

Bacterial pathogens from bed linen used in secondary and tertiary health facilities in Benin city, Nigeria

Abstract

The importance of clean and safe bed linen used in health facilities for patients and staff cannot be over emphasized. A short study was conducted to provide information on the exposure of hospital laundry workers to bacterial pathogens screened from different hospital linen samples. Bacterial isolates were identified and characterized by standard microbiological procedures. Total bacterial count from swab samples taken from different sampling sites ranged from $6.0 \pm 4.0 \times 10^1$ – $2.1 \pm 0.9 \times 10^3$ CFU/cm²; with *Staphylococcus aureus* being the most occurring bacterial isolate. The following bacterial pathogens were isolated; *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Bacillus cereus*, *Bacillus subtilis*, *Serratia* sp., *Klebsiella* sp., *Citrobacter freundii*, *Staphylococcus epidermidis*, and *Proteus* sp. Bacterial pathogens were found on the hospital linens, which could pose health risks to patients and laundry workers of the facilities. These pathogens can easily acquire antibiotic resistance and therefore, there is the need to establish effective infection control strategies.

Keywords: bacterial pathogens, linen, antibiotic resistance, health facility, laundry

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Introduction

Health Care Workers (HCW) are exposed to various occupational hazards that may threaten their health and safety.¹ However, exposure to hazardous agents depends upon the job category and the work environment of the HCW.² Healthcare textiles include bed sheets, blankets, towels, personal clothing, patient apparel, uniforms, gowns, and drapes for surgical procedures.³ The importance of a clean environment and linen for optimal patient care has been stressed upon since the very inception of hospitals. Clean bedding and clean clothes create a psychological confidence in the patients and public.⁴

Exposure to blood borne pathogens occur if personnel come into contact with healthcare textiles that are contaminated with blood or other potentially infectious body fluids.⁵ Individuals exposed to contaminated faecal material such as those whose work involves direct contact with fomites such as linen, bed-pans, etc are most at risk of acquiring hepatitis A in the course of their work.⁶ Contaminated textiles and fabrics may harbour high numbers of microorganisms from the different body substances they are in contact with, such as, blood, skin, stool, urine, vomitus, sputum, and other body tissue and fluid. When contaminated with potentially infective body substances, linen can contain bacterial loads of 10^6 – 10^8 CFU/100cm³.

Creamer et al.⁷ found methicillin-resistant *Staphylococcus aureus* (MRSA),⁸ *Pseudomonas aeruginosa*,⁹ vancomycin-resistant Enterococci (VRE)¹⁰ to have been associated with the spread of pathogens by bed linen as one of the possible environmental routes. Also, there have been reports on bacteria such as *Salmonella* and *Bacillus cereus*¹¹ viruses such as hepatitis B; fungi such as *Microsporium canis*; and parasites such as scabies, being transmitted from contaminated linen to healthcare workers via direct contact and aerosol droplets of lint, generated from sorting and handling linen.³ A report of a short study on bacterial pathogens from bed linen used in secondary and tertiary health facilities in Benin City, Nigeria is herewith provided.

Geographical location of study area

Benin City, the capital of Edo State, has a land area of 1,219.626km² and is bounded by latitude 6°20'North and longitude 5°39' East. The study was conducted in hospitals with laundry departments. They are University of Benin Teaching Hospital-UBTH (tertiary health facility) and secondary care health facilities which include: Central Hospital Benin (CHB), Stella Obasanjo Hospital (SOH), St. Philomena Catholic Hospital (SPCH), Faith Medical Complex (FMC) and Ihenyen Hospital (IH).

Methodology

Health facilities were randomly selected to represent each of the hospital categories (private secondary, government secondary and government tertiary health facility). The tertiary care facility is a specialized consultative health care facility, usually for inpatients and on referral from a primary or secondary health professional with facility that has personnel and facilities for advanced medical investigation and treatment. Secondary Healthcare facility refers to a second tier of health care facility in Nigeria which patients from primary health care facility are referred to specialists in higher hospitals for treatment. Three designated hospital linen types (clean linen, Used linen but not soiled with blood, urine or faeces and linen soiled with blood, urine or faeces) were used. Culture was prepared using nutrient agar to isolate the bacteria. The culture was produced using 0.5% peptone, 0.3% yeast extract, 1.5% agar, 0.5% sodium chloride and distille water with pH adjusted to neutral (6.8) at 25 °C. Morphological characterization of bacterial isolates was carried out using Gram staining procedure. The stained and air-dried slides were examined under microscope using oil-immersion objective technique. Biochemical characterization of bacteria using solubilization index based on colony formation were used in differentiating and identifying the types of bacteria.¹² Following suggested procedure

from Bacteriological Analytical Manual of US FDA, CFU/g=(average no. of colonies x total dilution factor)/ volume plated.¹³

