension, increased aspirates, retractions, grunting, hypotension, delayed capillary refill, pallor, jaundice, hepatomegaly, apnea, abnormal skin color, bradycardia, increased ventilator requirements, sclerema, shock, disseminated intravascular coagulation, pulmonary hemorrhage).

Exclusion Criteria

Neonates were excluded if they:

- Had shock and severe cardiorespiratory instability.
- Had contraindications for lumbar puncture (LP) or did not provide consent for LP.

Sample Size Calculation

As in a previous study by Hoque et al, prevalence of meningitis in clinically suspect cases of neonatal sepsis was 26.3%. We also targeted a similar prevalence in the targeted population. The sample size was calculated using the following formula:

$N=C^2P(1-P)/e^2$

Thus at 95% confidence and 80% power, the calculated sample size shall be 86. After adding for a contingency of 20%, the projected sample size comes out to be 145. The study shall target at 150 cases.

Data Collection

Demographic, maternal medical, and obstetric histories were obtained from participants:

- Details of gestation including complications, gestational age at delivery, mode of delivery, and birth weight were recorded.
- A thorough clinical examination was conducted.

Methods

Diagnostic Tests for Suspected Meningitis in Neonates:

- **Lumbar puncture** to obtain CSF for cell count, differential, gram stain, glucose level, protein level, bacterial cultures.
- **Blood cultures** for bacteria, serum glucose level, and urine culture.
- Consider: Latex antigen tests (CSF and urine), Polymerase chain reaction (PCR) for viruses, viral cultures (CSF, urine, stool, nasopharynx), serology for infectious etiologies, stain for acid-fast bacillus, CT or MRI brain scans.

Statistical Analysis

Data was compiled and entered into Microsoft Excel, then exported to SPSS version 15 for analysis. Quantitative variables were described using means and standard deviations or median and interquartile ranges based on their distribution. Qualitative variables were presented using counts and percentages. The confidence level was set at 95%, and the level of significance at 5%.

RESULTS

A study was conducted on suspected cases of neonatal septicemia in the NICU department of pediatrics. The aim was to compare the outcomes of neonates with meningitis to those without meningitis among clinically suspected cases of sepsis. The study included a total of 150 neonates. **The findings of the CSF examinations are as follows:**

Among the 150 neonates, the CSF examination results were as follows: 108 (72%) had normal findings, 30 (20%) showed signs of meningitis, and 12 (8%) had traumatic CSF specimens with inconclusive findings. As a result, these 12 patients were excluded from further assessment. [Table 1]

The clinical and general profiles of patients were compared based on their CSF findings. The comparison was made between two groups: group I, which had normal CSF findings (n=108), and group

II, which had CSF suggestive of meningitis (n=30). [Table 2]

The pathogens identified in the meningitis group included various gram-positive and gram-negative bacteria. Among the gram-positive pathogens were S. epidermidis (5.5%), S. hominis (2.5%), other CONS (8%), Enterococcus (5.2%), and group B Streptococcus (2.5%). The gram-negative pathogens identified were Klebsiella pneumoniae (5.5%) and P. aeruginosa (2.5%).

Table 1: Distribution of study population according to findings of CSF examination of neonate

CSF examination	Number	Percentage (%)
Normal	108	72
Meningitis	30	20
Traumatic	12	8

Table 2: Association of general and clinical profile with CSF findings

Variables	Overall (n=138)		Group I, (n=108)		Group II, (n=30)		P value
	Number	Percentage (%)	Number	Percentage (%)	Number	Percentage (%)	
Gender							
Male	110	79.71	85	78.7	25	83.3	0.09
Female	28	20.28	23	21.2	5	16.6	
Birth weight (kg)							
>2.5	72	52.17	60	55.5	12	40	0.12
1.5-2.5	54	39.13	38	35.18	16	53.3	
1-1.49	11	7.9	10	9.25	1	3.3	
<1	1	0.72	0	0	1	3.3	
Gestational age							
Term	102	73.91	77	71.29	25	83.3	0.32
Pre-term	36	26.08	31	28.70	5	16.6	
Multiple birth							
Single	134	97.10	107	999.07	27	90	0.002*
Twin	4	2.89	1	0.92	3	10	

DISCUSSION

The study has uncovered significant trends and characteristics of neonatal meningitis. The prevalence of meningitis in neonatal sepsis was 22.5%. In cases of early neonatal sepsis, the rate was 18.2%, while in cases of late neonatal sepsis, the rate was 32.3%. Several factors have been found to be linked to a higher risk of meningitis in early neonatal-twin birth. These include PROM, inadequate ANC visits, and acid-base imbalance. Significantly higher risk of meningitis was observed in cases of late neonatal sepsis with low platelet count and chest X-ray findings suggestive of pneumonitis.

Neonatal meningitis in the developing world is a serious concern. Various risk factors have been identified for newborns, such as low birth weight and prematurity. Maternal factors that increase the risk include premature ruptures of membranes, prolonged rupture of membranes (lasting more than 18 hours), maternal colonization with group B Streptococcus (GBS), maternal chorioamnionitis, and low socioeconomic status.[8] Neonatal meningitis has a higher overall incidence, which may be attributed to the prevailing high rate of infection or bacteremia in the developing world, as previously documented by Airede et al.[17] According to a study conducted in Australia by Isaacs et al, there were a total of 320 cases of sepsis reported in Australian units, impacting a total of 294 infants.[18]

According to a study conducted in 2001 by Aggarwal et al, it is recommended to perform a lumbar puncture in cases of early onset sepsis when there is either a positive blood culture or clinical symptoms of septicemia.[19] It is recommended to perform a lumbar puncture in all infants displaying signs and symptoms of late onset sepsis before initiating antibiotic treatment. In a study conducted by Bhagat et al. and Mehta, it was found that 42.6% and 49.6% of neonates with meningitis had positive blood cultures, respectively. In this study, Acinetobacter was found to be the most common organism recovered from culture, followed by Klebsiella. Mehta and Bhagat et al. found that Klebsiella and methicillin resistant Staphylococcus aureus were the most commonly isolated bacteria in blood cultures.[10,11]

According to a study conducted by Pong et al, it is necessary to collect cerebrospinal fluid (CSF) in order to diagnose meningitis in newborns.20 The bacterial culture is widely regarded as the most reliable method for diagnosing meningitis. Examining the gram-stained smear can provide valuable insights into the bacterial agent at an early stage. Out of the neonates diagnosed with gram-negative bacterial meningitis and evaluated through gram-stained smear, a positive result was found in 61% of cases.

Our study has a limitation in that we did not assess the impact of exclusive breast milk feeding on the prognosis of neonates with LOS.

CONCLUSION

Prevalence of meningitis in neonatal sepsis cases is a significant concern, especially in developing countries like India. The findings suggest a high risk

of meningitis among neonatal sepsis cases, with notable differences in prevalence between early and late neonatal sepsis. Early and focused treatment of meningitis is crucial in reducing morbidity and mortality rates. The recommendation to consider prompt lumbar puncture in cases of early onset sepsis to rule out meningitis is important for early detection and management.

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