Khalij Libya Journal of Dental and Medical Research. 2026;10(3):315-322
https://doi.org/10.47705/kjdmr.26320
eISSN:*2708-888X*

Original article

Bacterial Profile and Antimicrobial Susceptibility Patterns of Neonatal Infections among Neonates Admitted to the Neonatal Intensive Care Unit of Tobruk Medical Centre

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Abstract
Neonatal infections are significant causes of morbidity, mortality, and prolonged hospitalisation among newborns. Effective management requires optimal antimicrobial therapy guided by epidemiological studies of bacterial susceptibility. This study aimed to identify the most common bacteria implicated in neonatal infections in the neonatal intensive care unit (NICU) at Tobruk Medical Centre and their antibiotic susceptibility patterns, which, in turn, can assist in selecting effective treatment. This study included 311 culture records from all newborns admitted to the NICU at Tobruk Medical Centre between January 2019 and December 2020. Different types of samples were analysed in the microbiology laboratory, including blood, urine, cerebrospinal fluid (CSF), umbilical cord, and other samples. All samples were examined for microbiological confirmation and for patterns of antibiotic susceptibility by the disc diffusion method. In total, 55 (17.7%) of the specimens showed positive growth, including 50 (16.1%) clinically relevant positive cultures. Blood cultures showed the highest number of clinically relevant positive results (23/78; 29.5%), followed by umbilical cord (11/12; 91.7%). Bacteriological examination showed that the most frequently isolated microorganisms were Klebsiella pneumoniae (17; 34.0%), followed by Staphylococcus aureus (16; 32.0%), Escherichia coli (9; 18.0%), Staphylococcus epidermidis (5; 10.0%), and Enterobacteriaceae (3; 6.0%). Antibiotic susceptibility testing was performed for the major bacterial isolates. Among blood isolates, K. pneumoniae showed sensitivity to meropenem (100%), imipenem (50%), and ceftriaxone (25%), while E. coli showed greater sensitivity to imipenem (75%), amikacin (50%), and doxycycline (100%). S. aureus showed sensitivity to meropenem (100%) and vancomycin (25%), whereas S. epidermidis showed sensitivity to cefixime (100%) and vancomycin (33.3%). For urine isolates, K. pneumoniae showed 100% sensitivity to ciprofloxacin and 50% to ceftriaxone and cefotaxime, while E. coli showed limited sensitivity, with 33.3% sensitivity to colistin. In addition, S. aureus showed sensitivity to amikacin (100%). Eye-discharge isolates demonstrated 100% sensitivity of K. pneumoniae to neomycin and levofloxacin, while S. aureus showed 100% sensitivity to colistin. Among umbilical isolates, Klebsiella spp. showed 66.7% sensitivity to imipenem, while S. aureus demonstrated sensitivity to imipenem (75%), tetracycline (100%), clindamycin (100%), and gentamicin (100%). Generally, numerous isolates showed complete resistance to commonly used antibiotics, including amoxicillin/clavulanate, ampicillin, and several cephalosporins. The findings indicate that Klebsiella pneumoniae and Staphylococcus aureus were the most common bacteria in the NICU during 2019–2020. The marked resistance to commonly used antibiotics highlights an important challenge to management, especially in the neonatal critical care unit in Tobruk. Furthermore, the bacteria that cause newborn infections and their antibiotic susceptibility patterns can change over time and between hospitals. Continuous monitoring of microbial epidemiology and susceptibility profiles is therefore required to guide empirical treatment.
Keywords. *Neonatal Intensive Care Unit; Infections; Microorganisms; Antibiotic Sensitivity/Resistance*

Received*: 10/07/26*
Accepted*: 11/09/26*
Published*: 20/09/26*

Introduction

Neonatal infections are a major cause of mortality, prolonged hospitalisation, and morbidity among newborns, especially premature infants and those with low birth weight; in addition, their underdeveloped immune systems make them highly susceptible to infections (1). Despite significant progress in perinatal and neonatal medicine, infectious diseases remain a major cause of newborn deaths in both low- and middle-income countries (2). Internationally, infections cause about 23% of the estimated 2.4 million annual neonatal deaths (3). Neonatal sepsis, one of the major public health problems, occurs at a rate of 1 to 5 cases per 1000 live births, with the greatest threat to preterm and very-low-birth-weight infants (4). The mortality rate is about 50% among newborns who do not receive treatment (5).

