

Characterization of Bacteria Community Composition and Antimicrobial Susceptibility Profile in the Intensive Care Unit of a Community Hospital in Bermuda

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Abstract

Objective: This study was undertaken to determine the presence of multidrug-resistant (MDR) pathogenic bacteria in the environment of the Intensive Care Unit in a community hospital in Bermuda.

Methods: Twenty six environmental swabs taken from specific areas such as door handles, sinks, cupboards, drip stands, bed railings, work stations, computer keyboards and telephones were obtained for the study. Standard Microbiological methods using Clinical Laboratory Standards Institute (CLSI) were used in the study. Identification and susceptibility testing for all isolates were carried out using the Vitek II automated system (BioMerieux, Inc., Durham, NC).

Results: No multi-drug-resistant organisms were isolated from the ICU environment. The majority of the organisms isolated were non-pathogenic Gram-positive cocci such as coagulase negative *Staphylococcus*, *Micrococcus* spp and *Dermaococcus* spp. Opportunistic pathogenic Gram-negative bacteria such as *Pseudomonas aeruginosa*, *Acinetobacter hemolyticus* and *Klebsiella oxytoca* were detected and were relatively susceptible to antimicrobial agents. In addition, Gram-negative organisms such as *Brevundimons diminuta* and *Parococcus yeei* were isolated from the environment. However, these organisms are usually not pathogenic.

Conclusion: Good compliance with Infection Prevention and Control measures as well as antimicrobial stewardship are important in preventing hospital acquired infections (HAI) including those caused by MDR organisms especially in an ICU setting.

Keywords: ICU; Bacteria community; Antibiotic susceptibility; Multidrug resistance

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Introduction

The Intensive Care Unit (ICU) is a reservoir which facilitates opportunistic infections in critically ill patients, resulting in increased morbidity, mortality and healthcare costs [1,2]. ICU patients have risk factors for healthcare associated infections (HAI) due to their underlying conditions, impaired immunity and exposure to multiple invasive devices [3]. The ICU is considered a source for the dissemination of multidrug-resistant organisms (MDROs), primarily due to the extensive antimicrobial use in that setting which promotes a selection pressure promoting the emergence of MDROs [4]. The two predominant MDR Gram-

positive organisms responsible for causing HAIs are methicillin resistant *Staphylococcus aureus* (MRSA) and vancomycin resistant *enterococci* (VRE). MRSA has many routes of transmission including formite contacts or the hands of colonized healthcare professionals. The Gram-negative organisms *Pseudomonas aeruginosa*, *Acinetobacter baumannii*, *Klebsiella pneumoniae* and *Sterntrophomonas maltophilia* can also become MDRO and cause HAI, especially in an ICU setting.

It has been reported that room occupation by a patient with VRE, MRSA, *Clostridium difficile* or *Acinetobacter baumannii* infection, increases the risk for subsequent patients developing HAIs

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with these organisms, suggesting that the organisms remained in the environment despite room cleaning between patients [5]. The presence of biofilms may be a contributing factor for the persistence of environmental contamination. Biofilms can protect incorporated bacteria from both desiccation and the action of cleaning and disinfecting agents.

The aim of this study is to determine whether pathogenic MDROs are present in the ICU of a community hospital.

Methods

The study involved taking environmental swabs from the ICU which has 9 rooms at King Edward VII Memorial Hospital, a 193-Acute Care bed community hospital. The swabs were taken on two separate days: on September 16th and September 18th 2019, from the ICU environment, including 6 unoccupied rooms. The majority of the patients in the ICU have medical conditions such as sepsis, stroke and cardiac disease. The average length of stay in the ICU is 5-6 days. Twenty six environmental swabs were collected from various locations in the ICU. The samples were taken from specific areas such as sinks, door handles, cupboards, bed railings, equipment, work stations, computer keyboards and telephones. Each sample was plated on sheep blood agar and MacConkey agar and incubated at 37°C aerobically for 24-48 hours. Identification and susceptibility testing for all isolates were carried out using the Vitek II automated system (BioMerieux, Inc., Durham, NC).

Results

Twenty six environmental swabs were taken from the ICU: 21 of the swabs were positive for bacterial growth and the remaining 5 were negative after 24-48 hours of incubation. More than one type of bacteria was identified from some samples investigated in the study. 14 Gram-positive (GPC) were isolated from the 21 positive cultures. The GPC isolated were mainly coagulase negative *Staphylococci*, *Micrococcus* spp and *Dermacoccus* spp. Six Gram-negative bacilli (GNB) bacteria were isolated from the 21 positive cultures. The GNB bacteria isolated were

