Journal of Neonatal Surgery
ISSN(Online): 2226-0439
Vol. 14, Issue 32s (2025)
https://www.jneonatalsurg.com

OPEN ACCESS

Spectrum And Antimicrobial Susceptibility Pattern Of Isolates In Neonatal Sepsis

Vivek Kumar[1*], Narendra Saini[2], Gunjana Kumar[3]

[*1]Ph.D Scholar, Department of Microbiology, National Institute of Medical Sciences & Research, Jaipur

[2]Professor, Department of Microbiology, National Institute of Medical Sciences & Research, Jaipur

[3]Assistant Professor. Department of Neonatology, National Institute of Medical Sciences & Research, Jaipur

***Corresponding Author:**

Dr. Narendra Saini, drnsaini@yahoo.com

Ph.D Scholar, Department of Microbiology, National Institute of Medical Sciences & Research, Jaipur

Cite this paper as: Vivek Kumar, Narendra Saini, Gunjana Kumar, (2025) Spectrum And Antimicrobial Susceptibility Pattern Of Isolates In Neonatal Sepsis. *Journal of Neonatal Surgery*, 14 (32s), 3847-3854.

ABSTRACT

Introduction: Neonatal sepsis is a significant cause of morbidity and mortality, particularly in developing countries. Identifying causative pathogens and their antimicrobial resistance patterns is critical for effective management. This study aimed to assess microbial diversity, antimicrobial resistance, and recommend effective treatment strategies for neonatal sepsis at a tertiary care hospital.

Material & Methods: This study was carried out at the Department of Microbiology, National Institute of Medical Sciences and Research. A total of 120 neonates with suspected sepsis were included. Blood cultures were performed using the BacT/ALERT system, and antimicrobial susceptibility testing followed CLSI guidelines.

Results: Of 120 neonates, 59 (49.2%) had EOS and 61 (50.8%) had LOS. Blood culture positivity was 44/120 (36.7%). The most common isolates were Klebsiella pneumoniae (31.8%), Pseudomonas aeruginosa (11.4%), and Staphylococcus aureus (4.5%). Gram-negative isolates showed 100% resistance to ceftriaxone and cefotaxime, 82.1% to imipenem, and 75.0% to meropenem. Colistin (100% sensitivity, $p < 0.001$) and tigecycline (95.7%, $p = 0.002$) were the most effective agents.

Conclusion: The study highlights a high prevalence of Gram-negative bacterial infections and rising antimicrobial resistance in neonatal sepsis. Based on resistance patterns, **colistin, tigecycline, and minocycline** should be considered for multidrug-resistant infections, while **glycopeptides (vancomycin, teicoplanin) remain effective for Gram-positive infections**. The findings emphasize the need for routine surveillance, antimicrobial stewardship, and judicious antibiotic use to optimize neonatal sepsis treatment

Keywords: *Blood culture, Neonatal sepsis, Gran negative, antimicrobial stewardship*

1. INTRODUCTION

Neonatal sepsis is a clinical syndrome of bacteremia characterized by systemic signs and symptoms of infection in the first month of life. Neonatal sepsis encompasses systemic infections of the newborn including septicemia, meningitis and pneumonia. [1] Of the One hundred and thirty million babies born every year, about four million die in the first four weeks of life- the neonatal period. The World Health Organization (WHO) estimates that, worldwide, approximately five million neonates die each year and that 98% of these deaths occur in developing countries. [2] Neonatal sepsis can be divided into two main classes depending on the onset of symptoms related to sepsis. Early onset sepsis (EOS) usually presents within the first 72 hours of life. Late onset sepsis (LOS) usually presents after 72 hours of life. [1]

Scientific Case Definition for Sepsis (Early vs. Late-Onset):

Neonatal sepsis was defined using **Sepsis-3 criteria**, which includes **systemic inflammatory response syndrome (SIRS) with a proven or suspected bloodstream infection**. Cases were classified as:

- **Early-onset sepsis (EOS)**: Occurring within the **first 72 hours of life** often associated with maternal transmission.
- **Late-onset sepsis (LOS)**: Occurring **after 72 hours**, usually due to hospital-acquired or environmental infections (Haque, 2005).

