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Bacterial Contaminants on Exposed Surfaces and Their Antibiotic Sensitivity Patterns at the Benjamin Mkapa Hospital, Dodoma-Tanzania

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Authors' contributions

This work was carried out in collaboration among all authors. Author ABC designed the study and Involved in manuscript development, author RSM prepared a study, involved in sample and data collection, performed most of the technical laboratory tests or experiments, analysis of data as well as to develop manuscript, author BL proposed a study, involved for sample collection and wrote the manuscript author BCK involved for data collection and laboratory experiments, author WS proposed a study, involved in collection of data, analysis of data and wrote the manuscript, author CEK involved for data collection, author SJS involved for collection of sample author MLM performed some of the laboratory experiments, author JBL involved for designation of study, author LEM involved for sample collection and laboratory experiments. All authors read and approved the final manuscript.

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ABSTRACT

Background: Hospital acquired infection pose a great challenge in provision of healthcare services to many settings particulary in developing countries where there is limited availability of resources. The roles played by exposed surfaces in spreading of potential bacterial pathogens within the hospital environment have certainly contributed to the increased burden of bacterial infectious diseases such as morbidness, death as well as cost imolecation in healthcare. Our study aimed to determine common bacteria isolated on exposed surfaces and the antimicrobial sensitivity patterns.

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Methods: A sum of 516 specimens gathered and enrolled for study at Benjamin Mkapa Hopsital (BMH). The swab specimens were continuously gathered (collected) from different exposed objects in hospital environmental surfaces. All microbiological procedures or tests were performed using appropriate standard operating procedure. The obtained data were analysed using SPSS version 16.0.
Results: Among 516 samples, 317 (61.4%) were positive with variety of bacterial isolates from different sites. Out of 317 positive cultures, 120 (37.9%) *Staphylococcus aureus,* 97 (30.6%) *E. coli,* 28 (8.8%) *Enterobacter aerogenes,* 25 (7.9%) *Pseudomonas aeruginosa,* 23 (7.3%) other *Citrobacter species,* 20 (6.3%) *Citrobacter freundii,* 3 (0.9%) *Morganella morganii* and 1 (0.3%) *Serratia mercesens* were isolated from different source of exposed surfaces at BMH. *Serratia mercesens* were highly (100%) resistant to most of the antimicrobial agents including erythromycin, cefotaxime, ciprofloxacin, gentamicin, amikacin, penicillin,ceftriaxone, ceftazidime, levofloxacin, ampicillin, azithromycin and cotrimoxazoleTrimethoprim/sulfamethoxazole.
Conclusion: High levels of potentially pathogenic bacteria were isolated in swab specimens from a wide range of exposed surfaces at BMH. Variable pattern of antiobiotic resistance were observed among bacterial isolates with alarming levels demonstrated by isolates of *Serratia mercesens* which is amongst the common causes of surgical site infections. This findings call for improved actions for infection prevention and control measures at BMH.

Keywords: Bacterial; contaminants; exposed; surface; antibiotic; sensitivity patterns; Benjamin; Mkapa; hospital; Dodoma; Tanzania.

1. INTRODUCTION

Microorganisms are microbes and very small organisms which are invisible by bare eyes. They are normally called acellular even though other acellular protists are seen by bare whereas, multicellulars are not seen by bare eyes. Although microbes are too tiny to be seen by the naked eyes, they are worldwide distributed including in human anatomical body. The bacteria species named *staphylococcus aureus* 'gram stained positive' and gram stained negative bacteria for instance klebsiella, Citrobacter and *Escherichia coli*, species were build to pollute most of hospital surface like beds, equipment devices, landline, chairs, table, door handles and other household fixture [1-2].

Environmental surfaces act as a reservoir for microorganism in which they are expelled from an infected patient to health people through aerosol droplet, vomit, faeces or direct contact [2-3,4].

Doors and tap handles are surfaces that are really hard to avoid coming into contact with and this is because they have large traffic users. It is clear that one need to come into contact with taps before washing hands thus the same applies to door handles while going in and out. Therefore it is no surprise that they get filthy [2,5,6-7].

Hands always tend to carry microbes such as virus, fungus or bacteria from one surface to another through human contact either direct or indirect. The boy of human harbors several bacterial, viral or fungal species or protozoa [2-3]. Some of microorganisms live on part of human body with no harm to human and are called microflora. Thogh can cause harm when located on other site of human body for insistence staphylococcus in blood stream. [2,3,8,9]. Feaces may remain a reservoir of human infectious agents and may lead to infection outbeak like shigellosis, or cholera [2,9].

The tape handles, switches and door handles are also among the few surface that are frequently touched and that seems to act like reservoir of pathogenic infections. These pathogenic micro-organisms are direct or indirect transmitted from one surface or person by handles of health-care provider [2-3,9,7,10].