Numerous types of bacteria are able to cause bacteremia, with coagulase-negative staphylococci (CoNS), *Staphylococcus aureus*, and *Enterococcus* species being the most widely implicated (6). Gram-negative bacteria such as *Klebsiella*

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https://doi.org/10.47705/kjdmr.26320
eISSN:2708-888X

pneumoniae, *Escherichia coli*, *Pseudomonas aeruginosa*, *Acinetobacter* species, and *Haemophilus influenzae* are the predominant causative pathogens and are increasingly associated with multidrug-resistant phenotypes (7). Multidrug-resistant (MDR) bacteria responsible for neonatal sepsis are commonly associated with increased mortality rates. MDR-related sepsis represents a significant clinical challenge, mostly in developing countries, where limited treatment options lead to high fatality rates and poor outcomes (8).

Rapid identification of bacteria in the bloodstream is important for initiating optimal antibiotic therapy and effective clinical management, which reduces infant mortality, as bacteremia increases the mortality rate. Globally, suspected neonatal infections include septicemia, meningitis, osteomyelitis, arthritis, urinary tract infections, and pneumonia (9). The present study aimed to evaluate the microbiological patterns involved in neonatal infections and determine their antibiotic sensitivity and resistance patterns in a neonatal intensive care unit (NICU).

Methods

Study Design and Setting

This retrospective, cross-sectional study was conducted at Tobruk Medical Centre from January 2019 to December 2020. The study aimed to assess the bacteriological profile and antimicrobial susceptibility in neonatal samples.

Sample Size

The target group comprised all admitted neonates, and the total number of samples was 311.

Laboratory Methods

Various samples were collected, including blood, urine, CSF, umbilical cord, and other samples. Samples were collected for culture and sensitivity testing for every infant.

Blood Culture

The blood samples were collected under aseptic conditions and inoculated into BACTEC special bottles and incubated in the BACTEC system for 48–72 hours.

Cerebrospinal Fluid (CSF) and Other Specimens

CSF was collected by lumbar puncture, and other specimens were sent to the laboratory in culture tubes and transferred to specific plates. The isolated colonies were identified by their colonial morphology, odour, Gram staining, and specific biochemical tests.

Antimicrobial Susceptibility Testing

Antibiotic susceptibility of isolated bacteria was determined using the Kirby–Bauer disc diffusion method according to the standards of the Clinical and Laboratory Standards Institute (CLSI). The following antibiotics were tested: amoxicillin/clavulanate, ciprofloxacin, amikacin, gentamicin, ceftriaxone, cefotaxime, ceftazidime, vancomycin, cefixime, cefotetan, azithromycin, colistin, imipenem, penicillin, ampicillin, cefuroxime, oxacillin, tetracycline, erythromycin, levofloxacin, meropenem, norfloxacin, piperacillin, cefoxitin, ceftizoxime, cephalothin, doxycycline, and streptomycin.

Data Collection

Data on all isolates, their antibiotic susceptibility, and the gender of the neonates were extracted from the records of the microbiology laboratory.

Statistical analysis

Data entry was performed using Microsoft Excel 2013, and statistical analysis was conducted using SPSS version 16.

Results

A total of 311 culture samples were analysed during the study period: 205 (66%) from males and 106 (34%) from females, as shown in Figure 1. Of these, 256 (82.3%) cultures showed no growth and 55 (17.7%) showed growth, including 50 (16.1%) clinically relevant positive cultures and 5 (1.6%) contaminated cultures. A total of 128 specimens were from 2019 and 183 from 2020. In 2019, 96 (75.0%) cultures showed no growth, while 32 (25.0%) showed growth. Of the positive cultures, 27 (21.1%) were considered clinically relevant and 5 (3.9%) were recognised as contaminated. In 2020, 160 (87.4%) cultures showed no