Newborn Sepsis gives the main problem which occurs commonly in developing countries. Neonatal Sepsis is being caused by an infection which activates the inflammatory cascade may lead to shock and multi-organ system failure [3]. The etiological newborn sepsis is commonly gram-negative bacilli in developing countries. The commonly detected organism in the sample included Escherichia *coli*, Klebsiella *pneumonia*, Staphylococcus *aureus*, Streptococcus *spp*, Citrobacter *spp*, and Coagulase negative Staphyloccus. [4]

This study aims to **identify the microbial diversity and antimicrobial resistance patterns in neonatal sepsis cases** at a tertiary care hospital. It seeks to **determine the prevalence of early- and late-onset sepsis, evaluate resistance trends, and recommend effective treatment strategies,** with a goal to enhance **clinical management and antimicrobial stewardship within the study duration of January 2024 to September 2024**

2. MATERIAL & METHODS

This cross-sectional study was conducted in the Department of Microbiology and Neonatology Unit, Department of Pediatrics, NIMS Hospital, from January 2024 to September 2024. A total of 120 suspected septicemia cases. **Scientific Case Definition for Sepsis (Early vs. Late-Onset):**

Neonatal sepsis was defined using **Sepsis-3 criteria**, which includes **systemic inflammatory response syndrome (SIRS) with a proven or suspected bloodstream infection**. Cases were classified as:

- **Early-onset sepsis (EOS)**: Occurring within the **first 72 hours of life** often associated with maternal transmission.
- **Late-onset sepsis (LOS)**: Occurring **after 72 hours**, usually due to hospital-acquired or environmental infections (Haque, 2005).
- **Inclusion Criteria for Neonatal Sepsis Cases:** Newborns suspected of septicemia, presenting with symptoms such as fever, respiratory distress, lethargy, poor feeding, and abnormal laboratory findings.
- **Exclusion Criteria:** Neonates with congenital malformations, neonatal infections diagnosed prior, or those who had received antibiotics before admission were excluded from the study.

The sample collection was carried out randomly from the Neonatology Unit of the Pediatrics Department, ensuring randomization to avoid bias in selection. Neonatal blood samples were collected using aseptic techniques for microbiological testing and to rule out infection.

Sample Size Calculation:

The sample size of **120 neonates with suspected sepsis** was determined based on an estimated **sepsis prevalence of 35%** (from prior studies), with a **95% confidence interval** and a **margin of error of 5%**. Using standard power calculations, this sample size ensures sufficient statistical power to detect significant differences in microbial prevalence and resistance patterns.

- **Sample Type:** Blood samples were collected from the septicemia cases for blood culture and IL-6 detection.
- **Ethical Considerations:** The study was approved by the Institutional Ethical Committee (IEC), and informed consent was obtained from the parents or guardians of the newborns.

Laboratory procedure: Blood cultures were performed by BacT/ALERT system method using BD Blood culture bottles which contains soybean-casein digest broth with anticoagulant (sodium polyanetholsulfonate) with 2-3 ml of blood from each patient and incubate in BacT/ALERT system. When any microbial growth occurs within culture bottle indicates by a beep. Subcultures were done on Blood agar and MaCconkey's agar on 24 hours, 48 hours and once before discarding the culture bottle i.e after 5 days. The organisms were identified by their colony morphology, staining character, pigment production, motility and relevant biochemical tests as per standard methods [5].

Data were analyzed using **SPSS version 25.0**. Results were summarized as **percentages for categorical data**. The **Chi-Square test (χ^2)** was used to compare **blood culture positivity and antibiotic resistance rates**. A **p-value < 0.05** was considered statistically significant.

