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Analysis Of Bacterial Isolates And Antibiotic Sensitivity In A Neonatal Intensive Care Unit Of A Tertiary Care Hospital

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Abstract

Background:

Neonatal sepsis is a major contributor to mortality in neonatal intensive care units (NICU) in developing countries. However, studies on this topic are often lacking. To mitigate the high morbidity and mortality associated with neonatal sepsis, neonatologists must have a thorough understanding of the bacteriological flora and their susceptibility to antibiotics. Therefore, the purpose of this study is to investigate the bacteriological profile and antibiotic susceptibility pattern of neonatal sepsis cases that tested positive in the NICU of a tertiary hospital. **Methods:** The study included all neonates up to 28 days of age who were admitted to the Neonatal Intensive Care Unit (NICU) with clinical history, signs, and symptoms of sepsis. **Results:** Of the samples tested, 69.2% showed no growth, while the remaining samples showed growth of various microorganisms. Methicillin-resistant Staphylococcus aureus (MRSA) was the most commonly found microorganism at 26.2%, followed by Pseudomonas, Acinetobacter, and Klebsiella. The highest sensitivity was exhibited by doxycycline, with 48% of cultures being sensitive to this antibiotic. Ampicillin had the lowest sensitivity at 6%, while aztreonam, minocycline, vancomycin, and netilmicin had the lowest sensitivities, with only 2-5% of cultures being sensitive to these antibiotics. **Conclusion**: The study found that the majority of samples showed no growth. However, Methicillin-resistant Staphylococcus aureus (MRSA) was the most commonly identified organism, followed by Pseudomonas, Acinetobacter, Klebsiella, yeast, and Enterococcus. The study found that ampicillin had the lowest sensitivity, while doxycycline showed the highest sensitivity.

Keywords: Neonatal sepsis, Bacterial isolates, Antibiotic susceptibility pattern, Gram-positive, Gram-negative

Introduction

The Neonatal Intensive Care Unit (NICU) of a tertiary care hospital is a critical area where premature and sick newborns receive intensive medical care. One of the major concerns in NICU is the development of infections caused by bacterial pathogens, which can lead to serious morbidity and mortality in these vulnerable patients. Neonatal sepsis is a significant contributor to morbidity and mortality in newborns across the globe, affecting approximately 20% of newborns and resulting in a mortality rate of about 1%.[1-3] It currently accounts for almost 28% of annual global deaths during the neonatal period. Survivors of neonatal sepsis often experience significant neurodevelopmental sequelae and it poses a significant economic burden on families, society and the nation.[1] In low-resource settings, hospital-acquired infections associated with neonatal sepsis divert critical resources that could otherwise be utilized to improve access to and quality of healthcare services.[1] In addition to the initial admission, re-hospitalizations, long-term chronic illnesses and disabilities further exacerbate healthcare expenses, often with long-lasting societal implications. Neonatal sepsis often presents with nonspecific and subtle symptoms, which can overlap with other common noninfectious conditions.

The incidence of culture-proven sepsis varies between 1-8 cases per 1000 live births, with equal distribution of early and late-onset cases.4,5 Early-onset sepsis (EOS) and late-onset sepsis (LOS) are two subtypes of neonatal sepsis depending on the onset of symptoms before or after 72 hours of life.6 Group B streptococcus and E. coli are commonly associated with EOS in the western world, while in India, Gram-negative organisms such as E. coli, Klebsiella, and Enterobacter sp. are the leading causes.7,8 Organisms implicated in LOS include coagulase-negative Staphylococci, Staphylococcus aureus, Klebsiella pneumoniae, Escherichia coli, Enterobacter spp., Pseudomonas aeruginosa, and anaerobes.8,9 Prompt diagnosis and effective treatment are crucial to prevent deaths and complications due to septicemia. Although blood culture is the gold standard for the diagnosis of neonatal sepsis, its sensitivity ranges between 50-80 percent, and results can take hours to days, necessitating initial empirical treatment of suspected cases.9 The analysis of bacterial isolates refers to the identification of the bacteria causing infections in the NICU, while antibiotic sensitivity testing is performed to determine the most effective antibiotics for treating those infections. This information is essential for clinicians to make informed decisions about the selection of antibiotics and to avoid the inappropriate use of antibiotics, which can lead to antibiotic resistance. This study aims to investigate the prevalence of bacterial isolates and their antibiotic sensitivity in a NICU of a tertiary care hospital. The findings of this study will provide valuable insights into the current state of bacterial infections in the NICU and inform the development of appropriate treatment protocols. Additionally, this study will contribute to the broader understanding of antibiotic resistance patterns and the effective management of neonatal infections in tertiary care hospitals.