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eISSN:2708-888X

growth, whereas 23 (12.6%) showed growth (Table 1). (Table 2) shows that urine specimens were the most frequently cultured (154), but only 6 (3.9%) were positive. This was followed by blood specimens, which accounted for 78 cultures, of which 28 (35.9%) were growth-positive, and 23 (29.5%) were clinically relevant. All 52 cerebrospinal fluid (CSF) cultures showed no growth. Eye-discharge cultures were positive in all five cultures (100%). Umbilical cord cultures accounted for 11 of 12 (91.7%) clinically relevant positives. (Table 3) represents the distribution of isolated bacteria according to their Gram staining and bacterial species. Gram-negative bacteria predominated, accounting for 29 isolates (69.0%), whereas Gram-positive bacteria accounted for 21 (31.0%).

Among the Gram-negative organisms, *Klebsiella pneumoniae* was the most common, with 17 (34.0%), followed by *Staphylococcus aureus*, the most frequently isolated Gram-positive bacterium, accounting for 16 (32.0%); *Escherichia coli*, 9 (18.0%); *Staphylococcus epidermidis*, 5 (10.0%); and *Enterobacteriaceae*, 3 (6.0%). Regarding the distribution of bacteria across clinical specimens (Table 3), *Klebsiella pneumoniae* was the most prevalent bacterium, with 17 (34.0%) of the 50 positive cultures; it was particularly common in blood samples, with 8 (34.8%). This was followed by *Staphylococcus aureus*, 16 (32.0%), which was particularly frequent among eye-discharge and umbilical specimens. *Escherichia coli*, 9 (18.0%), was isolated frequently from urine samples. *Staphylococcus epidermidis* accounted for 5 (10.0%), while *Enterobacteriaceae* accounted for 3 (6.0%). In 2019, *Staphylococcus aureus* and *Escherichia coli* were the most frequently recorded organisms, each accounting for 9 (33.3%) of clinically relevant isolates, followed by *Klebsiella pneumoniae*, with 7 (25.9%). In 2020, *Klebsiella pneumoniae* was the predominant isolate, accounting for 10 (43.5%), followed by *Staphylococcus aureus*, with 7 (30.4%). *Escherichia coli* was not recorded among the clinically relevant isolates in 2020. *Staphylococcus epidermidis* increased from 7.4% in 2019 to 13.0% in 2020, while *Enterobacteriaceae* was recorded only in 2020. Overall, *Klebsiella pneumoniae* was the most common microorganism across the two years (Table 4). The blood isolates demonstrated generally low susceptibility to many of the tested antibiotics.

Among *Klebsiella pneumoniae*, susceptibility was observed to meropenem (100%; 1/1), followed by imipenem (50%; 1/2) and ceftriaxone (25%; 1/4). Only 12.5% (1/8) of *Klebsiella* isolates were susceptible to ciprofloxacin. For *Staphylococcus aureus*, susceptibility was observed to vancomycin (25.0%) and meropenem (100.0% of the single isolate tested). *Escherichia coli* showed susceptibility to doxycycline (100%; 1/1), followed by imipenem (75%; 3/4) and amikacin (50%; 2/4). *Staphylococcus epidermidis* showed 100% susceptibility to cefixime in the single isolate tested, while *Enterobacteriaceae* showed 100% susceptibility to levofloxacin in the single isolate tested. Several commonly tested antibiotics showed no susceptible isolates, including amoxicillin/clavulanate across the organisms tested. Among urine isolates, *Klebsiella pneumoniae* demonstrated 100% susceptibility to ciprofloxacin, while susceptibility to ceftriaxone and cefotaxime was 50.0% each. *Staphylococcus aureus* showed 100% susceptibility to amikacin, whereas no susceptibility was recorded for the other tested antibiotics. *Escherichia coli* showed limited susceptibility, with 33.3% susceptibility to colistin and no susceptibility to amikacin, ciprofloxacin, amoxicillin/clavulanate, cefotetan, or ceftazidime. These findings indicate substantial variation in antibiotic susceptibility among the organisms isolated from urine specimens.

