Original Article

Bacterial Isolates of Surfaces in the Neonatal Intensive Care Unit of Enugu State University Teaching Hospital, Parklane, Enugu, and Their Antibiotic Susceptibility Patterns

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Abstract

Introduction: The duration of admission in the hospital, mortality rates, and care costs is increased in Neonatal Intensive Care Unit (NICUs) by nosocomial infections (NIs). There is a need for routine and regular environmental sampling in NICUs. **Methodology:** This was a cross-sectional study conducted in the NICU of Enugu State University Teaching Hospital. The researchers collected samples for culture from equipment and hospital surfaces in the unit. Susceptibility testing was done for isolates by the agar diffusion method using standard nutrient agar 1 discs. **Results:** We observed bacterial growth in 58 (54.7%) samples from the 106 samples collected. *Staphylococcus aureus 35* (55.6%) was the most common isolate cultured, followed by *Escherichia coli 14* (22.2%) and then coagulase-negative *Staphylococcus13 (20.6%)*. Among *S. aureus* isolates, 48.6% were methicillin-resistant *S. aureus*. Among the Gram-negative isolates, resistance was highest for ampicillin followed by meropenem. **Conclusion:** The most common isolates were *S. aureus*, coagulase-negative *Staphylococcus*, and *E. coli*. Health-care providers need improved hygiene standards to reduce the burden of NI.

Keywords: Bacterial contamination, Neonatal Intensive Care Unit, Nigeria, susceptibility patterns

Introduction

Parvez and Jarvis[1] over 20 years ago defined nosocomial infections (NIs), or hospital-acquired infections (HAIs), as infections that are not present at the time of admission. Since then, other authors[2-6] have used more precise criteria to define nosocomial diseases as those acquired in medical facilities two days or more after hospital admission or within 30 days after discharge. These infections are still a challenge worldwide, but the incidence is even higher in Africa.[7] This higher incidence in Africa is reflected in the report that seven and ten of every hundred patients admitted in developed and low-middle-income countries (LMIC) will develop one of the HAIs.[8]

Neonatal mortality rates (NMR) remain unacceptably high in many LMICs with figures ranging between 40 and 50/1000 live births with infections being the main contributor to NMR.[9-13] As a result of their poorly developed immune systems, preterm neonates, especially those in Neonatal Intensive Care Unit (NICUs), are at greater risk of acquiring NI.[14] The rapid development of intensive care skills and facilities has also enhanced the survival rate of high-risk neonates, particularly those born with congenital anomalies or extreme prematurity.[15] This increasing population of fragile patients often requires several therapeutic interventions associated with NIs.[16-18] Thus, these neonates are often exposed to multiple antibiotics with the attendant consequences of poor antibiotic stewardship.[15,19,20]

Coagulase-negative Staphylococci, *Staphylococcus aureus*, Enterococci, *Enterobacter* species, and *Escherichia coli* are the most common nosocomial organisms implicated in

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neonates.[1,21] The presence of biofilms and adhesion molecules on these bacterial organisms enables them to live for long periods on hospital surfaces and equipment.[1,22-26]

The bacteriological profiles from environmental surveillance reports in different NICUs differ significantly but correlate significantly within the same units.[27,28] There is thus a need for periodic surveillance in NICUs to ensure rational antibiotic usage.[5]

This study is aimed to determine the bacterial organisms' profile on surfaces in the NICU of the Enugu State University Teaching Hospital (ESUTH), Parklane, Enugu, and their antibiotic susceptibility patterns as a guide for appropriate treatment and prevention of infection.

Methodology

This cross-sectional study was conducted in the NICU of ESUTH, Parklane, Enugu, Nigeria, in July 2020. It receives referrals from general hospitals, primary health centers, and private and mission hospitals within and around the state. The NICU offers 24-h services for both inborn and outborn babies. The researchers, before the commencement of the study, gave the unit prior notice. Ethical approval for the study was sought and obtained from the Research and Ethics Committee of the ESUTH, Enugu.

A total of 106 surfaces were swabbed, consisting of 12 walls/floors (six-floor surfaces and six wall surfaces), 49 portable medical appliances (two resuscitaires, eight incubators, three phototherapy machines, four oxygen humidifiers, four oxygen flowmeter knobs, 16-bed rails, eight drip stands, three Ambu bags, and one weighing scale), six doorknobs, 19 electrical appliances (eight plugins, four fan switches, four light switches, and three refrigerators), 11 furniture surfaces (seven tables and four chair arm-rests), seven protective wears (4 footwears and three aprons), and two handwashing sinks.

