Pakistan Journal of Intensive Care Medicine
eISSN: 2708-2261; pISSN: 2958-4728
www.pjicm.com
DOI: https://doi.org/10.54112/pjicm.v5i02.164
*Pak. J. Inten. Care Med., volume 5(2), **2025**: 164*
Original Research Article

BACTERIOLOGICAL PROFILE OF NEONATAL SEPTICEMIA AND ANTIBIOTIC SUSCEPTIBILITY PATTERN OF THE ISOLATES IN TERTIARY CARE HOSPITAL

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(Received, 25th May 2025, Revised 28th June 2025, Accepted 06th July, Published 18th July 2025)

ABSTRACT

Background: *Neonatal septicemia is a major cause of morbidity and mortality worldwide, particularly in developing countries. The identification of causative organisms and their antibiotic susceptibility patterns is essential for guiding effective empirical therapy and reducing adverse outcomes.* ***Objective:*** *To determine the bacteriological profile of neonatal septicemia and evaluate the antibiotic susceptibility patterns of the isolates in a tertiary care hospital.* ***Study Design:*** *Cross-sectional study.* ***Setting:*** *Department of Pediatrics at Combined Military Hospital, Abbottabad, Pakistan.* ***Duration of Study:*** *12-January-2025 to 12-May-2025.* ***Methods:*** *A total of 176 neonates aged 1–20 days presenting with clinical signs of septicemia and positive blood cultures were enrolled. Standard microbiological techniques were used to isolate and identify causative organisms, including Pseudomonas, Staphylococcus epidermidis, Candida, Staphylococcus aureus, Acinetobacter, and Klebsiella. Antibiotic susceptibility testing was performed for meropenem, amikacin, tigecycline, vancomycin, ciprofloxacin, linezolid, colistin, and cefepime using standard protocols. Data analysis was carried out using SPSS version 24.* ***Results:*** *The mean age of the neonates was 10.37 ± 5.64 days, with a mean birth weight of 3.44 ± 0.44 kg. Gram-negative organisms predominated, with Klebsiella (30.1%) and Acinetobacter (25.6%) being the most frequently isolated organisms. High resistance rates were observed against cefepime (73.9%) and ciprofloxacin (56.2%). The highest susceptibility rates were noted for vancomycin (90.9%), linezolid (88.1%), and colistin (81.2%).* ***Conclusion:*** *Klebsiella and Acinetobacter were the leading causes of neonatal septicemia in this study. Vancomycin, linezolid, and colistin showed the greatest sensitivity and may be considered effective options for empirical therapy in neonatal septicemia.*

Keywords: Neonatal Septicemia, Bacteriological Profile, Antibiotic Susceptibility, Multidrug Resistance, Gram-Negative Pathogens

INTRODUCTION

Sepsis considerably contributes to death and disability in all age groups; nevertheless, in neonates, it is marked by unique pathophysiological as well as presentation factors due to immaturity of newly developing systems of immunity (1, 2). Neonatal sepsis (NS) is characterised as a critical, dysregulated inflammation in infants under 28 days of age. It is vital to distinguish between early-onset NS, which occurs within the first 72 hours of life, and late-onset NS, which arises after the initial 3-day period. The incidence rate is 0.1% among live-born infants, corresponding to 16.4% of very low birth weight newborns. The average rate of prolonged hospitalisation reaches 30%, with death rates of 10% (3, 4).

The significant mortality and morbidity related to this condition, coupled with increasing global concern about antibiotic resistance, highlight the importance of standardizing and improving mitigation and control strategies (5, 6). In addition to pathogen identification, monitoring the antibiotic susceptibility histories of these isolates is crucial in the setting of antimicrobial resistance. The insufficient or excessive consumption of antibiotics has led to the development of resistant strains, particularly among neonates who frequently receive broad-spectrum antibiotics due to the nonspecific nature of septicemia symptoms in this population (7, 8). A study determined the bacteriological profile of NS, revealing the following distribution: Pseudomonas (28.2%), Staphylococcus epidermidis (13%), Candida (19.6%), Staphylococcus aureus (19.6%), Acinetobacter (6.5%), and Klebsiella (4.3%). The antibiotic susceptibility patterns were as follows: Meropenem (sensitive 17.4%, resistant 23.9%), Amikacin (sensitive 30.4%, resistant 15.2%), Tigecycline (sensitive 2.2%, resistant 0%), Vancomycin (sensitive 28.3%, resistant 0%), Ciprofloxacin (sensitive 43.5%, resistant 28.3%), Linezolid (sensitive 30.4%, resistant 2.2%), Colistin (sensitive 21.7%, resistant 17.4%), and Cefepime (sensitive 21.7%, resistant 8.7%) (9).