The eye-discharge isolates demonstrated limited susceptibility to most tested antibiotics. *Klebsiella pneumoniae* showed 100% susceptibility to neomycin and levofloxacin, although each result was based on a single tested isolate. *Staphylococcus aureus* showed 100% susceptibility to colistin, also based on a single isolate. No susceptibility was recorded for several other antibiotics, including amoxicillin/clavulanate, cefotetan, and ceftazidime. The umbilical isolates demonstrated variable susceptibility patterns. *Klebsiella pneumoniae* showed the highest susceptibility to imipenem (66.7%). *Staphylococcus aureus* showed susceptibility to imipenem (75.0%), tetracycline (100%), clindamycin (100%), and gentamicin (100%), although some of these percentages were based on small numbers of isolates. *Escherichia coli* showed 50.0% susceptibility to amikacin and 100% susceptibility to levofloxacin in the tested isolates. Most other antibiotics showed no susceptible isolates.

Table 1. Culture outcomes by year

Year	Total cultures	No growth / N.F.	Growth-positive	Marked contamination	Clinically relevant positive
2019	128	96 (75.0%)	32 (25.0%)	5 (3.9%)	27 (21.1%)
2020	183	160 (87.4%)	23 (12.6%)	0 (0.0%)	23 (12.6%)
Total	311	256 (82.3%)	55 (17.7%)	5 (1.6%)	50 (16.1%)

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https://doi.org/10.47705/kjdmr.26320
eISSN:2708-888X

Table 2. Culture results according to specimen source

Specimen source	Total cultures	No growth / N.F.	Growth-positive	Marked contamination	Clinically relevant positive
Blood	78	50 (64.1%)	28 (35.9%)	5 (6.4%)	23 (29.5%)
Urine	154	148 (96.1%)	6 (3.9%)	0 (0.0%)	6 (3.9%)
CSF	52	52 (100.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Eye discharge	5	0 (0.0%)	5 (100.0%)	0 (0.0%)	5 (100.0%)
Umbilical	12	1 (8.3%)	11 (91.7%)	0 (0.0%)	11 (91.7%)
Other	10	5 (50.0%)	5 (50.0%)	0 (0.0%)	5 (50.0%)

Table 3. Clinically relevant isolated microorganisms according to specimen source

Microorganism	Blood	Urine	CSF	Eye discharge	Umbilical	Other	Total
Klebsiella pneumoniae	8 (34.8%)	2 (33.3%)	0	2 (40.0%)	3 (27.3%)	2 (40.0%)	17 (34.0%)
Staphylococcus aureus	6 (26.1%)	1 (16.7%)	0	3 (60.0%)	5 (45.5%)	1 (20.0%)	16 (32.0%)
Escherichia coli	4 (17.4%)	3 (50.0%)	0	0 (0.0%)	2 (18.2%)	0 (0.0%)	9 (18.0%)
Staphylococcus epidermidis	4 (17.4%)	0 (0.0%)	0	0 (0.0%)	1 (9.1%)	0 (0.0%)	5 (10.0%)
Enterobacteriaceae	1 (4.3%)	0 (0.0%)	0	0 (0.0%)	0 (0.0%)	2 (40.0%)	3 (6.0%)
Total	23	6	0	5	11	5	50

Table 4. Clinically relevant microorganisms by year

Microorganism	2019, n (%)	2020, n (%)	Total, n (%)
Klebsiella pneumoniae	7 (25.9%)	10 (43.5%)	17 (34.0%)
Staphylococcus aureus	9 (33.3%)	7 (30.4%)	16 (32.0%)
Escherichia coli	9 (33.3%)	0 (0.0%)	9 (18.0%)
Staphylococcus epidermidis	2 (7.4%)	3 (13.0%)	5 (10.0%)
Enterobacteriaceae	0 (0.0%)	3 (13.0%)	3 (6.0%)