Several studies reported the presence of *Proteus mirabilis, staphylococcus aureus*, *Bacillus subtilis, Staphylococcus epidermis, Pseudomonas aeruginosa, Clostridium perfringens, Neisseria sicca, Enterobacter aerogenes, Escherichia coli* and *Micrococcus luteus* on door handles, taps handle and even in public utilities [2, 10,11,12].

A previous study that involved indoor surface from pediatric units reported isolation of *Escherichia coli Staphylococcus aureus, Bacillus subtilis*, *Pseudomonas aeruginosa,* and *Streptococcus pneumoniae* after last contact cleaning, and disinfection time [2-3,5,13,14,6,7].

Despite of variety of methods or techniques used for decontamination, cleaning of hospital surfaces, yet they play a vital role for infectious microbe transmission in hospital settings including Methicillin and Vancomycin resistant to Staphylococci and Enterococci, respectively. These microorganisms cause clinical problems such as antimicrobiotic resistance and causes of hospital acquired infections (HAIs) especially to intensive-care-units [2-3,5,7,15]. Thus monitoring and evaluation of hospital exposed surfaces such as door knobs is an important technique for prevention and control of infection because contaminated surfaces increase transmission risk of infections through contact to door handles [2,7].

However in other part of the world, hospital surfaces have been associated with serious cross-contamination of diseases and several studies of bacterial contamination has been done in door handles, taps, keyboards, mobile phones and money but there are limited data in the health facilities in Tanzania on surfaces contamination**,** the hospital environment are not known in terms of contaminants and no previous study conducted at Benjamin Mkapa Hospital with the same objectives [4,11].

There is little doubt that surfaces contains existing microbe at the Benjamin Mkapa Hospital. However, there is no previous evidence or documentation for BMH carriage of microbe on exposed surfaces. But it has been debated for many years concerning the portrayal of surface for transmission of microbial infection, not only in hospital but also to the community [5].

The study was aiming to identify existing bacteria on surfaces at the Benjamin Mkapa Hospital. Therefore, the study was expecting to come up with basic information on the prevalence and sensitivity patterns of existing bacteria on hospital exposed surface. The findings of this study will alerts the hospital staffs, patients and visitors to always practice and implementation of personal hygiene to ensure that hospital surfaces are free from microbial contamination despite of frequent decontamination of the hospital surfaces.

2. MATERIALS AND METHODS

2.1 Site of Study

A study was carried out at Benjamin Mkapa Hospital located in Dodoma city, Tanzania. A study involved samples collected from hospital exposed surface of Clinical Laboratory, Pharmacy, Radiology and imaging, wards (medical, surgical, urology, paedriatrics, Obstetrics & gynecology (OBGY), Very important person (VIP)), theaters, and internal medicine, General Surgery, Urology, Pediatric and child healthcare, Obstetrics & gynecology, Ophthalmology, Ear, Nose & Throat (ENT), Physiotherapy, Nephrology (Haemodialysis and Kidney transplant), Cardiology (including Cath lab), Orthopaedics, Gastroenterology, Oral health, Oncology, Haematology, Councilling and Testing Clinic (CTC), Intensive Care Unit (ICU) and Emergency medicine department (EMD) including trauma unit. Also samples were collected from general reception, cash point and canteen area.

2.2 Design of Study and Method of Sampling

The study used cross sectional technique at the Benjamin Mkapa Hospital to assess availability of micro-organisms on exposed surfaces. A convenient sampling technique was used to recruit 516 swab samples from door knobs (handles), switches, mattresses, bed rails, tap handle, table surface, chair surface, hospital equipment or device, landline, cabinets and toilet seat in this study. The surface types selected are normally frequently touched contaminated surfaces by not only patients but also hospital staffs and relatives of patients. The samples were collected on daily basis for a period of six months. On every site samples were collected twice (morning before cleaning and evening after cleaning). The swab specimens were collected repeatedly in order to know which time with high concentration of bacterial contaminats whether is before cleaning or after cleaning. Each sample was assigned a specific serial sample number. The samples were obtained from hospital clinics, wards, theaters, departments and units using sterile swab [4].

2.3 Sample Collection

The specimens were collected using swab stick-rinsing technique as described by the American Health Association [4]. The sterile swab stick was moistened with sterile normal saline prior to specimen collection, whereby, the wet swab stick was centrically rubbed on door knobs (handles), switches, mattresses, bed rails, tap handle, table surface, chair surface, hospital equipment or device, landline, cabinets and toilet seat and placed into Cary Blair transport medium. The

swabs were transported to Clinical laboratory, Microbiology department for microbiological processing.