Methods:

A one-year prospective observational cohort study was conducted in the Department of Paediatrics at …, in collaboration with the Department of Microbiology. The study included all neonates up to 28 days of age who were admitted to the Neonatal Intensive Care Unit (NICU) with clinical history, signs, and symptoms of sepsis. Prior approval was obtained from the Research and Ethical Committee, and informed consent was obtained from each patient's next of kin. A neonate is an infant who is less than 28 days old. Early-onset sepsis is believed to originate from the mother and typically manifests within 72 hours of birth, whereas late-onset sepsis is thought to be of environmental origin and usually presents after 72 hours of life. The study included all neonates who were admitted to the neonatal intensive care unit (NICU) with clinical history, signs, and symptoms of sepsis, up to 28 days of age.

The inclusion criteria for the study required neonates with clinical history, signs, and symptoms of sepsis, who were admitted to the NICU of the tertiary care hospital. Exclusion criteria were infants older than 28 days of age. As the study focused mainly on the microbiological aspects and outcomes of sepsis, clinical risk factors of the neonates and their outcomes were not reviewed. Data were obtained from the NICU registers, Medical Department Records, and microbiology laboratory records, which were used to determine the antimicrobial sensitivity pattern. A minimum of 3 ml of blood was collected from a peripheral vein after proper cleaning of the venipuncture site (an area of 5 cm) with spirit and povidone iodine. Blood samples were collected on the day of admission or when sepsis was suspected during hospital stay. Samples from NICUs were sent to the microbiology department for analysis, where manual methods of culture growth were followed.

Samples were incubated in glucose/bile broth and inoculated in MacConkey agar, and growths (if any) were reported. All positive microbial growth cultures underwent antibiotic sensitivity testing using the Kirby-Bauer disk diffusion susceptibility test. The tested antibiotics were reported as susceptible, intermediate, or resistant.

Results

We observe that out of the total 80 neonates included in the study, 58.75% were male and 41.25% were

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female. The data suggests that microbial growth was observed in both male and female neonates.

Table 1: Microbial growth pattern based on culture studies

Total samples	260	Percentage	Culture positive
No growth	180	69.2%	
MRSA	21	8%	26.2%
Pseudomonas	14	5.3%	17.5%
Acinetobacter	12	4.6%	15%
Klebsiella	11	4.2%	13.7%
Yeast	7	2.6%	8.7%
Enterococcus	7	2.6%	8.7%
E. Coli	5	1.9%	6.2%
Staphylococcus	2	0.7%	2.5%
Proteus	1	0.3%	1.2%

The table 1 presents the results of a culture study conducted on a total of 260 samples. Out of these, 180 samples (69.2%) showed no growth. The remaining samples showed growth of various microorganisms, with the highest percentage of culture positivity observed for Methicillin-resistant Staphylococcus aureus (MRSA) at 26.2%, followed by Pseudomonas (17.5%), Acinetobacter (15%), Klebsiella (13.7%), yeast (8.7%), and Enterococcus (8.7%). E. coli was found in 1.9% of samples, while Staphylococcus and Proteus were found in 0.7% and 0.3% of samples, respectively.

Table 2: Antibiotic sensitivity based on microbial culture growths

Antibiotic	Sensitivity detected	Percentage of cultures sensitive
Ampicillin	5	6%
Amikacin	23	28%
Cefotaxime	8	10%
Clindamycin	12	15%
Ciprofloxacin	15	18%
Doxycycline	39	48%
Gentamycin	28	35%
Linezolid	21	26%
Piperacillin-tazobactum	21	26%
Meropenem	19	23%
Vancomycin	4	5%