Table 5. Antibiotic sensitivity pattern of clinically relevant blood isolates

Antibiotic	Klebsiella pneumoniae	S. aureus	E. coli	S. epidermidis	Enterobacteriaceae
Amoxicillin/clavulanate	0/8 (0.0%)	0/6 (0.0%)	0/4 (0.0%)	0/3 (0.0%)	0/1 (0.0%)
Ciprofloxacin	1/8 (12.5%)	0/6 (0.0%)	0/4 (0.0%)	0/3 (0.0%)	0/1 (0.0%)
Amikacin	0/8 (0.0%)	0/4 (0.0%)	2/4 (50.0%)	0/3 (0.0%)	0/1 (0.0%)
Gentamicin	0/5 (0.0%)	0/3 (0.0%)	—	0/3 (0.0%)	0/1 (0.0%)
Ceftriaxone	1/4 (25.0%)	0/3 (0.0%)	0/2 (0.0%)	0/1 (0.0%)	—
Cefotaxime	0/4 (0.0%)	0/3 (0.0%)	—	0/2 (0.0%)	—
Ceftazidime	0/5 (0.0%)	0/2 (0.0%)	0/1 (0.0%)	0/1 (0.0%)	—
Vancomycin	0/1 (0.0%)	1/4 (25.0%)	—	1/3 (33.3%)	—
Cefixime	0/5 (0.0%)	—	—	1/1 (100.0%)	0/1 (0.0%)
Cefotetan	0/3 (0.0%)	—	0/4 (0.0%)	—	—
Azithromycin	—	0/3 (0.0%)	—	0/3 (0.0%)	—
Colistin	0/3 (0.0%)	—	0/3 (0.0%)	—	—
Imipenem	1/2 (50.0%)	—	3/4 (75.0%)	—	—

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https://doi.org/10.47705/kjdmr.26320
eISSN:2708-888X

Penicillin	—	0/5 (0.0%)	—	0/1 (0.0%)	—
Ampicillin	0/2 (0.0%)	—	0/2 (0.0%)	—	0/1 (0.0%)
Cefuroxime	0/2 (0.0%)	0/1 (0.0%)	0/2 (0.0%)	—	—
Oxacillin	—	0/2 (0.0%)	—	0/3 (0.0%)	—
Tetracycline	0/4 (0.0%)	—	—	—	—
Erythromycin	—	—	0/1 (0.0%)	0/1 (0.0%)	0/1 (0.0%)
Levofloxacin	—	—	—	0/1 (0.0%)	1/1 (100.0%)
Meropenem	1/1 (100.0%)	1/1 (100.0%)	—	—	—
Norfloxacin	—	—	—	0/1 (0.0%)	0/1 (0.0%)
Piperacillin	0/1 (0.0%)	—	—	—	0/1 (0.0%)
Cefoxitin	—	—	0/1 (0.0%)	—	—
Ceftizoxime	—	—	—	—	0/1 (0.0%)
Cephalothin	0/1 (0.0%)	—	—	—	—
Doxycycline	—	—	1/1 (100.0%)	—	—
Streptomycin	—	—	—	—	0/1 (0.0%)

Table 6. Antibiotic sensitivity pattern of clinically relevant urine isolates

Antibiotic	**Klebsiella spp.**	**S. aureus**	**E. coli**
Amikacin	0/2 (0.0%)	1/1 (100.0%)	0/3 (0.0%)
Ceftriaxone	1/2 (50.0%)	0/1 (0.0%)	0/3 (0.0%)
Ciprofloxacin	2/2 (100.0%)	0/1 (0.0%)	0/3 (0.0%)
Amoxicillin/clavulanate	0/1 (0.0%)	0/1 (0.0%)	0/3 (0.0%)
Cefotetan	—	0/1 (0.0%)	0/3 (0.0%)
Ceftazidime	0/1 (0.0%)	0/1 (0.0%)	0/1 (0.0%)
Co-trimoxazole	0/1 (0.0%)	—	0/2 (0.0%)
Colistin	—	—	1/3 (33.3%)
Cefotaxime	1/2 (50.0%)	—	—
Levofloxacin	0/1 (0.0%)	0/1 (0.0%)	—
Azithromycin	0/1 (0.0%)	—	—
Gentamicin	0/1 (0.0%)	—	—
Meropenem	—	0/1 (0.0%)	—
Vancomycin	—	0/1 (0.0%)	—