2.4 Isolation and Identification Bacteria

The swab samples were inoculated using sterile wire loop onto Sheep blood, MacConkey and Chocolate agar medium for twenty four hours anaerobic incubation at tirty seven Celsius (37^0C). A single to three similar colonies were picked up to prepare smear for gram stain after reading culture plates. Bacterial identification was performed depending on the gram stain results following antimicrobial susceptibility testing. Meanwhile, bacteria of gram stained positive were identified using biochemical tests named optochin, catalase, bacitracin, coagulase and novobiocin disks, disks whereas, bacteria of gram stained negative were identified using biochemical tests; urea agar, Kliglier Iron Agar, Sulfur Indole Motility, Simmon's citrate agar, Lysine Iron Agar and oxidase test using existing standard operating procedures (SOP).

2.5 Antimicrobial Susceptibility Testing

A two to three colonies of confirmed isolates were stabbed in sterile normal saline using sterile swab and compared turbidity of 0.1 McFarland Equivalent standards prior to spreading onto Muller Hinton agar (MH). The stabbed isolates were spread onto MH agar using swab sticks that was sterile. The disks of antibiotics were situated on top of inoculums to obseve drug sensitivity patterns of commonly used antibiotics disks such as; Ampicillin (10µg), Amoxicillin/Clavulanic acid (30µg), Gentamycin (10µg), Trimethoprim/Sulphamethoxazole (5/25 ug), Azithromycin (30µg), Nitrofurantoin (300µg), Tetracycline (30 mg), Amikacin (30ug), Nalidixic Acid (30 mg), Ceftriaxone (30µg), Ceftazidime (30µg), Cefotaxime (30µg), Norfloxacin (30mg), Erythromycin (30mg), Chloramphenicol (30mg), Penicillin (30mg), Ciprofloxacin (30µg) and Levofloxacin (30µg). Inhibition zone diameter around the disk was accurate measured by using millimeter scale under surface of the MH agar plate in eighteen to twenty four hours of incubation at 37 °C. Zone diameter in millimeter around each antibiotic disk were interpreted as resistant, intermediate or sensitive based on CLSI 2019 guideline [8,16].

2.6 Quality Control

A reference strain *Escherichia coli* American Type of Culture Collection (ATCC) of 25922 as well as for *Staphylococcus aureus* with an ATCC of 25923 were both used for performing quality in controlling Microbiological procedures following existing SOPs and CLSI guideline [16].

2.7 Analysis of Data

Analysis of data were performed using SPSS software version 16.0. Statistical descriptive such as crosstabs were used to summarize the isolates and antimicrobial susceptibility patterns using tables, charts and graphs. The proportions as well as frequency of occurrence of bacteria species and pattern of drug resistance was compared using chi square. The *P*-value of not more than 0.05 was significantly as considered in statistics.

3. RESULTS

3.1 The Frequency of Bacterial Isolates

Out of 516 samples, 317 (61.4%) were positive with variety of microorganism from different sites (Table 1).

Table 1. Microorganisms isolated from various exposed surfaces

Bacterial species	Frequency	Percent (%)
Pseudomonas aeruginosa	25	7.9
Staphylococcus aureus	120	37.9
Morganella morganii	03	0.9
Escherichia coli	97	30.6
Serratia mercesens	01	0.3
Enterobacter aerogenes	28	8.8
Citrobacter freundii	20	6.3
Citrobacter species	23	7.3
Total	317	100.0

3.2 The Common Microorganism Isolated from Various Exposed Surfaces

The study is presenting eight common bacteria isolated from various exposed surface at BMH named *Escherichia coli, Serratia mercesens, Enterobacter aerogenes, Citrobacter freundii, Staphylococcus aureus, Morganella morganii, Pseudomonas aeruginosa* and other citrobacter species (Table 1). About all departmental surfaces found to commence one or more bacterial species (Table 2).

3.3 Concentration of Bacterial on Various Exposed Surfaces

Out of 317 (61.4%) microorganisms isolated, 120 (37.9%) *Staphylococcus aureus,* 97 (30.6%) *E. coli,* 28 (8.8%) *Enterobacter aeruginosa,* 25 (7.9%) *Pseudomonas aeruginosa,* 23 (7.3%) other *Citrobacter species,* 20 (6.3%) *Citrobacter freundii,* 3 (0.9%) *Morganella morganii* and 1 (0.3%) *Serratia mercesens* were isolated from different source of exposed surfaces in BMH. The department with high frequency of bacterial isolates was Trauma unit 21 (6.6%), Cardiac clinic with 17 (5.4%), Dialysis unit with 16 (5.0%), and ENT 13 (4.1%). The department with less number of isolates 1 (0.3%) were Urology clinic, Medical clinic and Cash office (point) whereas; X-RAY had no any isolate (Table 2).