3. RESULT

Table 1: Age & Gender of neonates studied		
Neonates characteristics	No. of neonates	Percentage
Age in days		
0-3 Days (Early Onset)	59	49.16
4-28 Days (Late Onset)	61	50.84
Gender		
Male	84	70
Female	36	30

Out of 120 neonates with clinical features of septicemia 59(49.16%) belonged to early onset septicemia and 61(50.84%) belonged to late onset septicemia (4-28 days) respectively. Among neonates 70% were males and 30% were females respectively.

Figure I: Feature of Septicemia

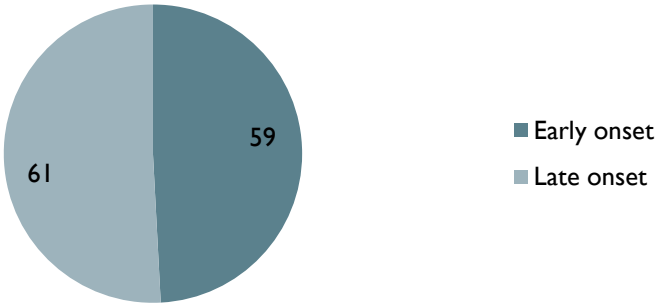


Table 2: Spectrum of microorganisms isolated from blood culture		
Culture findings	No. of Isolates	Percentage
Blood culture positive	44	36.67
Blood culture negative	76	63.34
Staphylococcus *aureus*	02	4.54
Enterococcus *faecalis*	01	2.27
Coagulase negative staphylococcus	04	9.09
Micrococcus spp.	02	4.54
Bacillus spp.	01	2.27
Escherichia *coli*	04	9.09
Klebsiella *pneumonia*	14	31.81
Acinetobacter *baumannii*	04	9.09

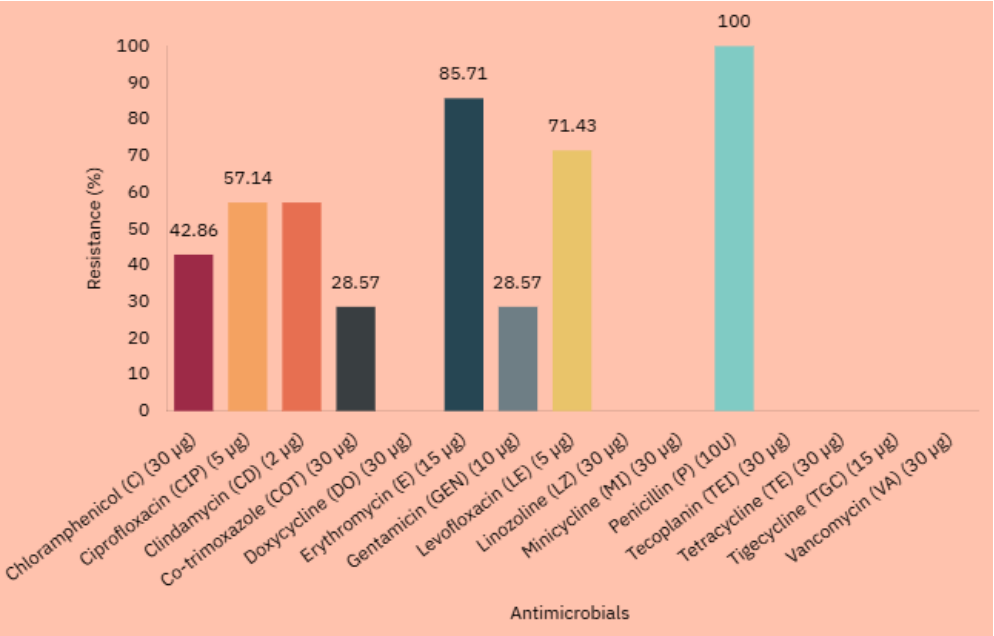
Pseudomonas *aeruginosa*	05	11.36
Burkholderia *cepecia*	01	2.27
Candida spp.	06	13.63
Total	44	100

