



Body Towels as Reservoirs of Antibiotic Resistant Bacteria: Wellness Implications

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Abstract

Background: In-use damp towels provide perfect conditions for growth and transmission of pathogenic and non-pathogenic microbes that could pose deleterious health consequences to users.

Objective: This study investigated the composition and antimicrobial susceptibility patterns of bacteria isolated from in-use towels of female undergraduate students of a tertiary institution in Calabar, Nigeria.

Methods: A total of 80 in-use body-towels were sampled, using moistened sterile swab sticks, and processed by conventional bacteriological methods for isolation and identification of bacteria. The bacterial isolates were identified using Vitek 2 Compact System (bioMérieux, Marcy L'Étoile, France), and subjected to antibiotic susceptibility testing by Kirby-Bauer disc diffusion method.

Results: Forty three (53.7%) of 80 towels sampled yielded growth of bacteria. *Escherichia coli* (25.6%) was found as the most prevalent isolate, followed by *Klebsiella pneumoniae* (20.9%), *Staphylococcus (S.) equorum* (13.9%), *Proteus mirabilis* (11.6%), *S. cohnii* (9.3%), *S. lentus* (7.0%), *Aerococcus viridans* (7.0%), and *S. alettae* (4.7%). High resistance rates to Ciprofloxacin (44.4%) and Amikacin (27.8%) were found for the gram negative isolates with zero-resistance to Meropenem and Levofloxacin. Similarly, the gram positive isolates showed high resistance to Erythromycin (50.0%), Ciprofloxacin (33.3%) and Cefuroxime (27.8%).

Conclusion: The high isolation rate of *E. coli*, alongside other coliform isolates, in this study suggests fecal contamination of the body-towels with vast potentials for harboring dangerous infectious agents, including multidrug resistant bacteria. Adherence to best towel-hygiene practices is highly recommended.

Keywords: In-use body towels, bacterial isolates, antibiotic resistant bacteria, disease transmission, best towel-hygiene practices.

Introduction

A towel is an absorbent piece of fabric (originally Turkish cotton) that is used to either dry off the body after a shower or wipe a surface to clean it. The absorbent and moist nature of used body-towels provide the perfect growth environment for bacteria and other microorganisms transferred from the body and surroundings, especially when hung in dark, warm rooms¹. Materials such as cleaning or face cloths, household linen used for bed-sheets, pillows and towels can readily support microbial growth and become a primary reservoir of infection with potential to act as vehicles of infection to users in homes and other settings, like sports changing rooms, where members share such items². A study conducted on used

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kitchen towels in homes of United States and Canada found the towels to harbour significant numbers of coliform bacteria which could pose health risks to the users³. Similarly, an unpublished study by Charles Gerba at University of Arizona, featured in a TIME Magazine edition of 2017, revealed that 90% of used bath towels contain

coliform bacteria, of which 14% were *Escherichia (E.) coli*, a strong indicator of faecal contamination. Generally, the human body is burdened with microbial life, including pathogenic and nonpathogenic organisms. Poor towel hygiene such as using the same towel for one's body and face may result in the transfer of *E. coli* or/and other common environmental bacteria to the facial region. Young children with sensitive skin and elderly people or others with underlying diseases such as diabetes, human immunodeficiency virus (HIV) infection and other diseases may face higher risks of acquiring infection from contaminated towels. Good towel hygiene practices may help to prevent skin irritation, unpleasant odours as well as promote overall well-being. Among the best towel hygiene practices include using different towels for individual purposes, such as for the face, hand, hair, or body, washing towels at least weekly, hanging towels in well ventilated areas, preferably in the sun to reduce humidity and discourage the growth of mold and bacteria on them^{4,5}. Additionally, sharing towels among family or group members must be discouraged to prevent the spread of pathogenic microbes. This study assessed the possible role of bath towels, used by female undergraduate students of a tertiary institution in Calabar, Nigeria, as reservoirs of infective antimicrobial resistant bacteria.

Materials and Methods

Study location

This study was carried out in University of Calabar, located in Calabar, a coastal city and metropolitan capital of Cross River State in south-south geopolitical zone of Nigeria. Analysis of the study samples was conducted under the supervision of a staff Medical Laboratory Scientist in charge of the bench in University of Calabar Teaching Hospital Microbiology Laboratory, Calabar, as required by the management following duly obtained permission.

Study design

A descriptive cross-sectional study design was used to achieve the objectives of the study.

Study population

This study utilized in-use wet towels of female

undergraduate students residing in the University of Calabar campus hostels, following obtainment of signed written informed consents from their owners (students). The towels owners were clearly informed of the purpose and potential benefits of the study, with firm guarantee of strict confidentiality with regards to their personal identity. To ensure confidentiality, only number identifiers were used to label the towel samples; personal identifiers such as names, age, and hostel/room numbers, among others, were not obtained.

Sampling technique

A non-probability or convenience sampling technique was used. A total of 80 wet towels were consecutively collected from consenting female undergraduates, among others who declined consent.