3.4 Antimicrobial Sensitivity Patterns to Common Isolated Microorganisms from Surface at the Benjamin Mkapa Hospital

The results of *in vitro* drug (commercially from manufacturer) susceptibility patterns of 317 isolates shown that *Pseudomonas aeruginosa* were highly sensitive to only Ceftriaxone, Ceftazidime, Chloramphenicol and Erythromycin; *Morganella morganii* were high sensitive to Ceftriaxone, Ceftazidime, Amoxicillin clavulanic acid and Erythromycin; *Serratia mercesens* were high sensitive to Amoxicillin clavulanic acid, Nalidixic Acid, Chloramphenicol, Norfloxacin, Nitrofurantoin and Tetracycline; *Citrobacter freundii* were high sensitive to Chloramphenicol, Ceftriaxone, Erythromycin and Ceftazidime; other citrobacter species were high sensitive to Erythromycin, Chloramphenicol, Ceftazidime and Ceftriaxone. *Escherichia coli* were high sensitive to only Chloramphenicol (Table 3 (a) and 3 (b)).

3.5 Microbial communities of hospital environment (environmental cleaning)

The results obtained between morning (before cleaning) and afternoon hours (after cleaning) are considered significantly correlating (relating) with coefficient of correlation, R^2 = 0.917963; X^2 =27.197; *P* value = 0.001 (Fig. 1 and Table 4).

3.6 The Bacterial Transmission Patterns in Hospital and Interrelatedness from Different Source and Transmission Routes

The bacteria isolated on the exposed surface were statistically significant relating to each of the bacteria species on various surface (X^2 =5.578; *P* = 0.00). *Staphylococcus aureus* was isolated to the entire exposed surface in the departments except from pharmacy, Cash office, urology & medical clinics, CTC, X-ray and urology, whereas, *Escherichia coli* was not isolate in X–ray, urology and medical ward, urology and medical clinics, surgical ward, BMH canteen, cash office and BMH main reception (Table 2).

4. DISCUSSION

This was a first study conducted to rule out the existencing bacteria on surfaces and its sensitivity to antimicrobial drugs at the Benjamin Mkapa Hospital. Our study revealed most common microorganisms (*Staphylococcus aureus, E. coli* and *Pseudomonas aeruginosa)* that previously noted in another studies [17-18].

The study observed a higher prevalence of microorganisms 317 (61.4%) and *Staphylococcus aureus* were highly 120 (37.9%) isolated species. This possibly due to *Staphylococcus aureus* being the common commensal of human skin resulting to transimission from person to person or surface through direct contact. The *E. coli* was noted to be second species 97 (30.6%) isolated in larger concentration after *Staphylococcus aureus.*

Since *E. coli* is the common microflora of gastrointestinal tract of both human and animals, people might have contaminated hands in toilet and inadequately cleaning of hands leading to contaminated door handles, water tape knobs, benchs and table surfaces. Carriage of microorganisms through contact was believed to be a common route of transmission from one site to another. This was due to similar bactria species to various exposed surface in the hospital.

Table 2. Microorganisms isolated from various exposed surfaces

Site Location	*Pseudomonas aeruginosa*	*Staphylococcus aureus*	*Morganella morganii*	*Escherichia coli*	*Serratia mercesens*	*Enterobacter aerogenes*	*Citrobacter freundii*	*Citrobacter species*	Total
Reception BMH	0	2	0	0	0	0	0	0	2 (0.6%)
Cash office	1	0	0	0	0	0	0	0	1 (0.3%)
Canteen	1	2	1	0	0	0	0	0	2 (0.6%)
Laboratory	0	3	0	4	0	0	0	0	7 (2.2%)
Dialysis	0	4	0	7	0	0	0	5	16 (5.0%)
Sterilization	0	8	0	1	0	0	0	0	9 (2.8%)
VIP	0	5	0	3	0	2	2	0	12 (3.8%)
Surgical Ward	0	3	0	0	0	0	0	0	3 (0.9%)
Trauma	2	8	1	3	1	2	4	0	21 (6.6%)
Laundry	2	3	0	6	0	1	0	0	12 (3.8%)
Pharmacy	0	0	0	3	0	0	0	2	5 (1.6%)
Pediatrics clinic	1	1	1	1	0	1	4	1	10 (3.2%)
Urology & Medical clinic	0	0	0	0	0	0	0	5	5 (1.6%)
Radiology	1	0	0	4	0	0	0	2	7 (2.2%)
CT Scan	0	1	0	7	0	0	0	2	10 (3.2%)
General Surgery & OT	0	5	0	6	0	1	0	0	12 (3.8%)
Oncology	1	4	0	5	0	1	0	0	11 (3.5%)
Cardiology	4	5	0	4	0	2	0	2	17 (5.4%)
OGD	1	1	0	1	0	0	6	0	9 (2.8%)
Dental Clinic	0	2	0	2	0	2	1	0	7 (2.2%)
Physiotherapy	1	3	0	4	0	1	1	0	10 (3.2%)
Neonates Baby	1	3	0	5	0	2	0	0	11 (3.5%)
ENT	2	6	0	4	0	1	0	0	13 (4.1%)
CATH LAB	4	4	0	2	0	1	0	0	11 (3.5%)
CTC	0	0	0	6	0	2	0	3	11 (3.5%)
EYE	1	4	0	1	0	1	0	1	8 (2.5%)
XRAY	0	0	0	0	0	0	0	0	0 (0.0%)
Urology	1	0	0	0	0	0	0	0	1 (0.3%)
Medical	0	1	0	0	0	0	0	0	1 (0.3%)
OBGY CLINIC	1	4	0	5	0	1	1	0	12 (3.8%)
Total	25 (7.9%)	120 (37.9%)	3 (0.9%)	97 (30.6%)	1 (0.3%)	28 (8.8%)	20 (6.3%)	23 (7.3%)	317 (100%)

