Bed Linen: A Reservoir Of Antibiotic-Resistant Bacterial Pathogens

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Abstract

The study was aimed at evaluating the prevalence and antibiotic sensitivity of *Staphylococcus aureus* and *Escherichia coli* in bed linens of undergraduate students living in a university hostel. A total of twenty-three (23) bed linens from randomly selected female students living in a university hostel were sampled by swabbing with sterile swab sticks moistened with sterile normal saline. Bacterial strains were isolated and characterized from the samples using standard microbiological and biochemical methods. The antibiotic susceptibility profile of the isolates was determined using the Kirby-Bauer disk diffusion method. A total of nine (9) bacterial isolates were obtained from the samples, including *S. aureus* (7) and *E. coli* (2). Antibiotic susceptibility testing revealed that the majority of the isolates were resistant to cefuroxime, nitrofurantoin, ceftazidime, cefixime, erythromycin, and augmentin. All *E. coli* and *S. aureus* strains showed 100% resistance to cefuroxime, ceftazidime and nitrofurantoin. However, both bacterial species were only most susceptible to gentamicin and ofloxacin, with *E. coli* demonstrating the least resistance (0%) to the two antibiotics. The antibiotic resistance of these isolates necessitates immediate attention.

Keywords: *Staphylococcus aureus*, *Escherichia coli*, antibiotic resistance, bed linen

Introduction

Clothing materials have been shown to act as microorganism reservoirs, as these organisms can survive on such surfaces for periods ranging from a few seconds to several hours or days (Olowomofe *et al.*, 2020; Gopal and Solabannavar, 2020). It has been reported that fabrics such as bed linen serve as a potential reservoir for both pathogenic and non-pathogenic microorganisms. When bed linens are heavily contaminated with potentially infectious agents, they can contain bacterial loads of 10^6 -10^8 Colony Forming Unit (CFU)/100 cm^2 (Koca *et al.*, 2012).

Students at academic institutions with inadequate and suboptimal sanitary practices are vulnerable to microbial infections and poor hygiene (Igudia *et al.*, 2019). Asymptomatic colonization by multidrug-resistant (MDR) organisms has been

identified as the first step prior to subsequent infection (Jans *et al.*, 2013). According to one study, undergraduate university students were found to harbour potentially harmful multidrug-resistant microorganisms (Chukwunwejim et al., 2018). Another study discovered the predominance of bacterial species as compared to fungal isolates in bed linens from students who live in university hostels (Olowomofe *et al.*, 2020).

The purpose of this study was to evaluate the prevalence and antibiotic sensitivity of *Staphylococcus aureus* and *Escherichia coli* in bed linens of undergraduate students living in a university hostel at Nnamdi Azikiwe University in Nigeria.

Materials and Methods

Collection of samples, isolation and identification of microorganisms

A total of twenty-three (23) bed linens from randomly selected female students living in the university hostel at Nnamdi Azikiwe University, Agulu campus, Anambra State, Nigeria was sampled. The samples were collected by swabbing the bed linens with sterile swab sticks moistened with sterile normal saline. The samples were inoculated aseptically into a sterile nutrient broth and incubated at 37º for 24 h. Mannitol salt agar (MSA) and MacConkey agar were used for the isolation of *S. aureus* and *E. coli* respectively. The isolates were identified using their microscopic and macroscopic characteristics, Gram stain reaction, and confirmatory biochemical test results.

Antibiotic Susceptibility studies

The modified Kirby-Bauer susceptibility testing method (CLSI, 2016) was used to evaluate the resistance/susceptibility of the test organisms to beta-lactam, macrolide, fluoroquinolone and aminoglycoside antibiotics. Antibiotic discs containing different antibiotics (ceftazidime 30 µg, cefuroxime 30 µg, gentamicin 10 µg, cefixime 5 µg, ofloxacin 5 µg, erythromycin 15 µg, augmentin 30 µg, and nitrofurantoin 300 µg) were carefully placed on the surface of Mueller Hinton agar and was incubated for 24 h at 37°c. After incubation, observable inhibition zone diameters (mm) were measured. The experiment was conducted in triplicates plates, and the mean inhibition zone diameters (IZDs) were calculated and recorded.

Results

From the bed linens of 23 undergraduate students, 9 bacterial isolates were obtained, including strains of *S. aureus* (7) and *E. coli* (2). Antibiotic susceptibility testing revealed that a significant number of the isolates were resistant to cefuroxime, ceftazidime, cefixime, nitofurantoin, erythromycin, and augmentin (Table 1). The *E. coli* and *S. aureus* strains showed 100% resistance to cefuroxime, ceftazidime and nitrofurantoin. Both bacterial species were more susceptible to gentamicin and ofloxacin, with *E. coli* exhibiting the least resistance (0%) to the two antibiotics (Table 2).

