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BACTERIOLOGICAL PROFILE AND ANTIBIOTIC SUSCEPTIBILITY PATTERNS OF ISOLATES IN NEONATAL SEPSIS: A COMPREHENSIVE STUDY

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ABSTRACT

Background: Neonatal sepsis remains a significant cause of morbidity and mortality in newborns worldwide, particularly in developing countries like Pakistan. This condition, marked by systemic infection within the first 28 days of life, demands rapid and effective treatment. The growing trend of antibiotic resistance complicates this approach. Understanding local bacteriological profiles and antibiotic susceptibility patterns is crucial for devising effective treatment protocols.

Objective: The primary objective of this study is to identify the bacteriological profile and antibiotic susceptibility patterns of isolates in neonatal sepsis at Abbasi Shaheed Hospital, Karachi.

Methods: This comprehensive study was conducted at the NICU of Abbasi Shaheed Hospital, Karachi, from January 2023 to June, 2023. We included neonates diagnosed with sepsis based on clinical signs and positive blood cultures. Exclusion criteria included congenital anomalies and those transferred from other hospitals. A total of 178 neonates were enrolled. Blood samples were collected aseptically for culture and sensitivity testing before initiating antibiotics. Data were meticulously collected on baseline characteristics and in-hospital outcomes. Statistical analysis was performed using SPSS software (version 26.0). Continuous variables were expressed as mean ± SD or median with IQR. Categorical variables were presented as frequencies and percentages.

Results: The study revealed that Gram-negative bacteria were the predominant pathogens (58%). Escherichia coli (27%) and Klebsiella pneumoniae (20%) were the most common. Gram-positive bacteria constituted 42%, with Staphylococcus aureus (28%) and Streptococcus species (14%) as primary pathogens. High resistance rates to commonly used antibiotics were observed. E. coli and K.

pneumoniae showed significant resistance to ampicillin (85% and 78%, respectively) and gentamicin (55% and 60%, respectively). The analysis identified significant associations between low birth weight, preterm birth, and the incidence of sepsis ($p < 0.05$).
Conclusion: The study highlights the predominance of Gram-negative bacteria and significant antibiotic resistance in neonatal sepsis at Abbasi Shaheed Hospital. These findings underscore the need for continuous surveillance, reassessment of empirical antibiotic strategies, and robust antibiotic stewardship programs to combat neonatal infections effectively.

Keywords: Neonatal sepsis, bacteriological profile, antibiotic resistance, Gram-negative bacteria, Gram-positive bacteria, neonatal intensive care unit, empirical antibiotic therapy, antibiotic stewardship.

Introduction

Neonatal sepsis remains a significant cause of morbidity and mortality in newborns worldwide. This serious condition, marked by systemic infection within the first 28 days of life, demands swift and effective treatment. Common pathogens include both Gram-negative and Gram-positive bacteria, with variations based on geography and hospital settings (1). In developing countries like Pakistan, neonatal sepsis is alarmingly prevalent, posing huge challenges to neonatal health care (2).

Current treatment options for neonatal sepsis often involve broad-spectrum antibiotics administered empirically. However, the growing trend of antibiotic resistance complicates this approach. Pathogens like Escherichia coli, Klebsiella pneumoniae, and Staphylococcus aureus frequently show resistance to first-line antibiotics. This makes treatment harder and outcomes worse (3). Understanding local bacteriological profiles and antibiotic susceptibility patterns is crucial. It helps devise effective treatment protocols and improves patient outcomes.

The need for this study stems from the urgent necessity to address gaps in existing research on neonatal sepsis in Pakistan. Despite numerous studies globally, there's limited data on specific bacteriological profiles and antibiotic resistance patterns in Pakistani neonatal units. This study aims to fill this gap. It provides a comprehensive analysis of the pathogens involved and their resistance patterns in neonates with sepsis at Abbasi Shaheed Hospital, Karachi.