Results

Total bacterial counts from swab samples

Total bacterial count from swab samples taken from different sampling sites ranged from $(96.0 \pm 4.00) \times 10^1$ – $(92.1 \pm 0.90) \times 10^3$ CFU/cm². The cultural, morphological and biochemical characterization of isolated bacteria are shown in Table 1, while total bacterial counts from swabs of different linen types sampled from the various hospital categories are presented in Table 2. Linen from the government tertiary hospital showed total bacterial count of $(96.5 \pm 2.8) \times 10^1$ CFU/

cm² for clean linen sample; $(1.3 \pm 0.6) \times 10^2$ CFU/cm² for dirty linen sample and $(2.1 \pm 0.9) \times 10^3$ CFU/cm² for soiled linen sample. For linen gotten from the government secondary hospital, total bacterial count of $(3.2 \pm 1.4) \times 10^2$ CFU/cm² was observed on clean linen sample, $(2.6 \pm 1.4) \times 10^3$ CFU/cm² on dirty linen sample and $(1.8 \pm 1.1) \times 10^3$ CFU/cm² on soiled linen sample. Linen from a private secondary hospital showed total bacterial count of $(6.0 \pm 4.0) \times 10^1$ CFU/cm² for clean linen sample; $(1.9 \pm 1.1) \times 10^2$ CFU/cm² for dirty linen sample and $(5.3 \pm 3.6) \times 10^2$ CFU/cm² for soiled linen sample. The identified bacterial isolates included; *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Bacillus cereus*, *Bacillus subtilis*, *Serratia sp.*, *Klebsiella sp.*, *Citrobacter freundii*, *Staphylococcus epidermidis* and *Proteus sp.*

Table 1 Cultural, morphological and biochemical characterization of isolated bacteria

Parameters	Bacteria isolates									
	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10
Cultural Characteristics										
Shape	Circular	Round	Circular	Irregular	Irregular	Circular	Circular	Circular	Circular	Round
Colour	White	Milky	Green	Cream	Cream	Red	Cream	Cream	White	Milky
Size	Large	Small	Small	Large	Large	Large	Large	Medium	Large	Small
Elevation	Flat	Raised	Flat	Flat	Flat	Flat	Raised	Convex	Flat	Raised
Transparency	Opaque	Translucent	Transparent	Opaque	Opaque	Opaque	Translucent	Opaque	Opaque	Opaque
Morphological characteristics										
Gram stain	+	-	-	+	+	-	-	-	+	-
Cell type	Cocci	Cocci	Rod	Rod	Rod	Rod	Rod	Rod	Cocci	Rod
Cell arrangement	Chains	Clusters	Single	Single	Single	Single	Single	Single	Chains	Chains
Spore staining	-	-	-	+	+	-	-	-	-	-
biochemical test										
Urease			-	-	-	-	-	-		+
Indole			-	-	-	-	-	-		-
Acid fast	-	-	-	-	-	-	-	-	-	-
Citrate utilization	-	+	+	-	+	+	+	+	-	+
Catalase production	+	+	-	-	-	-	+		-	-
Motility	-	+	+	+	+	+	+	+	-	+
Methyl red	-	+	+	-	-	-	-	+	-	-
Voges Proskauer	-	+	-	-	-	-	+	+	-	+
Coagulase	+	-	-	-	-	-	-	-	-	-
Starch hydrolysis	+	+	+	+	+	+	-	+	+	+
Oxidase	-	-	+	+	+	+	-	-	-	-
Hydrogen sulphide	-	-	-	-	-	-	-	+	-	-
Oxidative fermentation test										
Glucose	+	+	+	+	+	+	+	+	+	+
Fructose			+	+	+	+	+	+		-
Maltose				+	+	+	+	+		+
Lactose	+	-	+	-	-	-	+	+	+	-
probable identity	<i>Staphylococcus aureus</i>	<i>Escherichia coli</i>	<i>Pseudomonas aeruginosa</i>	<i>Bacillus cereus</i>	<i>Bacillus subtilis</i>	<i>Serratia sp.</i>	<i>Klebsiella sp.</i>	<i>Citrobacter freundii</i>	<i>Staphylococcus epidermidis</i>	<i>Proteus sp.</i>