Table 3 (a). Antimicrobial sensitivity to common isolated microbes from surfaces

Organism	Erythromycin (X^2 = 9.046 *P*=0.00)	Norfloxacin (X^2 = 1.041 *P* =0.00)	Cefotaxime (X^2 = 8.569 *P* =0.00)	Ciprofloxacin (X^2 = 9.108 *P P* =0.00)	Nitrofurantoin (X^2 = 9.875 *P* =0.00)	Gentamicin (X^2 = 9.367 *P* *P* =0.00)	Amikacin (X^2 = 6.437 *P* =0.00)	Tetracycline (X^2 = 9.571 *P* =0.00)	Penicillin (X^2 = 7.875 *P* =0.00)
Pseudomonas aeruginosa	25 (100.0%)	0 (0.0%)	1 (4.0%)	24 (96.0%)	0 (0.0%)	1 (4.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Staphylococcus aureus	14 (11.7%)	91 (75.8%)	20 (16.7%)	19 (15.8%)	67 (55.8%)	41 (34.2%)	30 (25.0%)	107 (89.2%)	46 (38.3%)
Morganella morganii	3 (100.0%)	1 (33.3%)	2 (66.7%)	3 (100.0%)	1 (33.3%)	3 (100.0%)	1 (33.3%)	0 (0.0%)	0 (0.0%)
Escherichia coli	94 (96.9%)	10 (10.3%)	0 (0.0%)	2 (2.1%)	5 (5.2%)	95 (97.9%)	2 (2.1%)	4 (4.2%)	2 (2.1%)
Serratia mercesens	0 (0.0%)	1 (100.0%)	0 (0.0%)	0 (0.0%)	1 (100.0%)	0 (0.0%)	0 (0.0%)	1 (100.0%)	0 (0.0%)
Enterobacter aeruginosa	24 (85.7%)	6 (21.4%)	24 (85.7%)	6 (21.4%)	16 (57.1%)	14 (50.0%)	5 (17.9%)	17 (60.7%)	17 (60.7%)
Citrobacter freundii	20 (100.0%)	1 (5.0%)	19 (95.0%)	1 (5.0%)	0 (0.0%)	19 (95.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
Citrobacter species	23 (100.0%)	0 (0.0%)	21 (91.3%)	2 (8.7%)	0 (0.0%)	21 (91.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)

Table 3 (b). Antimicrobial sensitivity to common isolated microbes from surfaces

Organism	Ceftriaxone (X^2 = 6.872 *P* =0.00)	Ceftazidime (X^2 = 8.109 *P* =0.00)	Levofloxacin (X^2 = 7.902 *P* =0.00)	Ampicillin (X^2 = 9.707 *P* =0.00)	Azithromycin (X^2 = 8.408 *P* =0.00)	Nalidixic Acid (X^2 = 8.652 *P* =0.00)	Co-trimoxazole (X^2 = 6.434 *P* =0.00)	Amoxclav (X^2 = 9.195 *P* =0.00)	Chloramphenicol (X^2 = 7.102 *P* =0.00)
Pseudomonas aeruginosa	25 (100.0%)	25 (100.0%)	1 (4.0%)	1 (4.0%)	1 (4.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	25 (100.0%)
Staphylococcus aureus	59 (49.2%)	43 (35.8%)	42 (35.0%)	8 (6.7%)	21 (17.5%)	97 (80.8%)	38 (31.7%)	110 (91.7%)	117 (97.5%)
Morganella morganii	3 (100.0%)	3 (100.0%)	0 (0.0%)	0 (0.0%)	1 (33.3%)	0 (0.0%)	0 (0.0%)	3 (100.0%)	2 (66.7%)
Escherichia coli	91 (93.8%)	94 (97.9%)	92 (95.8%)	92 (95.8%)	93 (96.9%)	3 (3.1%)	3 (3.1%)	4 (4.2%)	96 (100.0%)
Serratia mercesens	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (100.0%)	0 (0.0%)	1 (100.0%)	1 (100.0%)
Enterobacter aeruginosa	24 (85.7%)	13 (46.4%)	21 (75.0%)	6 (21.4%)	10 (35.7%)	16 (57.1%)	17 (60.7%)	21 (75.0%)	25 (89.3%)
Citrobacter freundii	20 (100.0%)	20 (100.0%)	19 (95.0%)	19 (95.0%)	19 (95.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	20 (100.0%)
Citrobacter species	23 (100.0%)	23 (100.0%)	21 (91.3%)	21 (91.3%)	21 (91.3%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	20 (100.0%)