Table 7. Antibiotic sensitivity pattern of clinically relevant eye-discharge isolates

Antibiotic	**Klebsiella pneumoniae**	**Staphylococcus aureus**
Amoxicillin/clavulanate	0/2 (0.0%)	0/2 (0.0%)
Cefotetan	0/1 (0.0%)	0/3 (0.0%)
Ceftazidime	0/2 (0.0%)	0/1 (0.0%)
Amikacin	—	0/2 (0.0%)
Ampicillin	—	0/2 (0.0%)
Ciprofloxacin	—	0/2 (0.0%)
Erythromycin	—	0/2 (0.0%)
Fusidic acid	—	0/2 (0.0%)
Neomycin	1/1 (100.0%)	0/1 (0.0%)
Tetracycline	0/1 (0.0%)	0/1 (0.0%)
Tobramycin	0/2 (0.0%)	—
Colistin	—	1/1 (100.0%)
Gentamicin	0/1 (0.0%)	—

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https://doi.org/10.47705/kjdmr.26320
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Imipenem	—	0/1 (0.0%)
Levofloxacin	1/1 (100.0%)	—

Table 8. Antibiotic sensitivity pattern of clinically relevant umbilical isolates

Antibiotic	Klebsiella spp.	S. aureus	E. coli	S. epidermidis
Amoxicillin/clavulanate	0/3 (0.0%)	0/5 (0.0%)	0/2 (0.0%)	0/1 (0.0%)
Amikacin	0/3 (0.0%)	1/4 (25.0%)	1/2 (50.0%)	0/1 (0.0%)
Ciprofloxacin	0/2 (0.0%)	0/5 (0.0%)	0/2 (0.0%)	0/1 (0.0%)
Imipenem	2/3 (66.7%)	3/4 (75.0%)	0/1 (0.0%)	0/1 (0.0%)
Cefotetan	0/2 (0.0%)	0/3 (0.0%)	0/1 (0.0%)	0/1 (0.0%)
Erythromycin	0/1 (0.0%)	0/4 (0.0%)	—	0/1 (0.0%)
Ceftriaxone	0/1 (0.0%)	0/2 (0.0%)	0/1 (0.0%)	0/1 (0.0%)
Tetracycline	0/2 (0.0%)	3/3 (100.0%)	—	—
Cefoxitin	0/2 (0.0%)	0/1 (0.0%)	0/1 (0.0%)	—
Ampicillin	0/1 (0.0%)	0/1 (0.0%)	0/1 (0.0%)	—
Ceftazidime	—	0/1 (0.0%)	0/1 (0.0%)	0/1 (0.0%)
Vancomycin	—	1/2 (50.0%)	—	0/1 (0.0%)
Cefotaxime	0/1 (0.0%)	0/1 (0.0%)	—	—
Cefuroxime	0/2 (0.0%)	—	—	—
Clindamycin	—	2/2 (100.0%)	—	—
Doxycycline	0/1 (0.0%)	—	0/1 (0.0%)	—
Gentamicin	0/1 (0.0%)	1/1 (100.0%)	—	—
Cephalothin	—	0/1 (0.0%)	—	—
Cinoxacin	0/1 (0.0%)	—	—	—
Levofloxacin	—	—	1/1 (100.0%)	—
Meropenem	—	—	0/1 (0.0%)	—
Tobramycin	0/1 (0.0%)	—	—	—

