Bio contamination of surfaces and medical devices in controlled environment areas at a hospital in Morocco

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Abstract. The hospital environment, especially medical devices and surfaces, represents a secondary reservoir for pathogens**.** This work aims to evaluate the microbiological quality of surfaces and medical equipment of controlled environment services (burn unit, operating room, and sterilization service) at a hospital in Meknes (center of Morocco). This study was carried out for three months (September-December of 2017). A total of 63 samples were taken by swabbing technique from different surfaces and medical equipment after bio-cleaning. Identification was performed according to conventional bacteriological methods and by microscopic observation for fungi. The study showed that 68% of the surface was contaminated. The operating room recorded a rate of 93% of contamination (p-value <0.01), 83% for sterilization service, and 47% for burn unit. A percentage of 67% of the isolates were identified as Gram-positive bacteria against 32% Gram-negative bacteria (p-value <0.05). Bacterial identification showed *Coagulase-negative Staphylococci* (45%), *Enterobacter cloacae (14%),* Micrococcus sp (10%), *Klebsiella pneumoniae*, peptostreptococcus sp and *Pseudomonas fluorescens* (7% for each one), *Escherichia coli, and* Methicillin-resistant *Staphylococcus aureus* (5% for each one). These results require corrective action represented by rigorous cleaning and disinfection procedures.

1. Introduction

The hospital environment is generally colonized by many opportunistic and pathogens microorganisms for humans [1]. The microorganisms can survive several days and months on moist and dry surfaces [2]. Hospital surfaces and medical devices could be contaminated by patients, caregivers' hands, or the environment [3, 4]. This contamination depends on the time, the services, the patients, and the care techniques used [5]. The contamination level of hospital surfaces could be related to several factors such as the quality of cleaning, the life of a microorganism on an inert object, its adhesion to the surface, its ability to produce a biofilm [6], and its ability to withstand adverse conditions [7]. Bacterial species isolated from surfaces are not necessarily pathogenic. However, the flora resulting from human activity, such as cutaneous flora [*Staphylococcus aureus*] or mucous membrane bacteria, and certain bacterial species of hydrous flora (*Pseudomonas aeruginosa*) may be responsible for Health-care Associated Infections (HAI) [8,9]. Many types of pathogenic microorganisms have been found on hospital surfaces including *Clostridium difficile* [10,11], Klebsiella sp [12,13], *Staphylococcus aureus* [14,15] and *Acinetobacter baumannii* [16, 17]. Several authors have confirmed the role of the hospital environment in HAI [18, 19]. Therefore, microbiological monitoring of the environment of healthcare facilities is an essential measure for detecting environmental risk. The aim of this work, which was carried for the first time at a hospital in Meknes, was to examine the microbiological quality of surfaces and medical equipment of controlled environment services (burn unit, central block, and sterilization service). Therefore, the purpose of microbiological monitoring of the environment is (i) to examine the presence of nosocomial pathogens and (ii) to evaluate hygiene standards and disinfection practices [20]. This study will help decision-makers to develop an appropriate risk analysis strategy to control the risk associated with the hospital environment.

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2. Material and methods

2.1Study design

We carried over three months (September-December of 2017) the sampling of surfaces and equipment of burn unit, operating room, and sterilization service (controlled environment areas) in a hospital at Meknes. The choice of these services was based on the following criteria:

- French Standard (NF S 90 351-2013).
- The immune status of patients.
- Access to services**.**

2.2 Sampling method

The microbiological sampling of the surfaces was carried out by swabbing using sterile swabs previously moistened with a volume of 1 mL of BHI (Brain Heart Infusion) [21] [22]. The swabbing technique has been used in numerous studies [17,13, 23]. The sampling of each critical point was repeated three times on the same surface. The samples were taken without human activity and after Bio cleaning except for the sterilization service [24].