Table 2 Total bacterial counts from swab samples (CFU/cm²)

Linen type	Sampling sites		
	GT	GS	PS
Clean linen	(6.5±2.8)×10 ¹	(3.2±1.4)×10 ²	(6.0±4.0)×10 ¹
Dirty linen	(1.3±0.6)×10 ²	(2.6±1.4)×10 ³	(1.9±1.1)×10 ²
Soiled linen	(2.1±0.9)×10 ³	(1.8±1.1)×10 ³	(5.3±3.6)×10 ²

Key: PS, private secondary health facility; GS, government secondary health facility; GT, government tertiary health facility

Occurrence and distribution of bacterial isolates among different samples

The percentage occurrence of identified bacterial isolates showed *P. aeruginosa* as the least occurring isolate (22.22%) and *S. aureus*

as the most occurring isolate (77.78%). *Serratia sp.*, *C. freundii*, *S. epidermidis* and *Proteus sp.* were observed to occur as 44.44% of sampled linen, while *B. Subtilis* and *Klebsiella sp.* were observed to occur in 55.56% of sampled linen. *B. Cereus* and *E. coli* however, were observed to occur in 66.67% of sampled linen (Table 3).

Table 3 The distribution of identified bacterial isolates among the different sampling sites

Linen type	Sampling sites		
	GT	GS	PS
Clean linen	B1, B4, B5, B9	B5, B9	B4, B7
Dirty linen	B1, B2, B4, B5, B7, B9, B10	B1, B2, B4, B6, B7, B9	B1, B2, B3, B4, B5, B6, B8, B10
Soiled linen	B1, B2, B3, B4, B6, B7, B8, B10	B1, B2, B6, B8, B10	B1, B2, B5, B7, B8

Key: PS, private secondary health facility; GS, government secondary health facility; GT, government tertiary health facility; B1, *S. aureus*; B2, *E. coli*; B3, *P. aeruginosa*; B4, *B. cereus*; B5, *B. subtilis*; B6, *Serratia sp.*; B7, *Klebsiella sp.*; B8, *C. freundii*; B9, *S. epidermidis*; B10, *Proteus sp.*

Discussion

The total bacterial count on contaminated laundry (dirty and soiled) was higher than on clean laundry. This finding supports a report by Schulster et al.,³ who noted that contaminated textiles and fabrics may harbour high numbers of microorganisms as a result of contact with different body substances such as, blood, skin, stool, urine, vomitus, sputum, and other body tissue and Fluid. It should also be noted that clean (laundered) textile was also observed to contain some bacterial pathogens, but low in estimation. This calls for proper disinfection of linen used. Identified bacterial isolates include; *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Bacillus cereus*, *Bacillus subtilis*, *Serratia sp.*, *Klebsiella sp.*, *Citrobacter freundii*, *Staphylococcus epidermidis* and *Proteus sp.* There have been reports of methicillin-resistant *Staphylococcus aureus* (MRSA),⁸ *Pseudomonas aeruginosa*⁹ and *Bacillus cereus*¹¹ to have been associated with hospital bed linens. Furthermore, a survey of bacterial contamination of hospital staff apparel in use in Anambra State, Nigeria, was carried out to determine the extent of contamination by clinically important bacteria. The potentially pathogenic bacteria isolated were *Proteus spp.*, *Pseudomonas aeruginosa* and *Staphylococcus aureus*,¹⁴ while a microbiological analysis of swabs taken from the cuffs and pocket mouths of physicians' white coats in an acute care hospital showed that 91.3% of the coats had bacterial contamination, specifically *Staphylococcus aureus* and gram-negative Bacilli which were resistant to nearly all of the antibiotics tested.¹⁵

Conclusion and recommendation

Bacterial pathogens were found on hospital linen, which could pose danger to laundry workers responsible for washing them and other health workers using them. These pathogens can easily acquire antibiotic resistance and therefore calls for the need to establish

an effective infection control policy that incorporates the welfare of hospital laundry workers and other healthcare workers in all healthcare facilities.

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None.

Conflicts of interest

The author declares no conflict of interest.

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