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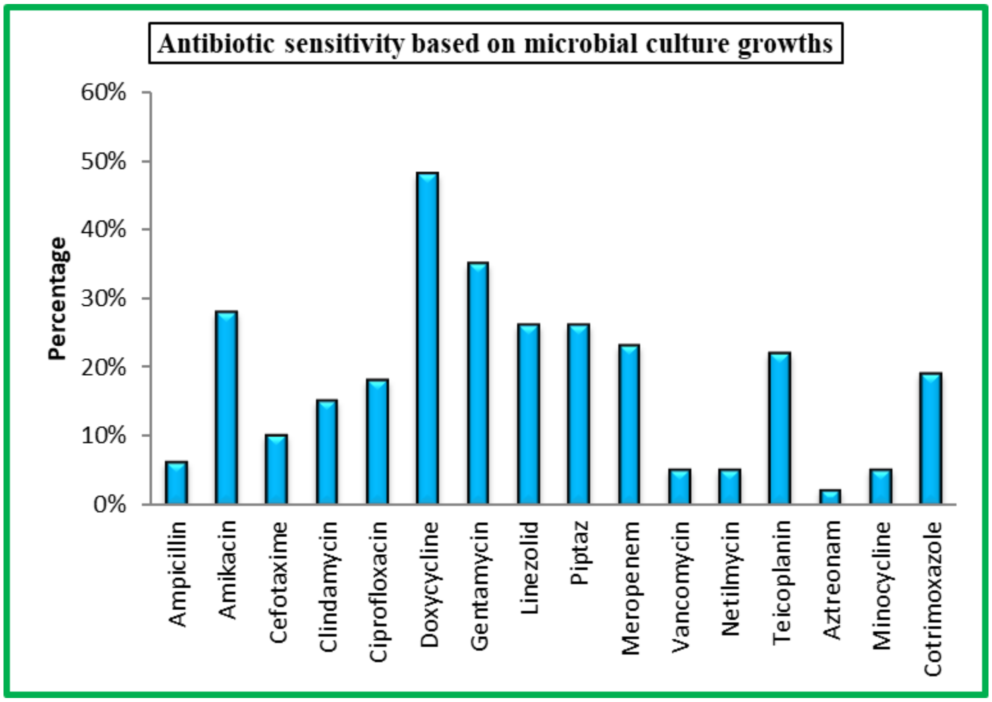
Netilmycin	4	5%
Teicoplanin	18	22%
Aztreonam	2	2%
Minocycline	5	5%
Cotrimoxazole	15	19%
Total cultures growths	80	

The antibiotic sensitivity pattern of the bacterial isolates was analyzed and the results are presented in Table 2. Out of a total of 80 cultures grown, the percentage of cultures sensitive to each antibiotic was determined. Ampicillin showed sensitivity in only 6% of cultures, while amikacin and gentamicin were sensitive in 28% and 35% of cultures, respectively. Doxycycline exhibited the highest sensitivity, with 48% of cultures being sensitive to this antibiotic. Other antibiotics that showed good sensitivity were clindamycin (15%), ciprofloxacin (18%), linezolid (26%), piperacillin tazobactum (26%), meropenem (23%), teicoplanin (22%), and cotrimoxazole (19%). Antibiotics with the lowest sensitivity were aztreonam, minocycline, vancomycin, and netilmicin, with only 2-5% of cultures being sensitive to these antibiotics.



Discussion

The analysis of bacterial isolates and antibiotic sensitivity is an important aspect of managing neonatal sepsis in a hospital setting. In this study, we analyzed the antibiotic sensitivity pattern of bacterial isolates in a neonatal intensive care unit (NICU) of a tertiary care hospital. In the present study, we observed out of the total 80 neonates included in the study, 58.75% were male and 41.25% were female. The sex distribution of the neonates in our study is consistent with previous studies that have shown a male predominance in neonatal sepsis cases (Thappa et al., 2019; Pandit et al., 2020; Shehab et al., 2015).[8-10] This may be attributed to the inherent susceptibility of male neonates to infections due to various factors such as hormonal differences, differences in the immune system, and differences in behavior. However, further studies are needed to confirm this association.

In the present study, we observed that out of 180 samples, (69.2%) did not reflected any growth. Among the remaining samples, various

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microorganisms were isolated, with Methicillin-resistant Staphylococcus aureus (MRSA) having the highest percentage of culture positivity at 26.2%, followed by Pseudomonas (17.5%), Acinetobacter (15%), Klebsiella (13.7%), yeast (8.7%), and Enterococcus (8.7%). Escherichia coli was detected in 1.9% of samples, while Staphylococcus and Proteus were found in 0.7% and 0.3% of samples, respectively. The results of the present study are consistent with several other studies reporting that MRSA, Pseudomonas, and Klebsiella are among the most common pathogens causing neonatal sepsis (Khaliq A et al., 2019; Vergnano S et al., 2005).[11,12] Similarly, a study conducted in India reported that the most common pathogens causing early-onset sepsis were coagulase-negative Staphylococcus, Escherichia coli, and Klebsiella, while the most common pathogens causing late-onset sepsis were Klebsiella and Pseudomonas (Zellelw et al., 2020).[13] Another study conducted in Nigeria reported that Klebsiella, Staphylococcus aureus, and Escherichia coli were the most common isolates causing neonatal sepsis (Uwe et al., 2022).[14]Therefore, the identification of these common pathogens is essential for proper treatment and management of neonatal sepsis. However; it is important to exercise caution when interpreting the results presented, particularly as distinguishing between community-acquired and hospital-acquired infections during the neonatal period can be challenging in disease conditions. This could result in a small number of nosocomial infections being included in the findings, which in turn could influence the distribution of pathogens identified. While coagulase-negative Staphylococci have been reported as a significant cause of neonatal infection in several studies, it is important to note that positive blood cultures for this pathogen may frequently be due to contamination of samples. The importance of the most common pathogens implicated in neonatal infections can vary depending on when the disease sets in (early or late onset), although many of the studies reviewed did not provide detailed information on this. Typically, early onset infections are attributed to pathogens transmitted from the vaginal or rectal flora of the mother to the child, while late onset infections are attributed to bacteria acquired from the infant's environment (either in hospitals or the community), with S. aureus and Klebsiella species more commonly implicated in hospital-acquired infections. Infection control measures that are designed to prevent the acquisition of bacteria from the environment may not be effective in preventing infections that are acquired at birth. Therefore, distinguishing between maternal and environmental sources of infection could potentially lead to more targeted and effective preventive strategies in these settings.