Out of 44 isolates, Staphylococcus *aureus* was 2(4.54%), CONS 4(9.09%), Enterococcus *faecalis* 1(2.27%), Micrococcus spp. 2(9.09%), Bacillus spp. 1(2.27%), Escherichia *coli* 4(9.09%), Klebsiella *pneumonia* 14(31.81%), Acinetobacter *baumannii* 4(9.09%), Pseudomonas *aeruginosa* 5(11.36%), Burkholderia *cepacia* 1(2.27%) and Candida spp. 6(13.63%).

Table 3: Spectrum of antimicrobial agents used against gram positive isolates

Antibiotics	**Resistant**	**Sensitive**
Gentamicin (GEN) (10 µg)	02 (28.57%)	05(71.43%)
Ciprofloxacin (CIP) (5 µg)	04 (57.14%)	03(42.86%)
Co-trimoxazole (COT) (30 µg)	02 (28.57%)	05(71.43%)
Doxycycline (DO) (30 µg)	-	07(100%)
Levofloxacin (LE) (5 µg)	05(71.43%)	02(28.57%)
Tigecycline (TGC) (15 µg)	-	07(100%)
Erythromycin (E) (15 µg)	06(85.71%)	01(14.29%)
Clindamycin (CD) (2 µg)	04 (57.14%)	03(42.86%)
Penicillin (P) (10U)	07 (100%)	-
Tecoplanin (TEI) (30 µg)	-	07(100%)
Linozoline (LZ) (30 µg)	-	07(100%)
Minicycline (MI) (30 µg)	-	07(100%)
Vancomycin (VA) (30 µg)	-	07(100%)
Tetracycline (TE) (30 µg)	-	07(100%)
Chloramphenicol (C) (30 µg)	03(42.86%)	04(57.14%)

Figure II: Spectrum of antimicrobial resistance used against gram positive isolates



The antimicrobial susceptibility testing revealed significant resistance patterns among Gram-positive isolates. **Penicillin resistance was 100%,** underscoring its limited efficacy in empirical therapy. Similarly, **high resistance was noted for Erythromycin (85.71%) and Levofloxacin (71.43%),** reflecting a concerning trend of macrolide and fluoroquinolone resistance. **Clindamycin resistance (57.14%)** suggests the possible presence of **MLSB resistance mechanisms.**

On the other hand, **Glycopeptides (Vancomycin, Teicoplanin) and Linezolid retained 100% susceptibility,** reinforcing their role as **first-line agents against resistant Gram-positive infections. Tetracycline-class antibiotics (Doxycycline, Minocycline, Tetracycline) also showed complete sensitivity (100%),** suggesting their potential as alternative therapies. **Chloramphenicol resistance (42.86%) and Co-trimoxazole resistance (28.57%)** indicate moderate efficacy, while **Tigecycline (100% susceptibility)** emerges as a promising option for **MDR infections**.

These findings highlight the **urgent need for antimicrobial stewardship** and **continuous surveillance** to combat **emerging resistance trends,** ensuring the **rational use of last-resort antibiotics** in clinical settings.