The researchers collected the samples between 7:30 am and 8:00 am of the same day before daytime cleaning of the equipment was carried out. This was done by swabbing the surfaces of the predetermined areas with sterile cotton swabs dipped in normal saline (0.9% w/v). These samples were transported in sealed bags within 30 min to the laboratory and inoculated into CLED, Salmonella Shigella Agar, and blood agar and incubated at 37°C for 24–48 h. Susceptibility testing was determined for isolates by the agar diffusion method using standard nutrient agar 1. SPSS version 20.0 (Chicago, IL, USA) was used for the analysis of data. The results were presented in prose, tables, and charts.

Results

There was the growth of bacteria in 58 (54.7%) samples out of the 106 samples collected. All of the surfaces swabbed had at least one bacterial isolate. The least proportion of isolates, 19 (21%) was obtained from electrical appliances.

Sixty-three bacterial organisms were identified from the 58 samples. Of these, 48 (76.2%) were Gram-positive, while 15 (23.8%) were Gram-negative bacteria. These consisted of four different bacterial species, namely, *S. aureus*, coagulase-negative staphylococcus, *E. coli*, and *Pseudomonas aeruginosa*. Polymicrobial growth of *S. aureus* and *E. coli* was observed in five samples.

Table 1 shows the distribution of bacterial isolates on the swabbed surfaces, while Figure 1 shows the percentages of the bacterial species isolated. The most common bacterial organism identified on 35 surfaces was *S. aureus*, followed by *E. coli*, from 14 areas. The majority of *S. aureus*, 28.6% (10/35), was isolated from portable medical appliances, followed by the furniture, walls/floors, and protective wears 20.0% (7/35) each, doorknobs 8.6% (3/35), and electrical appliances 2.9% (1/35).

Out of the 35 *S. aureus* isolates, 17 (48.6%) were methicillin-resistant *S. aureus* (MRSA), while 18 (51.4%) were

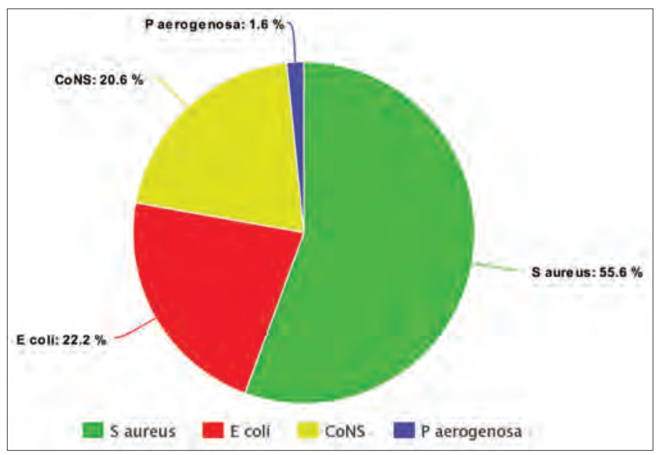

Figure 1: Percentage distribution of bacterial isolate species

Table 1: Distribution of swabbed surfaces and their bacterial isolate

Swabbed surfaces	*n*	*S. aureus* (*n*=35), *n* (%)	*CoNS* (*n*=13), *n* (%)	*E. coli* (*n*=14), *n* (%)	*P. aeruginosa* (*n*=1), *n* (%)
Wall/floor surface	12	7 (20.0)	2 (15.4)	2 (14.3)	-
Door knobs	6	3 (8.6)	1 (7.7)	-	-
Portable medical appliances	49	10 (28.6)	8 (61.5)	7 (50.0)	-
Electrical appliances	19	2 (5.7)	1 (7.7)	1 (7.1)	-
Furniture	11	7 (20.0)	-	4 (28.6)	-
Protective wears**	7	6 (17.1)	1 (7.7)	-	-
Handwashing sink	2	-		-	1 (100.0)

**Seven protective wears (4 footwears and three aprons). CoNS: Coagulase-negative staphylococci, *S. aureus: Staphylococcus aureus, E. coli: Escherichia coli, P. aeruginosa: Pseudomonas aeruginosa*

Table 2: Antibiotic resistance pattern of *Staphylococcus aureus* (methicillin-resistant *Staphylococcus aureus* and methicillin-sensitive *Staphylococcus aureus*) isolates

Antibiotics	Frequency (%)		
	S. aureus isolates (*n*=35)	MRSA isolates (*n*=17)	MSSA isolates (*n*=18)
Augmentin	13 (37.1)	6 (35.3)	7 (38.9)
Ofloxacin	2 (5.7)	1 (5.9)	1 (5.6)
Cloxacillin	22 (62.9)	14 (82.4)	8 (44.4)
Erythromycin	17 (48.6)	10 (58.8)	7 (38.9)
Ceftriaxone	13 (37.1)	6 (35.3)	7 (38.9)
Gentamicin	5 (14.3)	2 (11.8)	3 (16.7)
Cefuroxime	9 (25.7)	4 (23.5)	5 (27.8)
Ceftazidime	18 (51.4)	13 (76.5)	5 (27.8)
Meropenem	30 (85.7)	14 (82.4)	16 (88.9)
Cefixime+clavulanate	12 (34.3)	6 (35.3)	6 (33.3)
Imipenem	-	-	-

