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Types of Bacteria on Some Medical Devices Used in Sultan Qaboos University Hospital Wards

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Abstract: The objective of this study is to determine the nature of bacteria on the surfaces of some medical devices used in Sultan Qaboos University Hospital (SQUH) wards. Swab specimens were collected from surfaces of medical devices and plated on different bacteriological media. Organisms growing on the media were purified and identified using Phoenix Automated System. Of all the isolates, coagulase negative staphylococci were 43.9%, Gram positive rods, 35.1%, *Staphylococcus aureus,* 3.6%, *Serratia rubidaea,* 3.2%, *Klebsiella pneumoniae* and *Chryseomonas luteola,* 2.3% each, *Pantoea* species, 1.9%, *Flavimonas oryzihabitans* and *Stenotrophomonas maltophilia,* 1.4% each, *Pseudomonas aeruginosa,* 0.9%, *Providencia stuartii, Citrobacter freundii*, *Proteus penneri*, *Burkholderia stutzeri*, *Enterobacter cloacae*, *Acinetobacter baumannii*, *Serratia plymuthica* and *Pseudomonas fluorescence* 0.5% each. Though these organisms were found on the devices, none was an ESBL or beta lactamase producer. However, it is recommended that heightened surveillance of the microbial load on the devices should be undertaken at predetermined intervals.

Key words: Hospital · Bacteria · Medical devices · Ward · Contamination

INTRODUCTION

Sultan Qaboos University Hospital (SQUH) is a 380 bed hospital certified by ISO BS 9001, 2008 and regularly cleaned by 3 sets of hospital staff on 24 hour duty. The hospital has never had any major outbreak of hospital acquired infection since its inception twenty years ago, though some antibiotic resistant bacteria like *Pseudomonas aeruginosa*, *Stenotrophomonas maltophilia, Escherichia coli*, *Klebsiella pneumoniae, Acinetobacter baumannii* and *Staphylococcus aureus* are oftentimes isolated from long staying patients.

Since its certification by ISO BS 9001 2008 four years ago, the hospital has resolved to monitor and sustain its cleanliness through scrupulous supervision by the infection control team of the hospital through persistent checks on the microbial loads on some medical devices used for the patient care in the hospital.

Contact of healthcare workers with an infected patient or contaminated medical devices are the common routes of transmission of *Staphylococcus aureus* which can survive on dry surfaces for prolonged period of time [1]. Moreover, staphylococcal related infections were associated with contaminated pacemakers, implantable cardiovertor defibrillators, intravascular catheters, vascular grafts and stents, or left ventricular assisted devices [2].

Acinetobacter baumannii and other bacteria within Enterobacteriaceae were found to be associated with ventilator related pneumonia and were increasingly isolated from patient's bed linens, mattresses, pillows, fans, surfaces of hospital cupboards and on wet environments such as plastic tubing, pressure monitors, sinks, respirometers, cleaning cloths and face flannels [1, 3, 4]. Recent studies showed ventilator-associated pneumonia due to *Pseudomonas aeruginosa* to be 24.4%, *Acinetobacter* species 7.9%, *Stenotrophomonas maltophilia* 1.7%, *Klebsiella* species 15.6%, *Escherichia coli* 24.1%, *Proteus* species 22.3%, *Enterobacter* species 18.8%, *Serratia* species 12.1%, *Citrobacter* species 5.0%, *Hafnia alvei* 2.1%, *Haemophilus* species 9.8%, methicillin-resistant *S. aureus*, 55.7%, methicillin-susceptible *S. aureus*, 44.3%, *Streptococcus* species 8.0%, *Streptococcus pneumoniae* 4.1%, coagulase-negative staphylococci 1.4%, *Neisseria* species 2.6%, anaerobes 0.9% and fungi, 0.9% [5].

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Reinhardt *et al.* [6] found 50% of nebulizers contaminated by *Acinetobacter calcoaceticus* var *anitratus* alone or in association with *Pseudomonas* species while hospital computer monitors, computer mouse and keyboards were found to be reservoirs for *S. aureus*, *Pseudomonas, A. baumannii, Clostridium perfringens, Enterococcus* spp, *E. coli, Corynebacterium* species and *Bacillus* [7-9]. Surface swabs from blood pressure cuffs and ultrasound gel grew *Pseudomonas, Bacillus*, *Candida albicans*, *Enterococcus faecalis, Clostridium difficille, Acinetobacter, Burholderia cepacia,* coryneforms and *S. epidermidis* [10]. Cohen *et al.* [11] evaluated the degree of contamination of spacer devices and face masks and found *Pseudomonas* species, *Klebsiella, Proteus, Enterobacter*, *E. coli, S. aureus, S. epidermidis, Enterococcus, Bacillus* species, *Corynebacterium, Sarcina lutea* and *C. albicans* to be present.