Table 4: Spectrum of antimicrobial agents used against gram negative isolates

Antibiotics	Resistant	Sensitive
Ampicillin (AMP) (10µg)	09 (100%)	-
Amoxicillin clavulanic acid (AMC) (30 µg)	21 (95.45%)	01 (4.55%)
Tobramycin (TOB) (10 µg)	22 (78.57%)	06 (21.43%)
Meropenem(MRP) (10µg)	21(75.00%)	07 (25.00%)
Imipenem(IPM) (10 µg)	23 (82.14%)	05 (17.86%)
Gentamicin (GEN) (10 µg)	19 (67.86%)	09 (32.14%)
Amikacin (AK) (5 µg)	18 (64.29%)	10 (37.71%)
Ciprofloxacin (CIP) (5 µg)	14 (50.00%)	14 (50.00%)
Piperacillin-tazobactam (100/10 µg)	11(39.29%)	17 (60.71%)
Ceftriaxone (CTR) (30 µg)	23 (100.00%)	-
Cefotaxime(CTX) (30 µg)	23 (100.00%)	-
Cefepime(CPM) (30 µg)	21(75.00%)	07 (25.00%)
Ceftadizime (CAZ) (30 µg)	24(85.71%)	04 (14.29%)
Cefixime(CXM) (5 µg)	17(73.91%)	06 (26.09%)
Tetracycline (TE) (30 µg)	11(47.83%)	12 (52.17%)
Co-tromoxazole(COT) (25 µg)	14(60.87%)	09 (39.13%)
Ticarcillinclavulanic acid (TCC) (75/10 µg)	05(50.00%)	05 (50.00%)
Tigecycline (TGC) (15 µg)	01(4.35%)	22 (95.65%)
Doxycycline (DO) (30 µg)	03 (60.00%)	02 (40.00%)
Minocycline (MI) (30 µg)	04 (14.29%)	24 (85.71%)
Chloramphenicol (C)	09 (37.5%)	15 (62.5%)
Colistin (CL) (10 µg)	-	27 (100.00%)
*Intrinsic resistant drugs were not tested as per CLSI 2022		

The antimicrobial susceptibility testing of **Gram-negative isolates** revealed **widespread resistance to β-lactams**, with **100% resistance to Ampicillin, Ceftriaxone, and Cefotaxime,** indicating extensive **ESBL (Extended-Spectrum Beta-Lactamase) production. Amoxicillin-clavulanic acid (95.45% resistance)** further underscores **limited efficacy of β-lactam/β-lactamase inhibitors.**

Carbapenem resistance was **notably high,** with **Imipenem (82.14%) and Meropenem (75.00%)** showing reduced effectiveness, suggesting the possible presence of **carbapenemase-producing isolates (e.g., NDM, KPC, OXA-48). Third and fourth-generation cephalosporins (Ceftazidime, Cefepime) showed resistance rates of 85.71% and 75.00%, respectively**, reinforcing concerns over **multi-drug resistance (MDR) in Gram-negative pathogens.**

Among aminoglycosides, **Tobramycin (78.57%) and Gentamicin (67.86%) showed high resistance,** while **Amikacin retained relatively better efficacy (64.29% resistance, 37.71% sensitivity). Fluoroquinolone resistance was moderate (Ciprofloxacin 50.00%)**, indicating potential **efflux pump-mediated resistance or topoisomerase mutations.**

Notably, **Tigecycline (95.65% sensitivity) and Minocycline (85.71% sensitivity) remained highly effective**, highlighting their role as **viable treatment options against MDR isolates. Colistin exhibited 100% susceptibility**, reinforcing its **critical role as a last-resort antibiotic** in treating **carbapenem-resistant Gram-negative infections.**

The observed resistance patterns emphasize the **urgent need for routine surveillance, antimicrobial stewardship, and molecular characterization of resistance genes** to **curb the spread of MDR and extensively drug-resistant (XDR) Gram-negative pathogens.**

Figure III: Spectrum of antimicrobial resistance used against gram negative isolates