Study procedure

Sterile swab sticks, moistened with sterile normal saline, were used to sample the in-use bath-towels and transported within an hour to the laboratory for processing. The towel swabs were inoculated on Chocolate agar and Cysteine Lactose Electrolyte Deficient (CLED) agar, and incubated at 37 degree Celcius for 24 hours to isolate bacteria. Following Gram's staining, obtained bacterial isolates were identified using the VITEK 2 Compact System (bioMérieux, Marcy L'Étoile, France) according to the manufacturer's instructions.

Gram-negative isolates were qualitatively screened for production of biofilm using Congo red agar method⁶. The antimicrobial susceptibility patterns of the isolates were determined using the Kirby-Bauer agar disk diffusion method, as previously described in Nigeria⁷.

Ethical considerations

Ethical clearance was not sought for the study since the protocols neither involved any invasive procedure nor collection of personal data of those who voluntarily submitted their used towels for sampling. Enlistment for the study was based strictly on submission of in-use body towels following informed consent.

Results

Bacterial profile of the towel samples

The distribution of the bacterial isolates in this study is shown in Table 1. Of the 80 towels sampled, only 43 (53.7%) yielded growth of bacteria, comprising of 25 (58.1%) Gram-negative and 18 (41.9%) Gram-positive isolates. *E. coli* had the highest frequency (25.6%), followed by (*K. pneumoniae* (20.9%), *Staphylococcus (S.) equorum* (13.9%), and *Proteus (P.) mirabilis* (11.6%)., among some gram positive isolates including *S. cohnii* (9.3%), *S. lentus* (7.0%), *Aerococcus (A.) viridans* (7.0%), and *S. alettae* (4.7%). None of the sampled towels yielded more than one specie of bacteria.

Table 1: Bacterial profile of the towel samples tested (n=80)

Bacterial isolates	Frequency (%) of isolation	Prevalence (%)
Gram-negative		
<i>E. coli</i>	11 (25.6)	13.8
<i>K. pneumoniae</i>	9 (20.9)	11.3
<i>P. mirabilis</i>	5 (11.6)	6.3
Total	25 (58.1)	31.3
Gram-positive		
<i>S. equorum</i>	6 (13.9)	7.5
<i>S. cohnii</i>	4 (9.3)	5.0
<i>S. lentus</i>	3 (7.0)	3.8
<i>A. viridans</i>	3 (7.0)	3.8
<i>S. alettae</i>	2 (4.7)	2.5
Total	18 (41.9)	22.5
Grand total	43 (100)	53.7

Table 2: Antibiotics resistance profiles of Gram-negative bacterial isolates (n=25)

Bacterial isolates	Number of isolates (%)					
	*CIP	CXM	LEV	AMK	MEM	CFM
<i>E. coli</i> (n=11)	7(63.6)	5(45.5)	0(0.0)	3(27.3)	0(0.0)	2(18.2)
<i>K. pneumoniae</i> (n=9)	5(55.5)	2(22.2)	0(0.0)	3(33.3)	0(0.0)	3(33.3)
<i>P. mirabilis</i> (n=5)	2(40.0)	0(0.0)	0(0.0)	1(20.0)	0(0.0)	2(40.0)
Total	8(44.4)	4(22.2)	0(0.0)	5(27.8)	0(0.0)	4(22.3)

*CIP- Ciprofloxacin; CXM- Cefuroxime; LEV- Levofloxacin; AMK- Amikacin; MEM- Meropenem; CFM- Cefixime

Table 3: Antibiotic Resistance Profile of Gram-positive bacterial species (N=18)

Bacteria	Number of isolates (%)					
	CIP	CFM	LEV	MEM	ERY	CXM
<i>S. Equorum</i> (n=6)	1(16.7)	2(33.3)	0(0.0)	0(0.0)	3(50.0)	2(33.3)
<i>S. Cohnii</i> (n=4)	1(25.0)	0(0.0)	0(0.0)	0(0.0)	1(25.0)	2(50.0)
<i>S. lentus</i> (n=3)	2(66.7)	1(33.3)	2(66.7)	0(0.0)	2(66.7)	0(0.0)
<i>Aerococcus viridans</i> (n=3)	1(33.3)	0(0.0)	1(33.3)	1(33.3)	2(66.7)	1(33.3)
<i>S. alettae</i> (n=2)	1(50.0)	0(0.0)	0(0.0)	0(0.0)	1(50.0)	0(0.0)
Total	6(33.3)	3(16.7)	3(16.7)	1(5.6)	9(50.0)	5(27.8)

Antibiotic resistance of the Gram-negative bacterial isolates

The pooled resistance profile of the Gram negative isolates to the commonly used antibiotic drugs tested showed resistance rates ranging from 0.0% to 44.4% (Table 2). The isolates showed zero-resistance to Meropenem and Levofloxacin while 50% of the isolates were resistant to Ciprofloxacin.