Table 4. Microbial communities of hospital environment

Bacterial species	Number of organism isolated during morning(AM) hours	Number of organism isolated during afternoon (PM) hours	Total
Pseudomonas aeruginosa	18	7	25
Staphylococcus aureus	60	60	120
Morganella morganii	3	0	3
Escherichia coli	48	49	97
Serratia mercesens	0	1	1
Enterobacter aeruginosa	23	5	28
Citrobacter freundii	5	15	20
Citrobacter species	8	15	23
Total	165	152	317

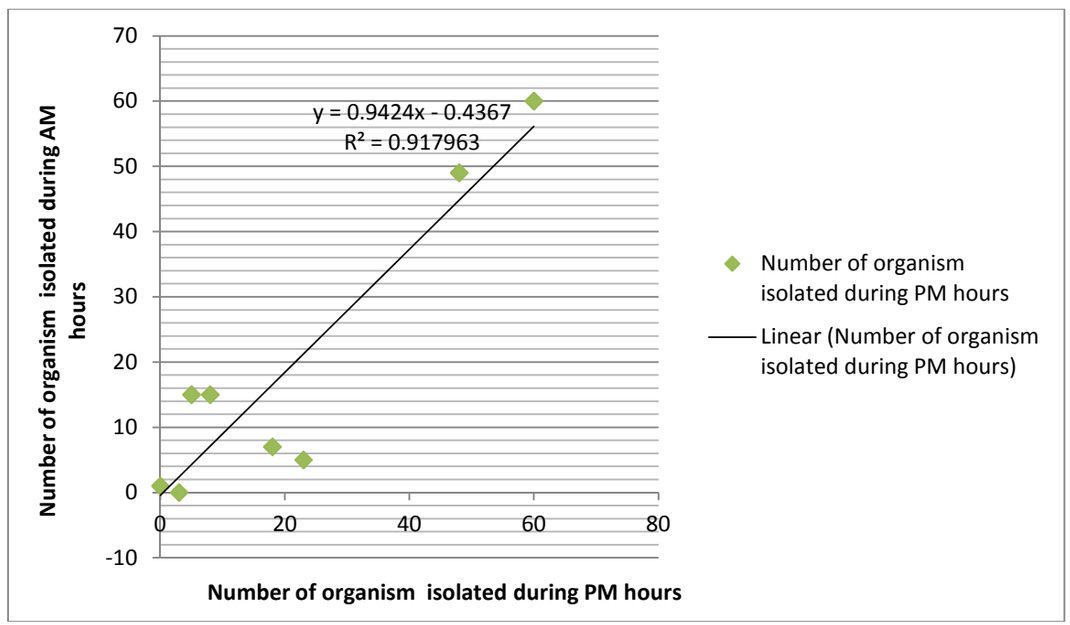

Fig. 1. Number of organisms isolated during morning and afternoon hours

Despite of the cleaning materials used such as soap water for invisibly soiled surfaces and Jik (Chlorine solution) for visibly soiled surfaces, the cleaning and decontamination of hospital surface was probably not effective for both morning and evening (cleaning were done twice a day, i.e. morning and evening) due to persistence of microbials isolated from various surface. It was believed that, there was cross transmission of bacteria from one department to another through toucghing of surface or sharing of medical device in use between medical staff, patients or patient relatives in the hospital as previous studies described route of transmission [17-18]. This was supported by the presence of the same bacteria species in various hospital departments.

In addition to similar deficiencies reported for performing cleaning of hospital medical equipment and many surfaces in the hospital remain contaminated with various microbes. This might happen because many rooms are inadequately cleaned [3,18-19].