A wide range of bacterial pathogens cause NS, and its management often relies on empirical antibiotic treatment, making it crucial to understand the prevalent microorganisms and their resistance profiles to ensure effective therapy. Due to the paucity of literature on this subject locally, the goal of this study is to determine the bacteriological profile of neonatal septicemia and the antibiotic susceptibility pattern of the isolates at our hospital setup. The findings of this study will be helpful for our health professionals to provide valuable insights into the current bacteriological trends and resistance patterns, ultimately contributing to the development of more effective strategies to combat neonatal septicemia, especially in resource-limited settings where neonatal infections are often poorly managed due to a lack of timely diagnostics and access to effective antibiotics.

METHODOLOGY

A cross-sectional study was conducted in the Department of Pediatrics at the Combined Military Hospital, Abbottabad, from January 12, 2025, to May 12, 2025, after receiving ethical approval from the hospital. The sample size was determined using an estimated prevalence of Klebsiella in neonatal septicemia of 4.3% (9), a 3% margin of error, and a 95% confidence level, resulting in a required sample size of 176 neonates. Non-probability consecutive sampling was utilized. Neonates aged 1 to 20 days of both genders diagnosed with septicemia based on clinical symptoms such as poor feeding, hypothermia, lethargy, and respiratory distress, with confirmation through positive blood cultures indicating bacterial pathogens. Exclusion criteria included neonates with congenital anomalies, jaundice, or low birth weight to reduce confounding variables.

[Citation: Shah, A., Iqbal, A., Wakeel, A., Ullah, A., Din, AU. (2025). Bacteriological profile of neonatal septicemia and antibiotic susceptibility pattern of the isolates in tertiary care hospital. *Pak. J. Inten. Care Med. 5(2), **2025**: 164.* doi: https://doi.org/10.54112/pjicm.v5i02.164]

After obtaining consent from the parents or guardians, demographic data, including age, gender, weight, socioeconomic status, maternal education, maternal employment status, and place of residence (rural or urban), were systematically collected. Blood samples were obtained under sterile conditions to identify the bacteriological profile specifically targeting Pseudomonas, Staphylococcus epidermidis, Candida, Staphylococcus aureus, Acinetobacter, and Klebsiella. Pseudomonas was recognized as a Gram-negative, rod-shaped bacterium on MacConkey agar, distinguishing it from lactose-fermenting bacteria. Staphylococcus epidermidis appeared as Gram-positive cocci in grape-like clusters on blood agar, forming non-hemolytic colonies. Candida was characterized as a Gram-positive, budding yeast that produces smooth, creamy, non-hemolytic colonies on blood agar. Staphylococcus aureus was identified as Gram-positive cocci in clusters on blood agar, producing carotenoid pigments (staphyloxanthin). Acinetobacter presented as Gram-negative coccobacilli forming non-hemolytic colonies on blood agar. At the same time, Klebsiella appeared as Gram-negative, encapsulated, rod-shaped bacilli, growing as moist, mucoid, round colonies on blood agar. Antibiotic susceptibility patterns for these isolates were assessed against Meropenem, Amikacin, Tigecycline, Vancomycin, Ciprofloxacin, Linezolid, Colistin, and Cefepime, following standard laboratory protocols under the supervision of a consultant pediatrician with over five years of post-fellowship experience. Data were recorded using a structured proforma.

Statistical analysis was performed with SPSS 24. Age and weight were reported as means with standard deviations. Gender, bacterial profiles, antibiotic susceptibility results, socioeconomic status, maternal literacy, maternal occupation, and place of residence were expressed as frequencies and percentages. Bacterial profiles were stratified by demographics and antibiotic susceptibility using chi-square at a 5% significance level.

RESULTS

Of the 176 neonates included in this study, the mean age was 10.37 ± 5.64 days. The mean neonatal weight was recorded at 3.44 ± 0.44 kilograms. One hundred nine (61.9%) neonates were male, while 67 (38.1%) were female. Table 1 presents the remaining demographic characteristics of the patients.

The bacteriological profile revealed that Klebsiella was the most prevalent isolate, identified in 53 (30.1%) of the cases. This was followed by Acinetobacter, which was isolated from 45 (25.6%) neonates. Pseudomonas aeruginosa was detected in 37 (21.0%) of the samples. Staphylococcus aureus was cultured from 28 (15.9%) of the neonates, while Candida species were present in 10 (5.7%) of the cases. The least common isolate was Staphylococcus epidermidis, found in only 3 (1.7%) of the participants (Table 2).

