

Environmental surfaces in healthcare setting: a great potential risk of pathogens transmission.

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Abstract

The aim of our study is to estimate bacterial contamination of the surfaces surrounding hospitalized patients. This study was achieved from March to June 2014, in an internal medicine ward at the Hospital University Hassan II in Fez. By using the swab technique, the samples were taken from different surfaces surrounding hospitalized patients. Bacterial analysis was performed according to conventional culture and identification techniques. Antimicrobial susceptibility was determined for each isolate by the disk diffusion method. During the study period, 112 samples were collected from different sites in 10 rooms. The bedrails are the most contaminated sites (100%), followed by bedside tables (60%). Toilets door knobs and room knobs come in third place (50%). We identified 200 isolates of bacteria: Coagulase Negative *Staphylococci*, *Staphylococcus aureus*, *Enterobacter sp.*, *Pantoea sp.*, *Klebsiella sp.*, *Escherichia coli*, *Pseudomonas sp.*, *Stenotrophomonas sp.* and *Enterococcus sp.* Different antibiotic resistance profiles were registered for isolated bacteria of which 1 isolate of *Enterobacter aerogenes* and 1 *E. coli* are ESBL. We report in this study that hospital environment is contaminated by a variety of pathogenic and opportunist, resistant and sensitive bacteria isolated from many surfaces sites of patients rooms. Hospital must implement evidence-based infection prevention measures that will reduce the risk of transmission of pathogens via contaminated hospital surfaces and medical equipment.

Keywords: Hospital environment, Bacterial contamination, Nosocomial transmission, Fez, Morocco.

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Introduction

Health-care associated infections HAIs are among the major causes of death and the increasing morbidity for hospitalized patients. The issue of the risk of patient infection through contaminated hard surfaces in hospital rooms has been widely discussed [1,2]. Environment represents the external source of HAI and includes air, food, water, surfaces surrounding the patient and medical devices. Patient environment are frequently contaminated by nosocomial pathogens, and are considered as a reservoir for pathogens transmission directly through patient contact with the environment or indirectly through contamination of health care workers' hands and gloves [3]. The contaminated surfaces contribute to the epidemic and endemic transmission of several pathogens including Gram-positive pathogens like *Clostridium difficile*,

Methicillin-resistant *Staphylococcus aureus* (MRSA), Vancomycin-resistant *Enterococcus* (VRE), and Gram-negative pathogens (*Pseudomonas*, *Klebsiella* and *Acinetobacter* sp.) as well as some viruses [3]. Furthermore, several studies have reported that contaminated surfaces in hospital are a well-recognized cause of common-source outbreaks of infection [1,4]. Moreover, hospitalization in a room in which the previous patient had been colonized or infected with these pathogens has been shown to be a risk factor for colonization or infection with the same pathogen for the next occupant admitted to the room [5,6]. Thus, microbial evaluation of surfaces is useful in monitoring the effectiveness of the cleaning and disinfecting practices. So, the aim of this study was to estimate bacterial contamination of the inanimate environment surrounding patients, and also to examine the presence of specific nosocomial multi-resistant pathogens

which may be the cause of nosocomial infection. This information will be needed for the control program and for the improvement pathogenic control practices.

Materials and Methods

Study design

This study was performed in HASSAN II University Hospital UH, a 880-bed tertiary care center located in Fez city. The study was carried out in response to demand from head of internal medicine ward, to evaluate the efficacy of routine cleaning and disinfection practices. However, neither cleaning nor ward staffs were informed about the environmental sampling, which was performed at random intervals during the day working. This study was undertaken during non-outbreak settings. Cleaning and disinfecting practices in the service are conducted as a routine activity by environmental services workers, using a quaternary amine based product or bleach, without any specific protocols. The cleaners have no training for what they are supposed to be doing. Internal medicine ward is consisting of 10 rooms housing about 24 beds; it is a specific unit which receives particularly immuno-compromised patients with complex medical problems of affecting blood, cancers and infections (AIDS). This makes these patients particularly susceptible to acquire nosocomial infection.

Samples collection and bacterial analysis

Swab technique is the method that we used to collect the samples from the surfaces of patients' rooms. During four months (March-June 2014) and in the absence of a known outbreak, the samples were taken weekly from environment surfaces surrounding hospitalized patients in all rooms of service. The following surfaces were chosen for sampling: bedrails, bedside tables, toilets door knobs, room's door knobs, electricity buttons, cupboards knobs and chemotherapy chairs arm.

Sterile cotton swabs pre-moistened in a buffer solution were used for sampling surfaces. At each site, an area of approximately 10 cm² was swabbed in two directions at right angles to each other in a close zigzag pattern while rotating the swab during sampling to ensure that the entire surface of the swab was used according to the guideline (Norme ISO/DIS 14698-1, 1999). Then, the swab was wetted in tubes containing Brain Heart Infusion Broth (BHI) that encourages the growth of microorganisms. The collected samples are transported immediately to the laboratory, and incubated for 24 to 48 h at 37°C. Selective and specific media were used: Mannitol salt agar for *Staphylococci*, Eosin-Methylen Blue Agar for *Enterobacteriaceae*, Cetremide Agar for *Pseudomonas sp.* Representative bacteria strains were selected on the basis of colony morphology, Gram staining, oxydase and/or catalase tests. Full identification of the bacteria was made by conventional biochemical techniques and confirmed by Galerie API 20E®, API 20NE® and Api Staph® tests according to the manufacturer's instructions (BioMérieux, France).