Table 1: Inhibition zone diameter (IZD) of the isolates to different antibiotics

Isolates	GEN	CXC	CAZ	CTR	NIT	ERY	AUG	OFL
E. coli (strain E6)	22 (S)	0 (R)	0 (R)	23(S)	0 (R)	0 (R)	15(I)	25(S)
E. coli (strain E16)	24(S)	0 (R)	0 (R)	0 (R)	0 (R)	19(I)	9 (R)	26(S)
S. aureus (strain S1)	13 (I)	0 (R)	0 (R)	14(I)	0 (R)	0 (R)	16 (I)	0 (R)
S. aureus (strain S8)	0 (R)	0 (R)	0 (R)	0 (R)	0 (R)	0 (R)	2 (R)	0 (R)
S. aureus (strain S11)	26(S)	0 (R)	0 (R)	0 (R)	0 (R)	0 (R)	0 (R)	16(I)
S. aureus (strain S13)	23(S)	0 (R)	0 (R)	14 (I)	0 (R)	0 (R)	11 (R)	25(S)
S. aureus (strain S14)	24(S)	0 (R)	0 (R)	0 (R)	0 (R)	0 (R)	11(R)	25(S)
S. aureus (strain S15)	13(I)	0 (R)	12 (R)	16 (I)	0 (R)	23(S)	0 (R)	16(I)
S. aureus (strain S16)	18(I)	0 (R)	0 (R)	26(S)	0 (R)	0 (R)	9 (R)	24(S)

GEN: Gentamicin, CXC: Cefuroxime, CAZ: Ceftazidime, ERY: Erythromycin, AUG: Augmentin, OFL: Ofloxacin, CTR: Cefixime, NIT: Nitrofurantoin. Determination of resistance or susceptibility: Resistant (IZD ≤ 12), Indifferent (IZD =12-19), Susceptible (IZD ≥ 20)

Table 2: Percentage resistance of the Isolates to the antibiotics

Isolates	Antibiotics							
	GEN	CXC	CAZ	CTR	NIT	ERY	AUG	OFL
E. coli	0%	100%	100%	50%	100%	50%	50%	0%
S. aureus	14.3%	100%	100%	42.9%	100%	85.7%	85.7%	28.6%

GEN: Gentamicin, CXC: Cefuroxime, CAZ: Ceftazidime, ERY: Erythromycin, AUG: Augmentin, OFL: Ofloxacin, CXR: Cefixime, NIT: Nitrofurantoin.

Discussion

S. aureus and *E. coli* strains were isolated from university students' bed linens in this study, and all were found to be MDR organisms. Multidrug resistance is defined as resistance to at least two of three classes of antibiotics tested (Odonkor and Addo, 2018). The MDR characteristics of the isolates in this study were identified by observing the resistance patterns of the isolates to the tested antibiotics.

In general, *S. aureus* has been shown to be a common cause of superficial infections in the human population, including skin infections, skin structure infections, and osteoarticular infection. *S. aureus* has also been linked to septicaemia, infective endocarditis, pneumonia, ocular infections, and Central nervous system infections (Ghalehnoo, 2018). *E. coli*, on the other hand, is made up of many strains that are normally found in the human large intestine and can be harmless. However, some strains can acquire bacteriophage or plasmid DNA-encoding enterotoxins or invasion factors and become pathogenic. These virulent strains cause diarrheal infections all over the world, including traveler's diarrhea, neonatal meningitis, septicemia, cholecystitis, cholangitis, pneumonia, and urinary tract infections (Makvana and Krilov, 2015).

Infections due to MDR bacteria are a major health concern globally. These organisms

could be linked to infections with a high morbidity and mortality rate, as well as a longer hospital stay and higher costs (Chukwunwejim *et al.*, 2018; Jans *et al*., 2013).

The emergence of drug-resistant strains known as methicillin resistant *Staphylococcus aureus* (MRSA) has resulted in an increase in the prevalence of community-acquired and hospital-acquired *S. aureus* infections. MRSA is now a global problem, and these drug-resistant organisms are considered resistant to all cephalosporins, cephems, and other beta-lactams (including ampicillin-sulbactam, amoxicillin-clavulanic acid, ticarcillin-clavulanic acid, piperacillin-tazobactam, and carbapenems), regardless of *in vitro* test results. Furthermore, most other commonly used antimicrobial agents, such as aminoglycosides, macrolides, chloramphenicol, tetracycline, and fluoroquinolones, are becoming less effective against MRSA strains (Ansari *et al.*, 2014; Deresinski, 2005; Fluit *et al*., 2001).

The proliferation of drug-resistant *E. coli* isolates of human and animal origin is also a global public health problem. Antibiotic-resistant *E. coli* infections are currently associated with increased morbidity, mortality, and invariably higher treatment costs when compared to infections caused by drug-susceptible strains. Drug resistant commensal *E. coli*, which may not directly cause disease, is still important in public health because it serves as a reservoir for drug resistance genes. These genes can be passed on to humans as well as zoonotic pathogens like *Salmonella*, and other Gram-negative bacteria in the gut (Aworh *et al.*, 2019; Szmolka and Nagy 2013; Fair and Tor, 2014).

As in this study, multiple resistance to commonly used antibiotics has been reported in several microorganisms, including *Escherichia* and *Staphylococcus* species, isolated from bed linens of university students (Olowomofe *et al.*, 2020). Bed linens used in other settings, such as hospitals, nursing homes, and the larger community, have also been identified as potential sources of pathogenic microorganisms (Okareh, 2018; Pinon *et al.*, 2013; Bloomfield *et al.*, 2011).

Conclusion

The findings of this study reveals the contamination of bed linens of undergraduate students with MDR strains of *E. coli* and *S. aureus*. A majority of these bacterial isolates were found to be resistant to three cephalosporin (ceftazidime, cefixime and cefuroxime), one macrolide (erythromycin), a nitrofuran (nitrofurantoin) and a penicillin (augmentin) antibiotic. As a result, it is concluded that these bed linens could be a source of bacterial infections.

Conflict of interest statement: The authors declare no conflict of interest.

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