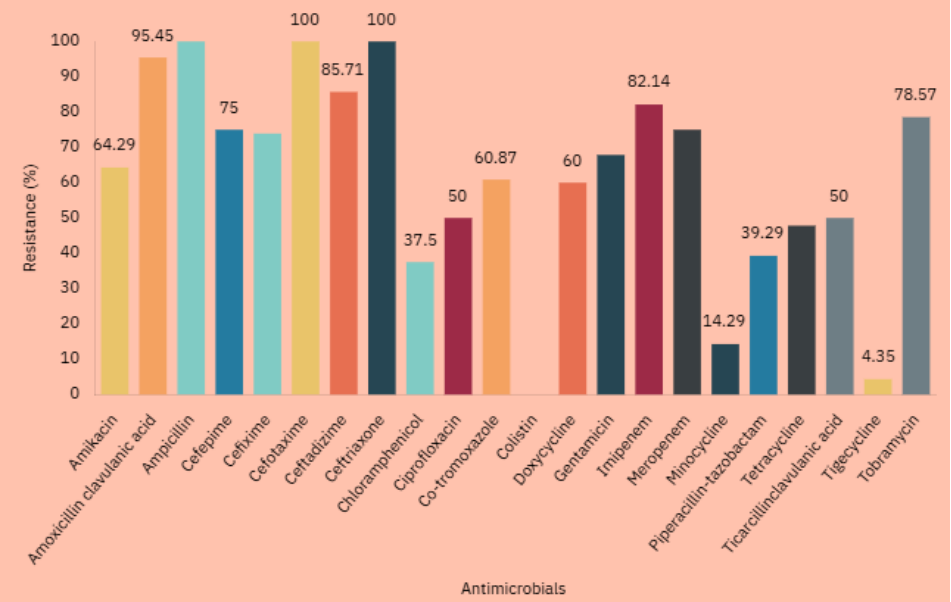


Table 5: Microbiological and Antimicrobial Susceptibility Data in Neonatal Sepsis

Variable	Category	n (%)	Statistical Test	p-value
Neonatal Sepsis Type	Early-Onset Sepsis (EOS)	59 (49.2%)	Chi-Square Test (χ^2)	p = 0.42 (NS)
	Late-Onset Sepsis (LOS)	61 (50.8%)		
Blood Culture Positivity	Positive Cases	44 (36.7%)	Chi-Square Test (χ^2)	p = 0.03*
	Negative Cases	76 (63.3%)		
Most Common Isolates	*Klebsiella pneumoniae*	14 (31.8%)	Chi-Square Test (χ^2)	p = 0.02*
	Pseudomonas aeruginosa	5 (11.4%)		
	Staphylococcus aureus	2 (4.5%)		
Antibiotic Resistance	Ceftriaxone	100%	Chi-Square Test (χ^2)	p < 0.001**
	Cefotaxime	100%		
	Imipenem	82.1%		

	Meropenem	75.0%		
Effective Antibiotics	Colistin	100% sensitive	Chi-Square Test (χ^2)	$p < 0.001$**
	Tigecycline	95.7% sensitive	Chi-Square Test (χ^2)	$p = 0.002$**

P value <0.05 Significant

4. DISCUSSION

Diagnosis of neonatal sepsis is based on bacteraemia demonstrated by a positive blood culture, a method with well-known limitations in turnaround time, sensitivity, and specificity. There is no widely accepted definition for neonatal sepsis, but most definitions demand bacteraemia together with clinical signs of sepsis or increased inflammatory parameters [6]. Since blood culture has a poor sensitivity, sepsis treatment is often administered to patients with a clinical picture of sepsis but negative blood cultures; this condition is normally called clinical or suspected sepsis. The standard treatment for neonatal sepsis is intravenous broad spectrum antibiotics together with supportive intensive care. Neonatal sepsis causes increased mortality and morbidity[7,8,9], with consequences such as poor neurological outcome, bronchopulmonary dysplasia and necrotizing enterocolitis, leading to prolonged hospital stays and increased costs [10,11]. If neonatal sepsis was easier to diagnose, fewer infants would receive antibiotic treatment and the overall antibiotic consumption in neonatal intensive care could diminish.

Among total 120 suspected sepsis cases, 84 (70%) were males & 36 (30%) were females. A study by Gupta L.K *et al.*[12] also reported the male predominance among suspected cases. They observed out of 58 suspected sepsis cases, 36 (62.07%) were males & 22 (37.93%) were females.