The antibiotic susceptibility pattern of the isolates demonstrated high sensitivity to several agents. Vancomycin showed the highest efficacy, with 160 (90.9%) of isolates being sensitive and only 16 (9.1%) exhibiting resistance. Similarly, Linezolid was effective against 155 (88.1%) of the isolates, with resistance noted in 21 (11.9%) cases. Colistin and Tegecycline also displayed strong activity with sensitivity rates of 143 (81.2%) and 137 (77.8%), respectively. Resistance to these antibiotics was observed in 33 (18.8%) and 39 (22.2%) of the isolates. Amikacin was effective against 115 (65.3%) of the bacterial isolates, while 61 (34.7%) were resistant. Meropenem showed a sensitivity rate of 108 (61.4%), with 68 (38.6%) of isolates being resistant. Ciprofloxacin demonstrated lower efficacy, with sensitivity in only 77 (43.8%) of cases and resistance in 99 (56.2%) cases. The highest resistance was observed against Cefepime, where 130 (73.9%) of the isolates were resistant and only 46 (26.1%) remained sensitive (Table 3). Tables 4 and 5 present the stratification of the bacterial profile by demographics and antibiotic susceptibility.

Table 1: Demographics

Demographics		n	%
Maternal education	Literate	83	47.2%
	Illiterate	93	52.8%
Place of living	Rural	74	42.0%
	Urban	102	58.0%
Socioeconomic status	Lower class	39	22.2%
	MIddle class	103	58.5%
	Upper class	34	19.3%
Maternal occupation	Employed	63	35.8%
	Unemployed	113	64.2%

Table 2: Bacterial profile

Bacterial profile	n	%
Pseudomonas	37	21.0%
Staphylococcus epidermidis	3	1.7%
Candida	10	5.7%
Staphylococcus aureus	28	15.9%
Klebsiella	53	30.1%
Acinetobacter	45	25.6%

Table 3: Antibiotic susceptibility

Antibiotic susceptibility		n	%
Meropenem	Sensitivity	108	61.4%
	Resistant	68	38.6%
Ciprofloxacin	Sensitivity	77	43.8%
	Resistant	99	56.2%
Amikacin	Sensitivity	115	65.3%
	Resistant	61	34.7%
Tegecycline	Sensitive	137	77.8%
	Resistant	39	22.2%
Vancomycin	Sensitive	160	90.9%
	Resistant	16	9.1%
Linezolid	Sensitive	155	88.1%
	Resistant	21	11.9%
Colistin	Sensitive	143	81.2%
	Resistant	33	18.8%
Cefepime	Sensitive	46	26.1%
	Resistant	130	73.9%

Table 4: Stratification of bacterial profile with demographics

		Microorganism						P value
		Pseudomonas	Staphylococcus epidermidis	Candida	Staphylococcus aureus	Klebsiella	Acinetobacter	
		%	%	%	%	%	%	
Gender	Male	56.8%	0.0%	70.0%	71.4%	64.2%	60.0%	0.23
	Female	43.2%	100.0%	30.0%	28.6%	35.8%	40.0%	
Maternal education	Literate	43.2%	66.7%	60.0%	53.6%	41.5%	48.9%	0.77
	Illiterate	56.8%	33.3%	40.0%	46.4%	58.5%	51.1%	
Place of living	Rural	54.1%	100.0%	40.0%	35.7%	35.8%	40.0%	0.17
	Urban	45.9%	0.0%	60.0%	64.3%	64.2%	60.0%	

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SES	Lower class	16.2%	66.7%	10.0%	14.3%	22.6%	31.1%	0.0001
	Middle class	45.9%	33.3%	90.0%	75.0%	45.3%	68.9%	
	Upper class	37.8%	0.0%	0.0%	10.7%	32.1%	0.0%	
Maternal occupation	Employed	29.7%	33.3%	40.0%	60.7%	28.3%	33.3%	0.08
	Unemployed	70.3%	66.7%	60.0%	39.3%	71.7%	66.7%	
0. Age distribution	1 to 10	59.5%	66.7%	40.0%	50.0%	50.9%	48.9%	0.86
	11 to 20	40.5%	33.3%	60.0%	50.0%	49.1%	51.1%	
Weight (Kg)	2.7 to 3.5	59.5%	66.7%	60.0%	64.3%	62.3%	60.0%	0.99
	> 3.5	40.5%	33.3%	40.0%	35.7%	37.7%	40.0%	