The objective of this study is to determine the prevalence of some bacteria on some medical devices used in Sultan Qaboos University Hospitis (SQUH) wards. The finding of the study is necessary for monitoring, evaluating and updating the hospital's surveillance data on the organisms associated with nosocomial infection.

MATERIAL AND METHODS

Sample Collection: Cotton wool swabs moistened with sterile saline were used to swab approximately 1 cm^2 of hospital computers, telephones, nebulizer machines, ECG machines, defibrillators, syringe pumps, weighing beds, trolleys, blood pressure cuffs, surgical masks, vital signs machines, ventilators, key board of central monitors, boxes containing medicine, hand sanitizers, X-ray machines, temperature pulses, laryngoscopes, blood gas analyzers and panel of baby incubators. These devices are found in some of the wards in the hospital.

Media: The media used in the investigation were cysteine lactose electrolyte deficient agar (CLED, HIMEDIA-India) and blood agar (BA, OXOID-England)

Inoculation of Media: The swabs were plated on the CLED and BA and incubated for 48 hours at 37°C. The organisms on plates were purified and identified using standard bacteriological procedures and Phoenix automated system (Becton-Dickinson, Maryland).

RESULTS

Table 1 gives the names of the wards and the equipment/instruments from where bacterial isolates were made while Table 2 indicates the percentage distribution of the isolates. The isolates were predominantly of skin, faecal or environmental origins. The most contaminated medical device was defibrillators where *K. pneumoniae, S. rubidaea*, *F. oryzihabitans*, *B. stutzeri* and S. *aureus* were isolated (Table 1). The most common isolates were coagulase negative staphylococci, 43.9% followed by Gram positive rods, 35.1%.

DISCUSSION

Most nosocomial infections in hospitals worldwide are linked to some human activities near or inside the hospitals, to available water supply, contaminated air and medical devices or equipment used in the healthcare delivery [1, 3, 12-14].

In this study, a wide range of medical devices were screened to determine which type of bacteria was present. The experiment is not aimed at establishing which counts (colony forming units per m^2 per hour (CFU/m^2/hour) used for assessing the degree of cleanliness of surfaces. The sampled equipment/instruments were found to be contaminated with the exception of the infusion pumps and panels of baby incubators in the neonatal ward. Though coagulase-negative staphylococci (43.9%) and *S. aureus* (3.6%) were the most prevalent isolates in this investigation, they are known to survive dryness and can remain dormant on medical devices for weeks or months especially where traces of coagulated proteins are present [1, 15]. In addition, the contact of healthcare workers with infected patients or contaminated equipment is observed to be the common routes of their transmission. The second most prevalent isolates were *Bacillus* (diphtheroids, 35.1%) followed by Gram negative rods.

The presence of the organisms on the medical devices highlights the flaws on the cleaning and disinfection processes of medical equipment in the hospital.

The wards are cleaned by 3 sets of cleaners on 24 hour basis while the medical devices are sterilized after exposure to patients, yet these organisms were found on some of the devices. Their presence is attributable to inadequate infection control measures that can arise from poor cleaning and disinfection processes as cleaning

Table 1: Types of Medical Devices Sampled From Each Ward and Bacteria Isolated

Medical Devices	Organism	Medical Devices	Organism
ICU[a]			
computer	*Pantoea* spp. *P. stuartii*	Syringe pumps	*S. rubidaea* *S. aureus* *C. freundii* *F. oryzihabitans*
Monitor holder	*K. pneumoniae* *P. penneri*	Defibrillators	*S. rubidaea* *S. aureus* *F. oryzihabitans* *B. stutzeri*
Weighing scale	*S. aureus* *E. cloacae*	Ventilators	*S. aureus*
Medicine boxes	*F. oryzihabitans*		
MMW_1[b]			
Vital sign machine	*S. aureus*	Temperature pulse	*S. aureus*
Blood pressure cuffs	*S. aureus*	X-ray machine	*P. aeruginosa* *Pantoea spp.*
MMW_2[c]			
Masks	*Pantoea spp.* *K. pneumoniae*	Defibrillators	*K. pneumoniae*
Blood pressure cuffs	*A. baumannii*		
FMW[d]			
Nebulizers	*S. rubidaea*	Mask	*S. plymuthica* *Pantoea* spp.
A and E[e]			
Blood gas analyzer	*K. pneumoniae*		
CTENTSW[f]			
Vital signs	*P.aeruginosa* *S. maltophilia* *C. luteala*	ECG machine	*S.maltophilia* *C. luteala*
MSW[g]			
Computer	*C. luteala* *S. rubidaea*	Telephone	*S. aureus* *S. maltophilia*
Vital signs	C. luteala		
FSW[h]			
Defibrillators	*S. rubidaea* *K. pneumoniae*	Masks	*C. luteala*
Telephones	*S. rubidaea*	Computers	*P. fluorescence*

a. Intensive Care Unit
b. Male Medical Ward 1
c. Medical Ward 2
d. Female Medical Ward
e. Accident and emergency
f. Cardio-Thoracic / Ear, Nose, Throat, Surgical Ward
g. Male Surgical Ward
h. Female Surgical Ward