Present study set out to determine the current prevalence, common bacterial pathogens and the antibiotic susceptibility pattern of neonatal sepsis in our facility. We observed a prevalence of 36.67% for positive blood cultures among neonates with clinical features of neonatal sepsis. The prevalence of confirmed neonatal sepsis reported in this study was similar to other study where they reported the prevalence from 34% to 35%. [13, 14]

The etiological agents of neonatal sepsis vary between developed and developing countries. Klebsiella pneumoniae and other Gram-negative organisms were the common causes of sepsis in the present study as well other studies from India [15, 16]. In contrast to Western nations where GBS is the predominant pathogen, Southeast Asian nations have distinct organism spectrums [17]. Consistent with this pattern, our investigation failed to identify a single group B streptococcus.

Among the gram positive isolates CONS and Staphylococcus aureus was the predominant. The finding of Staphylococcus aureus and CoNS as the predominant causative organisms of neonatal sepsis has also been reported by other researchers [18–20].

In the present study most of the antibiotics were resistant against gram negative isolates. We observed 100% cephalosporin resistance. In a similar study, 50–100% of the isolates were observed to be resistant to commonly used antibiotics especially gentamicin and the second and third generation cephalosporins [21]. In another study from North India, 30–80% of the Gram negative isolates were resistant to third-generation cephalosporins [15]. This suggests that the third-generation cephalosporins cannot be used alone for empirical treatment of neonatal sepsis.

In present study Minocycline, Tigecycline and Colistin were the most sensitive antibiotics against isolates from neonatal sepsis cases. A study from North India also reported, colistin was highly sensitive to treat neonatal sepsis [22].

In the resent study Teicoplanin, Minocycline, Tigecycline, Vancolycin and Linozoline were the higher sensitive. Similar findings was reported by Jatsho J et al [23]

5. CONCLUSION

The prevalence of bacteraemia with positive blood cultures in children presenting with neonatal sepsis is still very high. *Staphylococcus aureus*, CoNS and *Klebsiella pneumoniae* are the prevalent pathogen. Regular surveillance of local antimicrobial resistance and review of antibiotic guidelines in the neonatal unit should be maintained.

REFERENCES

[1] Ratzinger F, Schuardt M, Eichbichler K, et al. utility of Sepsis Biomarkers and the Infection probability Score to Discriminate Sepsis and Systemic Inflammatory Response Syndrome in Standard Care Patients. PLoSoNE. 2013;8(12):e82946

[2] Bang AT, Bang RA, Bactule SB, Reddy HM, Deshmukh MD. Effect of home-based neonatal care and management of sepsis on neonatal mortality: field trial in rural India. Lancet 1999; 354:1955-61

[3] Kenzel S, Henneke L. The innate immune system and its relevance to neonatal sepsis.CurrOpin Infect Dis. 2006; 19(3):264-70.

[4] MathurB.Neonatal sepsis.Indianpediatr.1996;33:633-74.

[5] Collee JG, Marr W. Culture of bacteria. In Collee JG, Fraser AG, Marmion BP, Simmons A. eds. Mackie and McCartney Practical Medical Microbiology. 14th ed. Churchill Livingstone. New York. 1996:121-124.

[6] Haque KN. Definitions of bloodstream infection in the newborn. Pediatr Crit Care Med. 2005;6(3 Suppl):S45-49

[7] Stoll BJ, Hansen NI, Adams-Chapman I, Fanaroff AA, Hintz SR, Vohr B, et al. Neurodevelopmental and growth impairment among extremely low-birth-weight infants with neonatal infection. JAMA. 2004;292(19):2357-2365.