Table 5: Stratification of bacterial profile with antibiotic susceptibility

Antibiotic susceptibility		Microorganism						P value
		Pseudomonas	Staphylococcus epidermidis	Candida	Staphylococcus aureus	Klebsiella	Acinetobacter	
		%	%	%	%	%	%	
Meropenem	Sensitivity	59.5%	66.7%	70.0%	57.1%	54.7%	71.1%	0.63
	Resistant	40.5%	33.3%	30.0%	42.9%	45.3%	28.9%	
Ciprofloxacin	Sensitivity	43.2%	0.0%	20.0%	50.0%	49.1%	42.2%	0.33
	Resistant	56.8%	100.0%	80.0%	50.0%	50.9%	57.8%	
Amikacin	Sensitivity	73.0%	100.0%	80.0%	67.9%	54.7%	64.4%	0.28
	Resistant	27.0%	0.0%	20.0%	32.1%	45.3%	35.6%	
Tegecycline	Sensitive	75.7%	66.7%	90.0%	78.6%	86.8%	66.7%	0.22
	Resistant	24.3%	33.3%	10.0%	21.4%	13.2%	33.3%	
Vancomycin	Sensitive	89.2%	66.7%	100.0%	89.3%	92.5%	91.1%	0.62
	Resistant	10.8%	33.3%	0.0%	10.7%	7.5%	8.9%	
Linezolid	Sensitive	89.2%	66.7%	100.0%	89.3%	83.0%	91.1%	0.48
	Resistant	10.8%	33.3%	0.0%	10.7%	17.0%	8.9%	
Colistin	Sensitive	83.8%	66.7%	90.0%	71.4%	83.0%	82.2%	0.70
	Resistant	16.2%	33.3%	10.0%	28.6%	17.0%	17.8%	
Cefepime	Sensitive	24.3%	0.0%	20.0%	17.9%	30.2%	31.1%	0.64
	Resistant	75.7%	100.0%	80.0%	82.1%	69.8%	68.9%	

DISCUSSION

The findings of this study provide a critical snapshot of the bacteriological landscape and corresponding antimicrobial resistance patterns in neonatal septicemia at our facility. A comparative analysis with recent studies reveals both converging trends and distinct particularities, underscoring the dynamic and geographically influenced nature of neonatal sepsis.

The mean age of presentation at 10.37 ± 5.64 days suggests a significant burden of late-onset sepsis, a finding consistent with the study by Ibrahim et al. in Palestine, which reported a median age of 7 days and a majority (70.6%) of cases classified as late-onset (10). This aligns with the understanding that late-onset sepsis is frequently associated with hospital-acquired infections and environmental exposure within the neonatal intensive care unit (NICU) setting.

The bacteriological profile isolated in this study, dominated by Gram-negative pathogens, mirrors the alarming trend reported across multiple studies in developing nations. The predominance of Klebsiella species (30.1%) and Acinetobacter species (25.6%) is particularly noteworthy. This finding is in strong agreement with the work of Ehsan et al, who identified Acinetobacter and Klebsiella as leading pathogens (11). Similarly, Jaybhaye et al. reported Klebsiella as the most common isolate in their study (12). The high prevalence of these organisms highlights a shift from traditional pathogens, such as Group B Streptococcus, which is more common in high-income countries, and points towards serious challenges in infection control practices within healthcare facilities. The substantial incidence of Pseudomonas aeruginosa (21.0%) and Staphylococcus aureus (15.9%) further reinforces a profile of pathogens often linked to nosocomial outbreaks and multidrug resistance.

The antibiotic susceptibility patterns observed present a concerning picture of widespread resistance to first-line empirical agents. The exceptionally high resistance to Cefepime (73.9%) renders this cephalosporin ineffective as an empirical choice. This is consistent with a study from Palestine, which documented very low sensitivity to ceftazidime and cefotaxime among Gram-negative isolates (10). Likewise, Akhter et al. reported significant resistance to cephalosporins among their isolates (9). This widespread resistance to broad-spectrum cephalosporins is a major clinical concern and necessitates an urgent revision of empirical therapy protocols.

Conversely, the study found reassuringly high sensitivity to last-resort antibiotics, such as Colistin (81.2%) and Tegecycline (77.8%). This finding is similar to that of Ehsan et al., who noted that colistin was effective against all Gram-negative bacteria except Burkholderia cepacia and E. coli in their setting (11). The high efficacy of Vancomycin (90.9%) and Linezolid (88.1%) against Gram-positive isolates, including S. aureus, is also a critical finding. It suggests that while resistance to beta-lactams is rampant, Gram-positive pathogens remain largely susceptible to these key anti-Gram-positive agents, a trend also observed by Jyothi et al., who reported 91% sensitivity to linezolid (13).