Discussion

Neonatal infections, especially neonatal sepsis and bacteremia, represent life-threatening situations that require prompt empirical antibiotic regimens. Neonatal sepsis is also a significant cause of prolonged hospitalisation and increased risk of neonatal mortality (10). In addition, underdeveloped immune systems make newborns highly susceptible to infections. Therefore, it is necessary to select an antibiotic combination that treats the most common causative bacterial pathogens (11). Antimicrobial resistance is an important problem in hospitals in developing countries. The present study aimed to identify the most common bacteria implicated in neonatal infections and their antibiotic susceptibility patterns, which can assist in selecting effective treatment. The results demonstrate that male newborns predominated (66%) compared with female newborns (34%). The most commonly positive cultures in our study were blood cultures (35.9% growth-positive, of which 29.5% were clinically relevant). The most common pathogen was *K. pneumoniae*, the most frequently isolated bacterium in this study, which belongs to the Gram-negative bacteria, followed by *Staphylococcus aureus*, the most frequently isolated Gram-positive bacterium. This finding is consistent with previous studies of neonatal infections, which have identified *Klebsiella* spp. and *S. aureus* as significant causes of neonatal sepsis and other neonatal infections (12). However, it contrasts with other studies that have reported *S. aureus* as the most frequently isolated pathogen in their NICUs (13). The prevalence of these bacteria may reflect their capability to inhabit and persist in healthcare environments, as well as their potential for spread among susceptible neonates. The most common bacterium isolated from blood samples was *K. pneumoniae* (34.8%), which aligns with a previous study by Ervina et al. (2025), which found *K. pneumoniae* to be the most frequent microorganism in blood (14). The most common pathogens in urine were *Escherichia coli* (50.0%) and *Klebsiella* (33.3%), as illustrated in numerous studies (15). *Staphylococcus aureus* was the most frequent microorganism in both eye-discharge and umbilical samples (60.0% and 45.5%, respectively). Recent evidence demonstrates that *S. aureus* was the most common bacterium in umbilical cord infections (46.0%) (16). Gad et al. found that *S. aureus* was the most common bacterium in eye swabs (17). The antimicrobial susceptibility results in the current study show noticeable resistance to numerous commonly used antibiotics. In particular, several isolates

https://doi.org/10.47705/kjdmr.26320
eISSN:2708-888X

revealed no or very low susceptibility to amoxicillin/clavulanate, ampicillin, ceftriaxone, ceftazidime, cefotaxime, and other commonly tested agents, with ciprofloxacin also showing limited activity against most blood isolates. This pattern is concerning because these antibiotics are frequently used as empirical therapy for neonatal infections. Similar high levels of resistance have been shown in neonatal sepsis studies from Ethiopia and Vietnam. The University of Gondar study reported high resistance amongst *Klebsiella*, *S. aureus*, and *E. coli* to frequently used antibiotics, whereas amikacin, ciprofloxacin, norfloxacin, and erythromycin demonstrated relatively better activity (18). The comparatively better sensitivity to carbapenems and selected aminoglycosides detected for some isolates in the present study is also notable. For example, *Klebsiella* showed 66.7% susceptibility to imipenem among umbilical isolates, whereas *S. aureus* showed 75% susceptibility to imipenem in blood. Blood isolates of *E. coli* demonstrated 75% susceptibility to imipenem and 50% to amikacin. Similar results have been described in recent Ethiopian data, where Gram-negative organisms displayed their highest susceptibility to amikacin and carbapenems (19). Nevertheless, the use of these antibiotics should be guided by culture and susceptibility results, as increasing carbapenem resistance has also been reported. This indicates the extent of broad-spectrum resistance. To combat antibiotic resistance, health systems must enforce stricter stewardship of empirical broad-spectrum use, rapid diagnostic testing for targeted treatment, and aggressive research into novel antimicrobials to protect high-risk groups in NICUs (20).

Conclusion

The findings indicate that *Klebsiella pneumoniae* and *Staphylococcus aureus* were the most common bacteria in the NICU during 2019–2020. The marked antibiotic resistance to commonly used antibiotics highlights an important challenge to management, especially in the neonatal critical care unit in Tobruk city. Furthermore, bacteria that cause newborn infections and their antibiotic susceptibility patterns can change over time and between hospitals. Continuous monitoring of microbial epidemiology and susceptibility profiles is therefore required to select empirical treatment. In addition, awareness should be increased among mothers, especially pregnant women, regarding the use of antibiotics and the risks of neonatal infections and other pregnancy-related problems.

Acknowledgements

The authors thank the head of Tobruk Medical Centre and the staff of the microbiology laboratory for their support.

Conflict of Interest

The authors declare that they have no conflict of interest.

Data Availability

The raw data will remain confidential; any further inquiries may be directed to the corresponding author, Asmai S. H. Mohammed.

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