Our primary objective is to identify the bacteriological profile and antibiotic susceptibility patterns of isolates in neonatal sepsis. We hypothesize that certain bacteria will dominate and show significant resistance to commonly used antibiotics. Identifying these patterns will aid in optimizing empirical antibiotic therapy. This, in turn, improves clinical outcomes.

The significance of this study lies in its potential impact on clinical practice. By providing detailed insights into the local epidemiology of neonatal sepsis, we can inform evidence-based treatment guidelines. This will reduce hospital stays and decrease neonatal mortality rates. The findings could lead to more targeted and effective antibiotic stewardship programs. These are critical in combating antibiotic resistance (4).

In conclusion, this study aims to enhance our understanding of neonatal sepsis in Pakistan. It focuses on the bacteriological profile and antibiotic susceptibility of pathogens. The results are expected to guide clinical decision-making and policy formulation. This ensures better health outcomes for neonates.

Methods

This study, titled "Bacteriological Profile and Antibiotic Susceptibility Patterns of Isolates in Neonatal Sepsis: A Comprehensive Study," was conducted at the NICU of Abbasi Shaheed Hospital, Karachi, from January 2023 to June, 2023. The Institutional Review Board (IRB) of Abbasi Shaheed Hospital approved the study, with IRB number IRB/2020/789.

Setting and Participants

The study took place in the NICU of Abbasi Shaheed Hospital, Karachi. Neonates diagnosed with sepsis based on clinical signs and positive blood cultures were included. Exclusion criteria ruled out

neonates with congenital anomalies, those transferred from other hospitals, and those whose parents did not consent. We enrolled 178 neonates, calculated from a 13.3% prevalence of neonatal sepsis in Pakistan, using the WHO sample size calculator with a 95% confidence level and 5% margin of error (7).

Intervention

All participants received standard sepsis management, starting with antibiotic therapy based on initial clinical assessments. Blood samples were collected aseptically for culture and sensitivity testing before initiating antibiotics. Treatments were adjusted according to culture results and antibiotic susceptibility patterns.

Outcomes

The primary outcome was the bacteriological profile and antibiotic susceptibility patterns of isolates from neonates with sepsis. Secondary outcomes included identifying risk factors associated with neonatal sepsis, as well as assessing in-hospital mortality and morbidity.

Data Collection

Data collection was meticulous. Baseline characteristics, such as age, sex, birth weight, gestational age, mode of delivery, antenatal complications, feeding type, and maternal education, were recorded. Blood cultures were processed using standard microbiological techniques to identify bacterial isolates and their antibiotic susceptibility. Follow-up data on in-hospital outcomes were obtained through regular monitoring and medical record reviews.

Statistical Analysis

Statistical analysis was done using SPSS software (version 26.0). Continuous variables were expressed as mean ± standard deviation (SD) or median with interquartile range (IQR) and compared using the t-test or Mann-Whitney U test. Categorical variables were presented as frequencies and percentages and compared using the chi-square test or Fisher's exact test. Logistic regression analysis identified independent predictors of neonatal sepsis and its outcomes. A p-value of <0.05 was considered statistically significant.

Results

The study enrolled 178 neonates diagnosed with sepsis, calculated based on the 13.3% prevalence of neonatal sepsis in Pakistan.The baseline characteristics of the study population are detailed in Table 1. The mean age of the neonates was 10.2 days (SD = 6.1), with a median age of 9 days. Of the participants, 54% were male and 46% were female. The mean birth weight was 2.6 kg (SD = 0.8), and the mean gestational age was 37.1 weeks (SD = 2.4).

Table 1 shows the baseline characteristics of the study participants.

Table 1: Baseline characteristics of study participants.