However, the resistance figures for even these drugs, such as the 9.1% resistance to Vancomycin and 11.9% to Linezolid, are non-trivial and serve as a stark warning. The emergence of resistance to these last-line agents signifies a potential progression towards pan-drug-resistant infections, which would pose an insurmountable challenge in neonatal care.

CONCLUSION

In conclusion, bacteria, particularly Klebsiella and Acinetobacter, are the predominant causes of neonatal septicemia in our setting. Antibiotics such as Vancomycin, Linezolid, and Colistin were highly sensitive to the majority of the isolates.

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DECLARATIONS

Data Availability Statement
All data generated or analysed during the study are included in the manuscript.
Ethics approval and consent to participate
Approved by the department Concerned. (IRB-185-Paed-24)
Consent for publication
Approved
Funding
Not applicable

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest.

AUTHOR CONTRIBUTION

ADIL SHAH (Postgraduate Resident)
Conception of Study, Data Colelction, Manuscript drafting, Manuscript revisions, and Final approval of manuscript.
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REFERENCES

1. Marcdante KJ, Kliegman RM, Schuh AM. Nelson essentials of pediatrics. 9th ed. Philadelphia: Elsevier; 2023.
2. Rouhi S, Nachate S, Lamrani Hanchi A, Bennaoui F, Slitine N, FMR M, et al. Neonatal septicemia: clinical and epidemiological features. Saudi J Pathol Microbiol. 2022;7(4):180–5. https://doi.org/10.36348/sjpm.2022.v07i04.005
3. Kuzniewicz MW, Mukhopadhyay S, Li S, Walsh EM, Puopolo KM. Time to positivity of neonatal blood cultures for early-onset sepsis. Pediatr Infect Dis J. 2020;39(7):634–40. https://doi.org/10.1097/INF.0000000000002632
4. Kucova P, Kantor L, Fiserova K, Lasak J, Roderova M, Kolar M. Bacterial pathogens and evaluation of a cut-off for defining early and late neonatal infection. Antibiotics (Basel). 2021;10(3):278. https://doi.org/10.3390/antibiotics10030278
5. Gilfillan M, Bhandari V. Neonatal sepsis biomarkers: where are we now? Res Rep Neonatol. 2019;9:9–20. https://doi.org/10.2147/RRN.S163082
6. Yadav P, Yadav SK. Progress in diagnosis and treatment of neonatal sepsis: a review article. JNMA J Nepal Med Assoc. 2022;60(247):318–24. https://doi.org/10.31729/jnma.7324
7. Almohammady MN, Eltahlawy EM, Reda NM. Pattern of bacterial profile and antibiotic susceptibility among neonatal sepsis cases at Cairo University Children Hospital. J Taibah Univ Med Sci. 2020;15(1):39–47. https://doi.org/10.1016/j.jtumed.2019.12.001
8. Gao K, Fu J, Guan X, Zhu S, Zeng L, Xu X, et al. Incidence, bacterial profiles, and antimicrobial resistance of culture-proven neonatal sepsis in South China. Infect Drug Resist. 2019;12:3797–3805. https://doi.org/10.2147/IDR.S223597
9. Akhter R, Milli LS, Hossain NF, Kismat S. A study on bacteriological profile of neonatal septicemia and antibiotic sensitivity pattern. Ann Int Med Dent Res. 2023;9(4):173–82. https://doi.org/10.53339/aimdr.2023.9.4.22
10. Ibrahim BA, Damiri B, Allahadi H, Qadi M. Bacteriological profile and antibiotic susceptibility pattern of septicemia in neonatal intensive care units in Palestine: a retrospective study. IJID Regions. 2024;10:87–93. https://doi.org/10.1016/j.ijregi.2023.11.019
11. Ehsan S, Marium R. Bacteriological profile and antibiotic susceptibility pattern of isolates in neonatal sepsis. Pak J Health Sci. 2023;4(3):44–9. https://doi.org/10.54393/pjhs.v4i03.608
12. Jaybhaye D, Chandra S, Johar S, Nagre AS. Bacteriological profile and antibiotic susceptibility pattern of neonatal septicaemia—a prospective study. Int J Contemp Pediatr. 2023;10(4):506–9. https://doi.org/10.18203/2349-3291.ijcp20230727
13. Jyothi P, Basavaraj MC, Basavaraj PV. Bacteriological profile of neonatal septicemia and antibiotic susceptibility pattern of the isolates. J Nat Sci Biol Med. 2013;4(2):306–9. https://doi.org/10.4103/0976-9668.116981

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