Pseudomonas aeruginosa, Staphylococcus aureus, Morganella morganii, Serratia mercesens, Citrobacter freundii and *Citrobacter species* were highly resistant to atleast one of the following antimicrobials named Erythromycin, Norfloxacin, Cefotaxime, Ciprofloxacin, Nitrofurantoin, Gentamicin, Amikacin, Tetracycline, Penicillin, Chloramphenical, Amoxclav, Cotrimoxazole, Nalidixic Acid, Azithromycin, Ampicillin, Ceftazidime, Levofloxacin and Ceftriaxone. This might be a cross transmission of resistance strain from one person to environmental surface and vice versa [8].

The results of high prevalence in this study correlated with previous studies which suggested that hospital acquired infection and transmission was associated with long term staying in hospital. This need to reduce hospitalization stay as to minimize hospital acquired infection and transmission [8,20].

Furthermore, most of isolated bacteria were highly resistant in each tested antimicrobial drugs, including aminoglycosides possibly due to co-transfer of resistance from one bacterial species to another as ESBL are plasmid mediated [8,14,21,22]. The study has shown co-resistance of Extended Spectrum Betalactamase (ESBL) producing *E. coli* against most of antibiotics used, which was consistent with reports of recent studies [8,23-24].

We recommended other similar studies involving a wide range of sites and more tests for profiling the level of drug resistance, Multidrug resistance as well as identifying marker for resistance. Moreover, there is a need to carry out a study to assess the possible factors resulting to Multidrug resistance in human from consumption of antibiotic in food producing animals [8,18].

The nation should provide health education to people on the usefulness of good hygiene to reduce spread of infection. It would be important to identify ESBL producers as routine in the hospitals and to direct appropriate antibiotics for adequate treatment as to save patients and control from spreading infection to other health people or cattle [3-8,18].

5. STUDY LIMITATIONS

The study was lacking the reagents for performing molecular characterization (genotyping) of bacterial Deoxyribonucleic acid (DNA) from each bacterial species that will exhibit gene of resistance to antimicrobial such as betalactams.

6. STUDY RECOMMENDATIONS

We advise the hospital personel to adequate clean the surfaces, frequent washing hands using clean running water with soap or use of sanitizer and adequate decontamination of surface and instruments by following the standard operating procedures developed as recommended by the national Infectious Prevention and Control (IPC) guideline 2018 and the application of advanced IPC in hospital settings as safety rules to protect hospital staffs, patients or visitors attending or visiting the Benjamin Mkapa Hospital. There should be regular checkup of surface for any existing bacteria by performing swab culture in Microbiology department. People are strongly adviced to practice good personal hygiene to reduce or prevent transmission of infectious bacteria in hospital and or in the community.

7. CONCLUSION

BMH cleanliness was suspected to be not adequate due to existence of microbes in both morning and afternoon, few hours after cleaning has been done. Most of the bacteria were believed to be transmitted through hand to hand contact between one person to another or on one person to surface and vice versa [2,3]. Direct

contacting contaminated surface were the causal of hospital transmission of infectious bacteria in hospital and cariage of infectious bacteria to the community and vice versa [2,5,6-7]. The study is supporting the frequent washing hands using clean running water with soap (or use of sanitizer) and adequate decontamination of surface and instruments to maintain cleanliness of environmental surfaces and hence eradication or lowering transmission of bacterial infection and slowing the spread of bacteria that are most resistant in humans [8].

CONSENT

Not Applicable.

ETHICAL APPROVAL

The Central Zone Health Research Ethics Review Committee (CZHREC) approved and granted certificate with Ref No.002/2020 (Appendix I). BMH authority granted permission to conduct this study at Benjamin Mkapa Hospital. The study was complying with the principals of Helsinki for Good laboratory practices that Confidentiality to be kept for all information gathered from study.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Maori L, Agbor VO, Ahmed WA. The prevalence of bacterial organisms on toilet door handles in secondary schools in Bokkos LGA, Jos, Plateau Sate, Nigeria. IOSR Journal of Pharmacy and Biological Sciences. 2013;8(4):85-91.
2. Odigie AB, Ekhiase FO, Orjiakor PI, Omozuwa S. The role of door handles in the spread of microorganisms of public health consequences in university of benin teaching hospital (UBTH), Benin City, Edo State. Pharmaceutical Science and Technology. 2017;2(2):15-21.
3. Boyce JM. Environmental contamination makes an important contribution to hospital infection. Journal of Hospital Disease. 2007;65:50-54.
4. Reynolds KA, Hurst CJ. Manual of Environmental Microbiology 2nd Annual Public Health Association. 2005;9.
5. Bright KR, Boone SA, Gerba CP. Occurrence of bacteria and viruses on lementary classroom surfaces and the potential role of elementary classroom hygiene in the spread of infectious disease. Journal of School of Nursing. 2010;26(1):33-41.
6. Doring G, Jansen S, Noll H, Grupp H, Frank F, Botzenhart K, Magdorfand K and Wahn U. Distribution and transmission of *Pseudomonas aeruginosa* and *Burkholderia cepacia* in a hospital ward. Paediatrics Pulmonologist. 1996;21:90-100.
7. Nworie A, Ayeni JA, Eze UA, Azi SO. Bacterial Contamination of Door Handles/Knobs in Selected Public Conveniences in Abuja Metropolis, Nigeria: A Public Health Threat. Continental Journal of Medical Research. 2012;6(1):7 – 11.
8. Mkala RS, Azizi KA. Prevalence and antimicrobial resistance patterns of extended spectrum beta lactamase producing enter Ohemorrhagic *Escherichia coli* strain O157:H7 from cattle and humans in Moshi, Northern Tanzania. Microbiology Research Journal International. 2017;19(3):1-10.
9. Zinzaro F. http://ezineartides.com? Normal Microbial flora and Id=4121703; 2010.
10. Onwubiko NE, Chinyeaka AH. Isolation and identification of bacterial contaminants from door handles in a Tertiary institution in Umuahia, Abia State, Nigeria. Nigerian Journal of Microbiology. 2015;29:3139-3147.
11. Saka KH, Akanbi II AA, Obasa TO, Raheem RA, Oshodi AJ. Bacterial contamination of hospital surfaces according to material makes, last time of contact and last time of cleaning/disinfection; 2017.
12. Damaceno QS, Iquiapaza R, Oliveira AC. Comparing resistant microorganisms isolated from patients and environment in