Antimicrobial susceptibility testing

Antimicrobial susceptibility was determined for each isolate by the disk diffusion method on Mueller-Hinton (MH) agar plates (Bio-Rad, Marnes-la-Coquette, France). The tested antibiotics were chosen depending on species identified according to the Committee of Antimicrobial Testing, French Society of Microbiology (CA-SFM, 2013).

Results

A total of 112 samples were collected from different sites in 10 rooms during the study period. These samples are distributed in the following surfaces sites of patients rooms: bedrails, bedside tables, toilets door knobs, room's door knobs, electricity buttons, cupboards knobs and chemotherapy chairs arm. These chairs were reserved for AIDS patients. All the sampled patient rooms were positive for at least 1 gender of bacteria at one or more environmental sites. The bedrails are the most sites contaminated (100%), followed by bedside tables (60%), toilets door knobs and room's door knobs in third place (50%) (Figure 1).

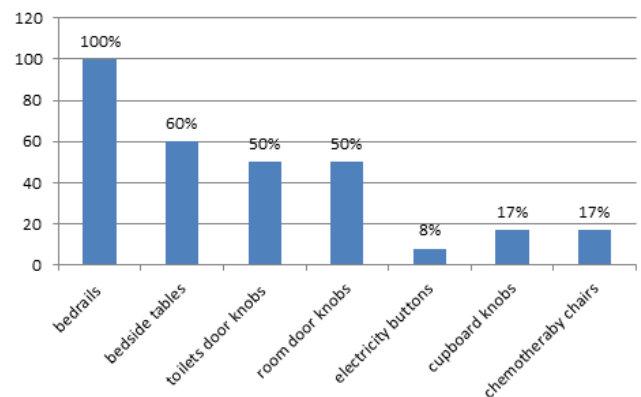


Figure 1. Contamination rate of different sampling sites.

From 112 collected surfaces samples, we identified 200 isolates of bacteria and 38 isolates have not been identified despite our effort. CNS were the large types of identified bacteria 94 (47%), 30% of them were taken from bedrails, 19% from bedside tables and room's doors knobs, 21% from toilets doors knobs, 7% from chemotherapy chairs arm, 2% from cupboard knobs and 2% from electricity buttons. Four isolates of *S. aureus* were identified, 2 strains on bedrails and 2 on room's doors knobs. *Enterobacteriaceae* were present on surfaces analyzed at 39.2%: 18 isolates of *Enterobacter sp.* (9 strains of *E. aerogenes*, 8 *E. cloacae* and 1 *E. amnigenus*), 10 isolates of *Pantoea agglomerans*, 10 *Klebsiella ozaneae*, 2 *Ewingella sp.* and 2 *E. coli*. All these species were regularly taken from bed rails and bed side tables (40 to 45%) except for *Enterobacter species* which were isolated from cupboard knobs (33%) and toilet door knobs (11%). Whereas *E. coli* and *Ewingella sp.* were isolated exclusively from toilet door knobs. Furthermore, 10 strains of *Pseudomonas fluorescence* and 4 *Stenotrophomonas maltophilia* were taken mainly from bed rails and bed side tables (40%), from toilets and doors knobs (20%), while 50% of *Pasteurella sp.* (4 strains) were isolated

from bedside table and 50% from cupboard knobs. Other species are found in this study: 40 isolates of *Bacillus sp.* recovered from the all types of the analyzed surfaces: bed rails (40%), on room's doors knobs and on bedside tables (15% for each), on electricity buttons and on toilets doors knobs (10% for each), on cupboard knobs and on chemotherapy chairs (5% for each). Also, 2 *Enterococcus sp.* was identified from bedrails, and the two isolates are Vancomycin resistant VRE. The study of resistance profile of SCN isolated showed that 85% of bacteria were resistant at least to 1 antibiotic; 71% were resistant to penicillin and erythromycin, 57% were resistant to methicillin and fusidic acid, and 14% were resistant to rifampicin. No resistance of vancomycin and teicoplanin was observed. Concerning *S. aureus*, two strains of *S. aureus* were identified as MRSA and all isolates were resistant to penicillin. We noted also a resistance of 50% to erythromycin and of 50% to gentamycin. All isolates of *Pseudomonas* were resistant to ticarcilline but are sensitive to the other tested antibiotic. Regarding *Enterobacteriaceae* strains, different antibiotic resistance profiles were registered. One isolate of *Enterobacter aerogenes* and 1 *E. coli* are producing Extended Spectrum Beta-lactamase ESBL. These isolates are also resistant to quinolone and fluoroquinolone, gentamycin, tobramycin and trimethoprim-sulfamethaxazole (Figure 2).