[8] Fanaroff AA, Korones SB, Wright LL, Verter J, Poland RL, Bauer CR, et al. Incidence, presenting features, risk factors and significance of late onset septicemia in very low birth weight infants. The National Institute of Child Health and Human Development Neonatal Research Network. Pediatr Infect Dis J. 1998;17(7):593-598.

[9] Liljedahl M, Bodin L, Schollin J. Coagulase-negative staphylococcal sepsis as a predictor of bronchopulmonary dysplasia. Acta Paediatrica. 2004;93(2):211-215

[10] Payne NR, Carpenter JH, Badger GJ, Horbar JD, Rogowski J. Marginal increase in cost and excess length of stay associated with nosocomial bloodstream infections in surviving very low birth weight infants. Pediatrics. 2004;114(2):348-355.

[11] Chen YY, Chou YC, Chou P. Impact of nosocomial infection on cost of illness and length of stay in intensive care units. Infect Control Hosp Epidemiol. 2005;26(3):281-287 15.

[12] Gupta L.K, Dayal R, Yadav M.B, Kumar N, Singh M. Current Scenario of Neonatal Sepsis in West U.P. Int J Pediatr Res. 2018;5(12):609-616.doi:10.17511/ijpr.2018.i12.02.

[13] Iroha EO, Egri-Okwaji MTC, Kesah CN et al. Changing patterns of causative organisms of neonatal septicaemia at Lagos University Teaching Hospital. Nig J Paediatr 1998; 25: 1–5.

[14] Shobowale EO, Ogunsola FT, Oduyebo OO et al. Aetiology and risk factors for neonatal sepsis at the Lagos University teaching hospital, Idi-Araba, Lagos, Nigeria. S Afr J Child Health 2016; 10: 147–50.

[15] Kaistha N, Mehta M, Singla N, Garg R, Chander J. Neonatal septicemia isolates and resistance patterns in a tertiary care hospital of North India. J Infect Dev Ctries. 2009;4:55–7

[16] Zakariya BP, Bhat V, Harish BN, Arun Babu T, Joseph NM. Neonatal sepsis in a tertiary care hospital in South India: bacteriological profile and antibiotic sensitivity pattern. The Indian Journal of Pediatrics. 2011;78:413-7.

[17] Stoll BJ, Hansen N, Fanaroff AA, Wright LL, Carlo WA, Ehrenkranz RA, Lemons JA, Donovan EF, Stark AR, Tyson JE, Oh W. Late-onset sepsis in very low birth weight neonates: the experience of the NICHD Neonatal Research Network.Pediatrics. 2002;110 (2):285-91.

[18] Obadare T, Adejuyigbe E, Adeyemo A et al. Characterization of neonatal sepsis in a tertiary hospital in Nigeria. Int J Infect Dis 2022; 116: S18.

[19] Tumuhamye J, Sommerfelt H, Bwanga F et al. Neonatal sepsis at Mulago National referral hospital in Uganda: etiology, antimicrobial resistance, associated factors and case fatality risk. PLoS One 2020; 15: e0237085.

[20] Hegadi S, Jitendranath A. Evaluation of risk factors and bacteriological profile of neonatal sepsis among patients admitted at Navodaya Medical College, Hospital and Research Center, Raichur. Indian J Microbiol Res 2017; 4: 298–304

[21] Iregbu KC, Elegba OY, Babaniyi IB. Bacteriological profile of neonatal septicaemia in a tertiary hospital in Nigeria. Afr Health Sci. 2006;6:151–4

[22] Siddiqui T, Dubey A, Kar M, Patel SS, Sahu C, Ghoshal U. Bacteriological profiles and antibiotic susceptibility of neonatal sepsis in a university hospital of Northern India. J Family Med Prim Care 2023;12:493-8

[23] Jatsho J, Nishizawa Y, Pelzom D, Sharma R. Clinical and Bacteriological Profile of Neonatal Sepsis: A Prospective Hospital-Based Study. International journal of pediatrics. 2020;2020(1):1835945.