2.3 Analysis of samples

For isolation, a volume of 10 µL of each sample was inoculated on semi-selective media: Chapman (Staphylococcus and Micrococci), MacConkey (Enterobacteriaceae), Cetrimide (*Pseudomonas aeruginosa),* and Sabouraud (fungi). The Petri dishes of bacteria were incubated for 24 hours, 5 to 7 days for the fungi. The identification of bacteria was carried out according to conventional bacteriology methods. Fungi were identified by two fundamental examinations: macroscopic and microscopic [25].

2.4 Data processing and analysis

Data entry was using Microsoft Office Excel 2010 (version). The descriptive and the analytical part were realized using the XLSTAT extension. To give meaning to the results, we used the Chi-square test. *P-value* <0.001, *P-value* <0.01, *P-value* <0.05 were respectively considered highly significant, very significant, and significant.

3. Results

From 63 samples, 68% (n = 43) of the samples were found positive. The operating room recorded a very high percentage of 93%, followed by the Sterilization service with a percentage of 83%, and finally the Burn unit (47%) (**Fig.1**). The distribution is statistically very significant (Chi-square = 12.69, df = 2, p-value <0.01).

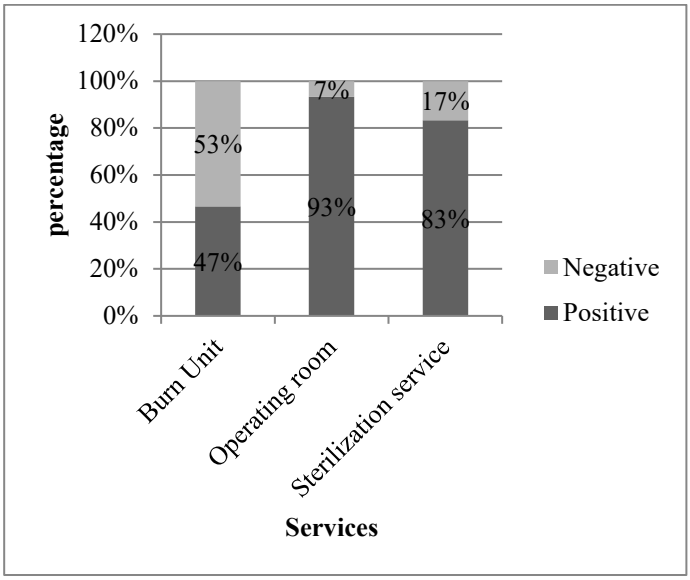

Fig. 1 Percentage of contamination by units.

Autoclave, surgical light, and anesthesia table are the most contaminated (100%), followed by cart (89%) and surfaces (78%) **(Fig.2).**