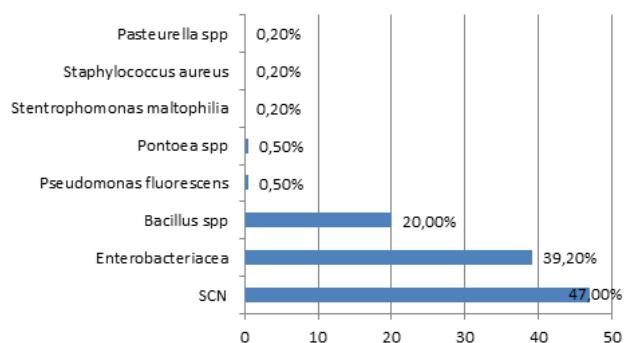


Figure 2. Distribution of bacteria isolated from environmental surfaces.

Discussion

The meaning of environmental cleaning for reducing microbial contamination of surfaces and subsequent risk for HAIs has been reported extensively [7-9]. However, the efficacy of traditional cleaning methods to remove surface contamination is under debate [10]. The cleaning process itself is subject to debate over frequencies, methods, equipment, benchmarks, monitoring, and standards for surface cleanliness [11]. This study was undertaken to estimate the effect of cleaning/disinfecting in a critical ward (internal medicine). As reported by Siegel et al., we showed that the sites frequently touched by patients and healthcare workers (bed rails and bedside tables) were the most commonly contaminated sites [12]. Boyces et al. have reported that environmental surfaces near patients such as bed rails, tray tables, telephones, bedside tables, patient chairs, and nurse call buttons are often heavily contaminated [13]. Furthermore, many bacteria as MRSA, *A. baumannii*, *Pseudomonas spp.*, *Salmonella spp.* and VRE, have been

associated with outbreaks and linked to contaminated mattresses, pillows and bed frames. In our ward, cleaning and disinfecting practices are conducted as a routine activity by environmental services workers, using a quaternary amine based product or bleach. However, we have likewise identified several bacteria of human and environmental origin, which is known to cause nosocomial infections. Coagulase Negative *Staphylococci* (CoNS) are isolated from 100% of sites studied, and are furthermore resistant to several antibiotics (penicillin and erythromycin 71%, methicillin and fusidic acid 57%). These opportunist bacteria are recognized as a cause of human infection including bacteremia and endocarditis particularly for immuno-compromised patients [13]. Also, when exposed to medical devices, CNS can form biofilms on polymer surfaces and devitalized tissue, making biofilm-associated CoNS more resistant to penetration by antimicrobial agents [14]. In our study, 0.16% of environmental surfaces was contaminated by MRSA (2/112), isolated from bedrails and rooms door knobs. This bacterium stills a major concern for hospital hygiene and represents one of the leading causes of hospital-acquired infection. We have also isolated 2 VRE from the bedrails (0.16%). Other authors have recovered this resistant pathogen at 16% in hospital room surfaces; even though, standard terminal cleaning protocols had been well followed [15]. Also, *Enterobacteriaceae* (10 *K. pneumoniae* 2 *E. coli* and 18 *Enterobacter sp.*) were present on 39.2% of analyzed surfaces. From these, 1 isolate of *E. aerogenes* are ESBL producing and 4 *E. cloacae* are resistant to Cephalosporin third generation. Worldwide, *E. cloacae* and *E. aerogenes* have been regularly involved in nosocomial infections outbreaks. They are considered as a part of the ESKAPE pathogens including: *Enterococcus faecium*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Acinetobacter baumannii*, *Pseudomonas aeruginosa*, and *Enterobacter species*. These bacteria represent the vast majority of isolates whose resistance to antimicrobial agents represents a serious therapeutic dilemmas for physicians [16]. *Pantoea spp.* was also isolated (12 isolates). Actually, several studies have reported the association of this germ with nosocomial infections [17,18]. In the other hand, *P. aeruginosa* haven't been isolated but we identified 10 isolates of *P. fluorescens* resistant to ticarcillin and 4 isolates of *S. maltophilia*. These species have acquired increasing importance as nosocomial pathogens and have been involved in many nosocomial infections outbreaks in immune-compromised patients [19].

A multiple studies have reported that cleaning and disinfection protocols were frequently inadequate [8]. Despite this, environmental cleaning may be regarded as a fundamental principle of infection prevention in healthcare settings (1). More, all hospitals should provide a written protocol of cleaning and develop programs to optimize the thoroughness of high touch surface cleaning as part of terminal room cleaning at the time of discharge or transfer of patients [20]. The results of our study will be used as pedagogical tool for hospital staff to raise awareness about hospital cleaning process and to ensure that environmental cleaning procedures must be followed consistently.

Conclusion

We report in this study that hospital environment is contaminated by a variety of pathogenic and opportunist, resistant and sensitive bacteria isolated from many surfaces sites of patients rooms. Hospital must implement evidence-based infection prevention measures that will reduce the risk of transmission of pathogens via contaminated hospital surfaces and medical devices.

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