S. aureus: Staphylococcus aureus, MRSA: Methicillin-resistant *S. aureus*, MSSA: Methicillin-sensitive *S. aureus*

Table 3: Antibiotic resistance pattern of Gram-negative isolates

Antibiotics	*E. coli* (*n*=14), *n* (%)	*P. aeruginosa* (*n*=1), *n* (%)
Ampicillin	12 (85.7)	1 (100.0)
Ciprofloxacin	7 (50.0)	-
Nitrofurantoin	5 (35.7)	1 (100.0)
Augmentin	5 (35.7)	1 (100.0)
Ofloxacin	4 (28.6)	-
Gentamicin	4 (28.6)	-
Cefuroxime	7 (50.0)	-
Ceftazidime	7 (50.0)	-
Ofloxacin+ornidazole	-	-
Meropenem	11 (78.6)	1 (100.0)
Cefixime+clavulanate	8 (57.1)	1 (100.0)

E. coli: Escherichia coli, P. aeruginosa: Pseudomonas aeruginosa

methicillin-sensitive *S. aureus* (MSSA). No resistance was noticed for imipenem. However, 30 (85.7%) of the S. aureus were resistant to meropenem. Table 2 shows the antibacterial sensitivity of the *S. aureus* isolates.

Among the Gram-negative isolates, the highest resistance was observed for ampicillin followed by meropenem. Table 3 shows the resistance pattern of the Gram-negative isolates.

Discussion

The duration of admission in the hospital, mortality rates, and care costs are all increased in NICUs by NIs.[29,30] The presence on hospital surfaces of nosocomial pathogens related to these infections has been demonstrated by several studies.[23,31-33] Furthermore, the contamination of hospital surfaces has been shown to transmit most of these infections.[22,25]

It has also been suggested that specific issues such as high unit occupancy density, traffic by medical personnel, and frequent visits by parents and visitors may be responsible for the high contamination rates recorded in NICUs.[25,34-36] However, microbiologically satisfactory results can be obtained by improved cleaning and disinfection practices.[37]

The bacterial growth observed in this study demonstrates the considerable contamination of different areas of the unit. Other authors from developing countries have reported similar findings.[38-43] However, these rates and the resultant healthcare-associated infections are much lower in developed countries.[27,43] The bacterial colonies isolated from different areas of our NICUs included four bacterial species with predominant Gram-positive cocci isolates. Kumar *et al*.[27] also reported a similar pattern. Among the bacterial species isolated, *S. aureus* constituted the majority, a finding also obtained by other authors in both developed and developing countries.[15,27] The increased occurrence of *S. aureus* may be due to its widespread presence as part of the normal flora of body surfaces that have frequent contact with contaminated areas in the hospital.[5] However, predominance patterns may vary for different centers,[37,41,44] and this may be due to differences in quality of cleaning, which is a commonly overlooked variable.[45]

The majority of the *S. aureus* isolates was resistant to meropenem; however, there was no resistance to imipenem. Shivesh in India also reported a similar finding.[46] Meropenem is less active against Gram-positive bacteria and more active against Gram-negative bacteria when compared with imipenem but offers other potential advantages such as the option of bolus administration and the absence of seizures.[47,48] These advantages of meropenem, in addition to its greater availability in the market, contribute to its more frequent use over imipenem and hence the higher incidence of resistance to meropenem.[46]

MRSA accounted for almost half of the *S. aureus* isolates identified in this study, and other authors reported similar results.[49-51] Because they are more aggressive and challenging to diagnose and treat, these hospital-acquired MRSA infections lead to higher mortality rates, more extended hospital stays, and increased financial burdens.[52-56] The possibility of developing a disease caused by MRSA thus justifies the need for improved cleaning protocols for newborn units.[5,56]

Although there are no standard cleaning protocols for most hospitals in Nigeria, it has been recommended that cleaning staff should be adequately trained and knowledgeable in hygiene matters appropriate to their work environment.[5]

Conclusion

The most common isolates identified in this study were *S. aureus* and *E. coli*. There was high *S. aureus* resistance to meropenem; however, there was no resistance to imipenem. There was high ampicillin resistance by Gram-negatives, but all the Gram-negative isolates were susceptible to ofloxacin + ornidazole. There is a need for standardized cleaning regimens and routine environmental sampling in NICUs to control hospital surface contamination to decrease the harmful effects of NI and ensure rational antibiotic usage.[5]

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Conflicts of interest

There are no conflicts of interest.

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