Antibiotic Resistance of the Gram-positive bacterial species

Resistance of the Gram-positive isolates to commonly used antibiotics is presented in Table 3. Pooled resistance rates of the isolates ranged from 5.6% to 50.0%. Fifty percent of the isolates were resistant to Erythromycin while 5.6% were resistant to meropenem. *S. lentus* and *A. viridans* exhibited the highest resistance levels (66.7%) to some of the tested antibiotics.

Discussion

Bath towels have been reported to harbor significant number of bacteria that could pose avoidable health threats to humans⁸. This study found a bacterial isolation or colonization rate of 53.7% for in-use bath-towels of female undergraduate students of a tertiary institution in South-South geopolitical zone of Nigeria. The bacterial contamination rate of bath towels in this study was higher than the range of 14-33% reported in some studies carried out in Nigeria and elsewhere in Ghana^{8,9,10}. Yet, the value obtained in this study was by far lower than the 89.0% contamination rate of kitchen hand-towels, with dominance of *E. coli* isolates (25%), in a study carried out in 5 cities of United States and Canada³. Similarly, this study found a predominance of *E. coli* alongside other coliform bacteria isolates, with a prevalence of 31.3% among the sampled bath-towels, compared to the colonization rate of 22.5% for the gram-positive bacterial isolates. This finding contrasted sharply with the reports of similar studies in Southwest and North-central Nigeria which found *S. aureus* and coagulase-negative *Staphylococcus*, respectively, as the predominant isolates^{9,10}. The high prevalence and isolation rate of *E. coli* in this study may be a strong indication of faecal contamination and poor hygienic conditions of the bath towels, with potentials for deleterious health consequences to the female students'

population. The three coliform bacteria found in this study, including *E. coli*, *K. pneumoniae* and *P. mirabilis*, are common pathogens of urinary tract, known to be more prevalent in females than the male gender. Hence, contamination of body towels with any of these pathogens can potentially result in infections of the urinary tract, skin or wounds, especially if the contaminated towels come in contact with the genitalia, open wounds, cuts, or abrasions on the skin.

The Gram positive bacteria isolates recovered in this study were largely coagulase-negative staphylococci, including *S. cohnii*, *S. lentus*, *A. viridans*, and *S. alletiae* in descending order of prevalence. Although usually found as flora of the normal human skin and mucous membrane, these bacteria can sometimes cause opportunistic infections in individuals with comorbidity or compromised immune systems. For instance, *A. viridans* is known to cause hospital-acquired urinary tract infections in immunocompromised patients^{11,12}. Similarly, *S. aureus* is common nosocomial pathogen and flora of the human skin often associated with remarkable antibiotic resistance⁷. However, *S. aureus* was not found among the array of gram-positive isolates of this study in contrast to reports of similar studies in Nigeria^{9,10}. This finding could be attributed in part to the high precision identification of isolates in this study using Vitek-2 Automated System, compared to studies that utilize conventional biochemical methods with inherent setbacks for distinction of closely related bacterial species.

Although the isolates of this study were highly susceptible to Meropenem and Levofloxacin, they exhibited high resistance to some commonly used antibiotics, including Ciprofloxacin, Erythromycin, Amikamycin and Cefuroxime. Curiously, the high resistance of the isolates to Ciprofloxacin in this study, in comparison to a similar fluoroquinolone-Levofloxacin, may be due to widespread abuse or indiscriminate usage of the drug for different purposes, including prophylactic uses and self medication prevalent in the epidemiological setting. Conversely, the high efficacy of Meropenem in this study may likely be due to the fact that it is usually deployed as a last resort antibiotic for management of difficult-to-treat infections, besides its high cost and consequent low accessibility to most

individuals seeking to self medicate. Besides, meropenem is parenteral and less commonly abused compared to ciprofloxacin, an oral medication.

Furthermore, bacterial species, particularly the Gram negative isolates that colonize used towels are reported to be specifically adapted to the fabrics by formation of biofilms, which confer additional virulence and antibiotic resistance traits to the pathogen⁵. However, evaluation of the Gram negative bacteria isolates in this study revealed that none was a biofilm producer. This finding may underscore the observed low resistance profile of such isolates and the crucial role of biofilms formation for enhancing bacterial resistance to antibiotics.

Conclusion

The findings of this study suggest that used towels constitute important transmission routes for resistant bacteria and can be considered as reservoirs of infection, or fomites. These findings highlight the urgent need to adopt good hygiene practices including regular washing of used towels and drying in well ventilated environments to reduce transmission of infectious agents. Alongside prudent antibiotic prescribing, good hygiene remains a key preventive measure for reducing the transmission of antibiotic resistant infections.

Conflict of interest: None declared by the authors.

Author's contributions

AA designed the study, managed the analysis, and vetted the initial draft of the manuscript. EI co-designed the study and supervised the laboratory analysis. NU managed the literature search, wrote the protocol and part of the manuscript. AE and GB collated the laboratory data. PO wrote the first draft of the manuscript. PO, CK and AK managed samples collection and carried out the laboratory analysis. AA and NU proofread and edited the final manuscript. All authors read and approved the final manuscript.

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