an intensive care unit. Advances in Infectious iseases. 2014;4:30-35.
13. Chilongola J, Msoka E, Juma A, Kajeguka D.C, Semvua H, Kituma E, Kwigizile E, Nyombi B. Antibiotics prescription practices for provisional malaria cases in three hospitals in Moshi, Northern Tanzania. Tanzania. Journal of Health Research. 2015;17:3.
14. Kajeguka DC, Nambunga PP, Kabissi F, Benjamin Kamugisha B, Kassam N, Nyombi B, Mataro C, Venance Maro V, Chilongola JO. Antimicrobial resistance patterns of phenotype Extended Spectrum Beta-Lactamase producing bacterial isolates in a referral hospital in northern Tanzania. Tanzan. J. Health Res. 2015;17.
15. Mendel M, Mirer A. Indoor thermal factors and symptoms in office workers: findings from the US EPA BASE study. Indoor –Air. 2009;19:219-302.
16. Clinical and Laboratory Standards Institute, CLSI (2019) Performance standards for antimicrobial susceptibility testing; 29th ed. *CLSI,* supplement *document M100*.
17. Mbim EN, Mboto CI, Agbo BE. A Review of Nosocomial Infections in Sub-Saharan Africa. MRJ. 2016;15(1):1-11.
18. Rutala WA, Weber DJ. Role of the hospital environment in disease transmission, with a focus on Clostridium difficile Healthcare Infection. 2013;18:14–22
19. Havill NL, Havill HL, Mangione E, Dumigan DG, Boyce JM. Cleanliness of portable medical equipment disinfected by nursing staff. Am J Infect Control. 2011;39:602–604.
20. Nair V, Sahni AK, Sharma D, Grover N, Shankar S, Chakravarty A, Patrikar S, Methe K, Jaiswal S.S, Dalal S.S, Kapur A, Verma R, Prakash J, Gupta A, Bhansali A, Batura D, Gopa, Rao G, Joshi DP, Chopra BK. Point prevalence & risk factor assessment for hospital-acquired infections in a tertiary care hospital in Pune, India. Indian J Med Res. 2017; 145:824-832.
21. Johnson JR, Sannes MR, Croy C, Johnston B, Clabots C, Kuskowski M. A, Bender J, Smith K. E, Winokur PL, Belongia EA. Antimicrobial drug-resistant *Escherichia coli* from humans and poultry products. Minnesota and Wisconsin, 2002-2004. Emerg. Infect. Dis. 2007;13:838-846.
22. Lee KE, Lim SI, Choi HW, Lim SK, Song JY, An DJ. Plasmid-mediated AmpC etalactamase (CMY-2) gene in *Salmonella typhimurium* isolated from diarrheic pigs in South Korea. BMC. Res. Notes. 2014; 7:329.
23. Mshana SE, Kamugisha E, Mirambo M, Chakraborty T, Lyamuya EF. Prevalence of multiresistant gram-negative organisms in a tertiary hospital in Mwanza, Tanzania. BMC of Global Infectious Diseases. 2009;2:263–274.
24. Mshana SE, Gerwing L, Minde M, Hain T, Domann E, Lyamuya E, et al. Outbreak of a novel *Enterobacter* sp. carrying blaCTXM- 15 in a neonatal unit of a tertiary care hospital in Tanzania. Int. J. Antimicrob. Agents. 2011;38:265–269.

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