Table 2: Positive Isolates and Their Percentage (%) Distribution

Bacteria	No. of isolates	Percentage (%)
Coagulase negative staphylococci	95	43.9
Gram positive rods	76	35.1
Staphylococcus aureus	8	3.6
Serratia rubidaea	7	3.2
Klebsiella pneumoniae	5	2.3
Chryseomonas luteola	5	2.3
Pantoea species	4	1.9
Flavimonas oryzihabitans	3	1.4
Stenotrophomonas maltophilia	3	1.4
Pseudomonas aeruginosa	2	0.9
Providencia stuartii	1	0.5
Citrobacter freundii	1	0.5
Proteus penneri	1	0.5
Burkholderia stutzeri	1	0.5
Enterobacter cloacae	1	0.5
Acinetobacter baumannii	1	0.5
Serratia plymuthica	1	0.5
Pseudomonas fluorescence	1	0.5
Total	216	100

without disinfection merely reduces the microbial load on some of the devices [16]. The acceptable bacterial count (CFU/m^2/hour) that ensures clean surfaces is not agreeable as the outcome of bacterial counts depend on the type of bacteria, their particulate sizes, their velocities/air movements and on the nature of the surfaces [textile, plastic, wood [17]. The nature of cloths used for cleaning is found to influence the outcome of bacterial counts as some cloths allow adhesion of bacteria on their surfaces and are subsequently transferred from one device to the other when the cloths are used. Bergen *et al*. [18] recommended that cleaning should start from less contaminated to grossly contaminated so as to cut down on the microbial transfer. The use of microfibre cloth, though recommended, does not ensure non transfer of bacteria between surfaces [19]. The other problem which may contribute to the high microbial load on the devices is the failure of the healthcare workers to strictly practice thorough hand washing after handling patients or their failure to wear gloves between patients or to get rid of the contaminated gloves used to handle patients before operating the devices. The presence of Gram negative rods on the devices is worrisome since they are known to be present in faeces and water, thrive in moist surfaces and are associated with nosocomial infections [12, 20]. Organisms like *Flavimonas oryzihabitans*, *Chryseomonas luteola* and *Pantoea* species isolated in this experiment are associated with serious infections in immunocompromised patients by some workers and should not gain entry into the wards [21-23]. However, hand washing and sanitization alone, though very important and essential in the control of microbes on surfaces are insufficient to prevent contamination of medical devices since contamination can come from the air, dust, human activities such as walking, vacuuming, talking and sneezing, or from the water supplied to the hospital. The patients care facilities in the wards like ventilation system, air conditioning, filtered air, filtered rather than chlorinated water (since some bacteria found in water are chlorine resistant), are important factors to be considered [24, 25]. Other factors of importance are the type of sanitizers used by the healthcare workers since some sanitizers like chlorhexidine is found not to kill bacteria like *Serratia* or *Pseudomonas* species [26, 27].

Though some of the Gram negative rod isolates in this study were found to be multiple drug resistant in other studies, their antibiotic susceptibility tests using Phoenix facilities (AST profiles) showed them to be non ESBL or beta lactamase producers. None of the isolates of *S. aureus* was an MRSA strain.

CONCLUSION

This study examined the degree of cleanliness of some of the medical devices used on patient care in SQUH. Though they are cleaned on regular basis, the study shows some of them to still harbour *C. luteala, S. maltophilia, P. aeruginosa, B. stutzeri, C. freundii, P. penneri, E. cloacae, A. baumannii, Serratia* and *Pantoea* species, *K. pneumoniae* and *Staphylococcus* species indicating that the cleaning modes are not optimum.

In as much as these organisms are found on medical devices, their association with nosocomial infections in SQUH is not established, though quite recently, *A. baumannii* with multiple drug resistance was isolated. The study calls to mind the need to maintain good surveillance and heightened monitoring of bacteria on the medical devices used in the hospital.

Recommendation: The hospital staff should practice thorough hand washing and dispose off contaminated gloves used between patients before operating medical devices. The healthcare workers should be provided with the right type of cleaning cloths and instructed to disinfect them between equipment. Filtered rather than chlorinated water should be used in such places like the operating theatre and intensive care units since *Pseudomonas* and bacterial spores found in water are resistant to chlorine [12, 13].

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