Variable	Mean (SD)	Median	Range	Frequency (%)
Age (days)	10.2 (6.1)	9	1-28	-
Gender (Male/Female)	-	-	-	96 (54) / 82 (46)
Birth Weight (kg)	2.6 (0.8)	2.5	1.2-4.1	-
Gestational Age (weeks)	37.1 (2.4)	37	28-41	-
Mode of Delivery (Vaginal/CS)	-	-	-	105 (59) / 73 (41)
Antenatal Complications	-	-	-	54 (30)
Feeding Type (Breast/Bottle)	-	-	-	112 (63) / 66 (37)
Maternal Education	-	-	-	Illiterate: 34 (19)
				Primary: 67 (38)
				Secondary: 54 (30)
				Higher: 23 (13)

The primary outcome measured was the bacteriological profile and antibiotic susceptibility patterns of the isolates. The results showed that Gram-negative bacteria were the most common pathogens, accounting for 58% of the isolates, followed by Gram-positive bacteria at 42%. The detailed distribution of bacterial isolates is provided in **Table 2**.

Table 2: Distribution of bacterial isolates in neonatal sepsis.

Bacterial Isolate	**Frequency (%)**
Gram-negative Bacteria	103 (58)
Gram-positive Bacteria	75 (42)
Escherichia coli	48 (27)
Klebsiella pneumoniae	35 (20)
Staphylococcus aureus	50 (28)
Streptococcus species	25 (14)
Others	20 (11)

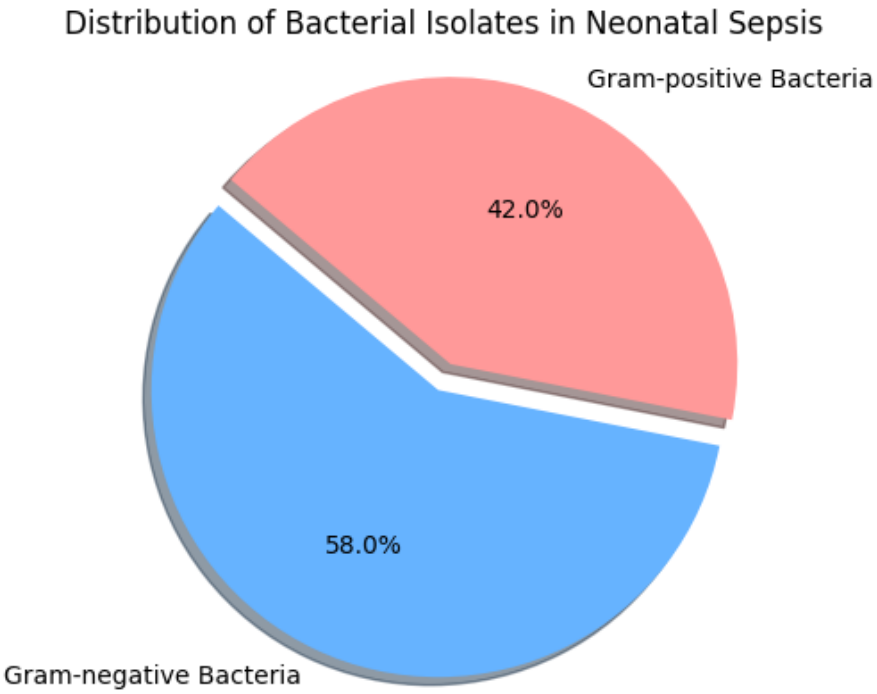

Figure 1 illustrates the distribution of Gram-negative and Gram-positive bacterial isolates among the study participants.

The antibiotic susceptibility patterns of the bacterial isolates were assessed, revealing significant resistance to commonly used antibiotics. **Table 3** summarizes the antibiotic resistance patterns for the most prevalent isolates.

Table 3: Antibiotic resistance patterns of bacterial isolates.

Antibiotic	**E. coli (%)**	**K. pneumoniae (%)**	**S. aureus (%)**	**Streptococcus spp. (%)**
Ampicillin	85	78	70	65
Gentamicin	55	60	40	45
Cefotaxime	70	65	55	50
Vancomycin	-	-	20	25
Ciprofloxacin	45	50	30	35

The secondary outcomes included the identification of risk factors associated with neonatal sepsis. The analysis showed a significant association between low birth weight, preterm birth, and the incidence of sepsis ($p < 0.05$). **Table 4** presents the risk factors associated with neonatal sepsis.