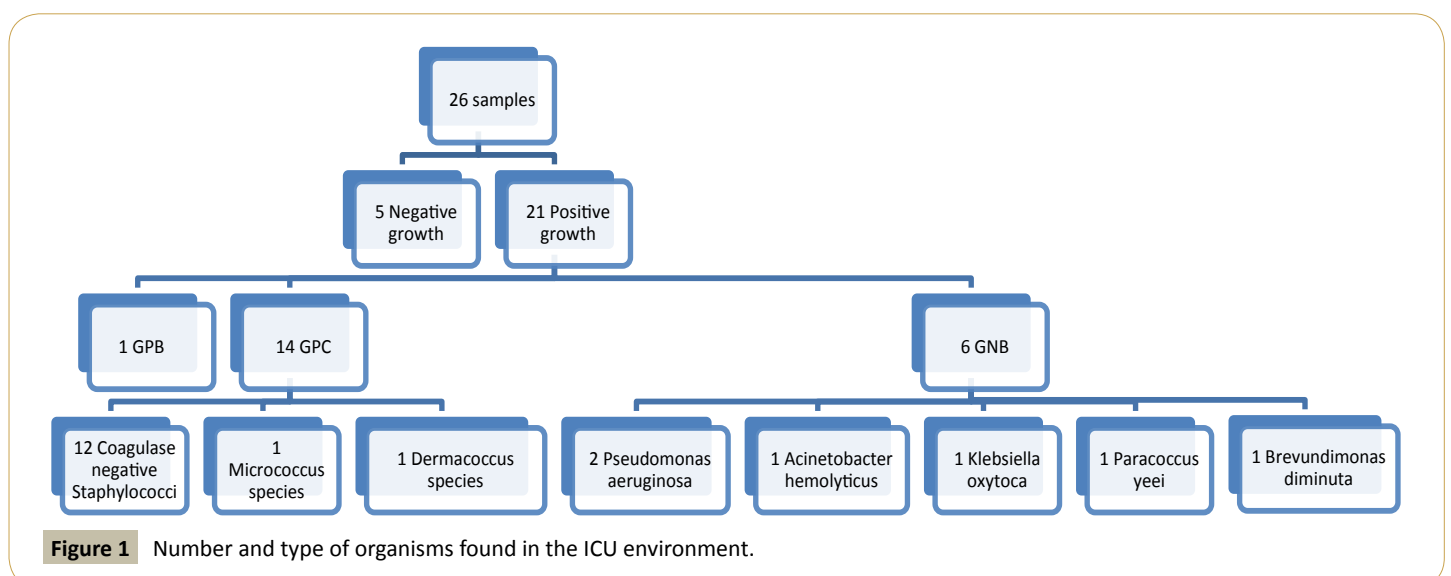
Pseudomonas aeruginosa, *Acinetobacter hemolyticus*, *Klebsiella oxytoca*, *Paracoccus yeei* and *Brevundimonas diminuta* (Figure 1). The GNB bacteria were isolated from the sinks in the ICU.

Antimicrobial susceptibility testing results of the opportunistic pathogens isolated in the ICU indicated that *Pseudomonas aeruginosa* and *Acinetobacter hemolyticus* bacteria were susceptible to Gentamicin, Ciprofloxacin, Piperacillin-Tazobactam and Ceftazidime. *Klebsiella oxytoca* was susceptible to Gentamicin, Trimethoprim-Sulfamethoxazole, Ceftriaxone, Ceftazidime and Piperacillin-Tazobactam.

Discussion

It is important to have a comprehensive understanding of the ICU environmental microbial community composition, which is essential for improving decontamination processes which may directly impact patient care. The results of this study showed that MDROs such as MRSA, VRE and extended spectrum beta lactamase (ESBL) producing organisms were not detected in the ICU environment. The majority of non-pathogenic organisms isolated were Gram positive cocci (GPC) such as *Staphylococcus* spp. Gram negative bacilli such as *Pseudomonas aeruginosa*, *Klebsiella oxytoca* and *Acinetobacter haemolyticus* were detected in the ICU but they were not multidrug-resistant. However, a recent study reported MDR *Acinetobacter* spp and *Pseudomonas aeruginosa* in the environment of the ICU in a tertiary care hospital in Jamaica [6].

Pseudomonas aeruginosa is ubiquitous in moist hospital environments [7]. Furthermore, it is an opportunistic pathogen in immunocompromised patients that causes a wide range of infections [8]. Hospital water can be a source of outbreaks in both neonatal and adult ICU, colonizing and forming biofilms in water, taps, sinks and showers [9,10]. Routes of transmission include environment to patient either directly from water or splashes from water outlets, or indirectly from contaminated hands or equipment. Multidrug resistance in *Pseudomonas aeruginosa* is common and the mortality rate in invasive infection is increasing and as such, controlling the spread of this organism is important [11]. *Acinetobacter* spp are usually opportunistic pathogens



reported to cause a number of outbreaks of HAIs such as septicemia, pneumonia and ventilator associated pneumonia in ICU [12]. The emergence of carbapenemase producing *Klebsiella oxytoca* has been reported in the literature [13,14]. Furthermore, carbapenemase producing *K. oxytoca* bacteria were isolated from five patients who were admitted to an ICU in Austria [15]. Carbapenem resistant *Acinetobacter baumannii* (CRAB) infections have been reported in a medical ICU in Singapore. In addition, environmental colonization of CRAB by patients highlighted the importance of environmental hygiene [16]. A related study confirmed the efficiency of combined hand and surface hygiene to ensure low rates of bacterial colonization in the ICU [17]. Recently, a study reported epidemiological, clinical and microbiological findings of a *Candida auris* outbreak in the Intensive Care areas and medical units as well as surgical units of a regional Omani hospital. Furthermore, the findings of the study highlighted the role of environmental contamination in facilitating *C. auris* transmission [18]. *Brevundimonas diminuta* is

an environmental Gram-negative bacillus previously assigned to the genus *Pseudomonas*. The organism is infrequently isolated in Clinical Microbiology. *Paracoccus yeei* is a Gram-negative coccobacillus which is found in a variety of environments especially soil. *Micrococcus* organisms are Gram-positive cocci which are not pathogenic and found in water, dust and soil. *Dermacoccus* organisms are Gram-positive cocci and are present on skin as a part of the normal flora [19].

Conclusion

The extensive use of antimicrobial agents in the ICU imposes a selection pressure promoting the emergence of MDROs. Infection Prevention and Control measures should be stringently practiced in order to prevent the transmission of infectious agents. The findings of the study reflect good compliance with Infection Prevention and Control policies and procedures in the ICU. Furthermore, frequent cleaning and decontamination are essential to prevent the development of biofilms on ICU surfaces.

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