According to the World Health Organization (WHO), the first-line treatment for neonatal sepsis is a combination of ampicillin and gentamicin, unless there is suspected infection of the skin or umbilicus with Staphylococcus aureus, in which case cloxacillin should be used instead of ampicillin. However, in present study ampicillin had a low sensitivity of 6%, while amikacin and gentamicin exhibited 28% and 35% sensitivity, respectively. The most effective antibiotic was doxycycline, with 48% of cultures being sensitive to it. Clindamycin, ciprofloxacin, linezolid, piptaz, meropenem, teicoplanin, and cotrimoxazole also demonstrated good sensitivity ranging from 15% to 26%. Conversely, the lowest sensitivity was observed for aztreonam, minocycline, vancomycin, and netilmicin, with only 2-5% of cultures being sensitive to these antibiotics. It is important to note that these findings should be interpreted with caution and antibiotic choice should be based on individual patient factors and local resistance patterns. Our findings are consistent with those of the study by Bhat et al., as they also reported high resistance to commonly used antibiotics like ampicillin and cloxacillin, and highlighted the effectiveness of aminoglycosides such as netilmycin, amikacin, and gentamicin against gram-negative organisms.[15] In the meta analysis conducted by Huynh BT et al., 2015) it was found that among Gram-negative bacteria (excluding Klebsiella spp.), resistance to penicillin/ampicillin ranged from 55% (95% CI 26%-84%) for E. coli isolates in Georgia to 100% for E. coli isolates in Uganda.[16] They reported that in contrast, resistance to gentamicin among Gram-negative bacteria ranged from 0% for Pseudomonas and E. coli in Pakistan and for K. pneumoniae in Nepal to 100% for K. pneumoniae in India. Resistance to third generation cephalosporins (3rd GC) among Gram-negative bacteria ranged from 6% for E. coli isolates in Uganda to 97% for K. pneumonia isolates in India.[16] Furthermore, other studies conducted by Mathur et al., Khatua et al., and

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Tallur et al. have also reported similar results, supporting the trend of growing antibiotic resistance among neonatal sepsis-causing organisms.[17,18] Therefore, it is important to note that antibiotic resistance patterns can vary among different NICUs, and periodic surveillance of antibiotic sensitivity is necessary to ensure effective treatment.

Conclusion

The study found that the majority of samples showed no growth. However, Methicillin-resistant Staphylococcus aureus (MRSA) was the most commonly identified organism, followed by Pseudomonas, Acinetobacter, Klebsiella, yeast, and Enterococcus. The sensitivity of various antibiotics against these organisms was also determined. The study found that ampicillin had the lowest sensitivity, while doxycycline showed the highest sensitivity. Other antibiotics such as amikacin, gentamicin, clindamycin, ciprofloxacin, linezolid, piptaz, meropenem, teicoplanin, and cotrimoxazole showed moderate sensitivity. Aztreonam, minocycline, vancomycin, and netilmicin had relatively the lowest sensitivity. Based on these findings, it may be recommended to consider doxycycline as a first-line treatment option for infections caused by MRSA, Pseudomonas, Acinetobacter, and Klebsiella. However, it is important to note that antibiotic resistance patterns can vary among different settings, and periodic surveillance of antibiotic sensitivity is necessary to ensure effective treatment. Additionally, a combination of antibiotics may be necessary for more severe infections or in cases where resistance to a single antibiotic is present. Consulting with a healthcare provider is recommended for proper diagnosis and treatment.

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