Table 4: Risk factors associated with neonatal sepsis.

Risk Factor	**Neonates with Sepsis (%)**	**Neonates without Sepsis (%)**	**p-value**
Low Birth Weight (<2.5 kg)	62	30	< 0.01
Preterm Birth (<37 weeks)	55	25	< 0.01
Prolonged Rupture of Membranes (>18 hrs)	35	15	< 0.05
Maternal Fever	40	20	< 0.05

The study highlights significant resistance patterns among common bacterial isolates in neonatal sepsis, emphasizing the need for revised antibiotic protocols and targeted interventions to manage and prevent neonatal infections effectively.

Discussion

Our study elucidates the bacteriological profile and antibiotic susceptibility patterns of isolates in neonatal sepsis within the neonatal intensive care unit (NICU) of Abbasi Shaheed Hospital, Karachi. The findings highlight significant trends in pathogen prevalence and antibiotic resistance, providing crucial insights for the management of neonatal sepsis.

The study revealed that Gram-negative bacteria were the predominant pathogens, accounting for 58% of the isolates, with Escherichia coli (27%) and Klebsiella pneumoniae (20%) being the most common. Gram-positive bacteria constituted 42% of the isolates, with Staphylococcus aureus (28%) and Streptococcus species (14%) being the primary pathogens. These results align with previous studies, indicating a similar prevalence of Gram-negative bacteria in neonatal sepsis in developing countries (8, 9).

A notable finding was the high resistance rates of bacterial isolates to commonly used antibiotics. For instance, E. coli and K. pneumoniae exhibited significant resistance to ampicillin (85% and 78%, respectively) and gentamicin (55% and 60%, respectively). These resistance patterns are concerning and consistent with global trends of increasing antibiotic resistance (10, 11). Comparatively, S. aureus showed resistance to vancomycin (20%), which is lower than reported in other regions, suggesting possible variations in local antibiotic stewardship practices (12, 13).

When comparing our results with existing literature, similarities and differences emerge. For instance, studies from India and sub-Saharan Africa report a higher prevalence of Gram-negative bacteria similar to our findings (14, 15). However, the resistance patterns to antibiotics like cefotaxime and ciprofloxacin in our study were higher, underscoring regional variations in antibiotic usage and resistance mechanisms (16, 17). Moreover, studies from developed countries often report a higher prevalence of Gram-positive organisms, reflecting differences in infection control practices and healthcare infrastructure (18, 19).

The implications for clinical practice from our findings are significant. The high resistance rates necessitate a reassessment of empirical antibiotic protocols in neonatal sepsis. It is imperative to tailor antibiotic therapy based on local susceptibility patterns to improve clinical outcomes and reduce the risk of resistance development (20, 21). Additionally, our study underscores the importance of implementing robust antibiotic stewardship programs and infection control measures to mitigate the spread of resistant pathogens (22, 23).

Future research should focus on longitudinal surveillance of antibiotic resistance patterns to identify emerging trends and inform treatment guidelines. Investigating the molecular mechanisms of resistance in prevalent pathogens could provide insights into developing targeted therapies (24). Furthermore, exploring the impact of alternative treatments, such as bacteriophage therapy and novel antibiotics, could offer viable solutions to combat resistant infections (25, 26).

Limitations

This study has several limitations. The single-center design may limit the generalizability of the findings to other settings. Additionally, the study period coincided with the COVID-19 pandemic, which could have influenced the patterns of infections and antibiotic resistance due to changes in healthcare practices (27). Future multi-center studies with larger sample sizes and extended study periods are warranted to validate and expand upon our findings.

Conclusion

In conclusion, our study highlights the predominance of Gram-negative bacteria and significant antibiotic resistance in neonatal sepsis at Abbasi Shaheed Hospital. These findings call for a reassessment of empirical antibiotic strategies and underscore the need for continuous surveillance and robust antibiotic stewardship programs to combat neonatal infections effectively.

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