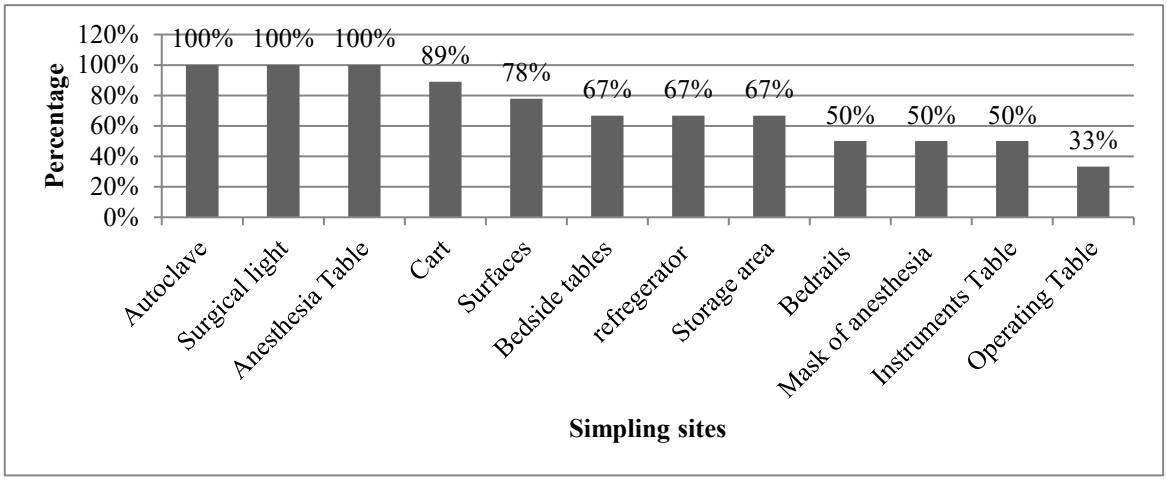

Fig. 2 Contamination rate of different sampling site

Distribution of contamination by sampling sites is highly significant (Chi-square = 4150,172, df = 11, p-value <0.001). A percentage of 98% of the isolates were bacteria, while fungi accounted for only 2%. Almost two-thirds (67%) of the isolated bacteria belong to Gram-positive bacteria against 32% of Gram-negative. The distribution of bacteria according to the Gram staining is statistically significant (chi-square = 7, df = 1, *p-value* < 0.05). Microbiological analysis showed that the bacteria to major nosocomial risk contaminate surfaces. Coagulase-negative Staphylococci was the microorganism most often encountered (45%), followed by Enterobacteriaceae [*Escherichia coli* (5%), *Enterobacter cloacae (*14%*),* and *Klebsiella pneumoniae* 7%] with a percentage of 26% and Micrococcus sp with a percentage of 10%. Peptostreptococcus spp and *Pseudomonas fluorescens* were represented by a percentage of 7% for each one. Finally, *Methicillin-resistant Staphylococcus aureus* has been present with a percentage of 5% **(Fig 3).** The bacterial distribution is highly significant (Chi-square = 32.28, df = 5, p-value <0.001).

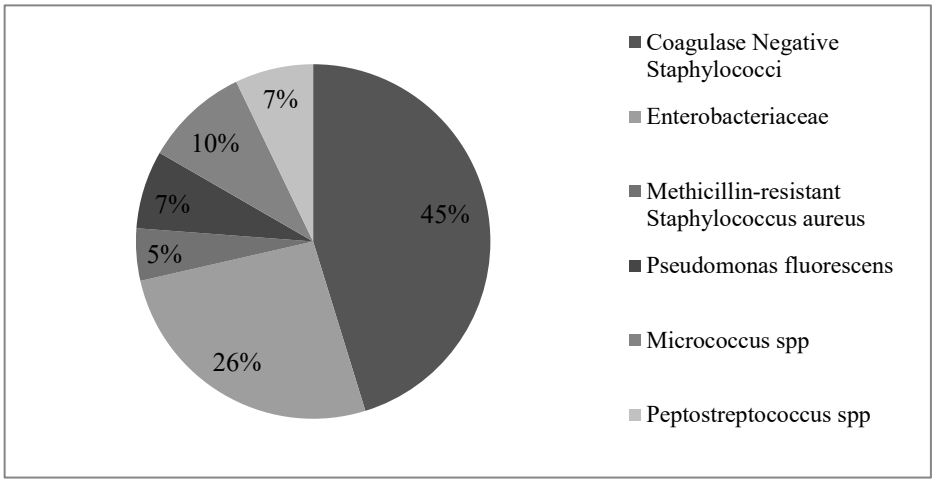

Fig. 3 Distribution of bacteria isolated from surfaces and medical devices.

4. Discussion

The environment close to the patient, especially surfaces and medical devices, carrying a resistant bacterium can serve as a second reservoir [26]. The role of medical equipment and surfaces in the indirect transmission of nosocomial pathogens is a subject of many studies [27, 28]. There is a debate about the appropriate treatment of hospital surfaces to prevent nosocomial pathogens. Some scientists postulate that cleaning surfaces with non-antimicrobial agents are generally enough [29]. Other scientists prefer the cleaning of surfaces with antimicrobial agents close to patients [30, 31]. The choice of disinfecting strategy depends on service, technical platform, and pathogens persistence in the surfaces. In this sense, this work aimed to monitor the microbiological quality of the surfaces and medical devices of controlled environmental services (operating room, burns unit, and sterilization service).

Our study showed a contamination rate of 68%. The operating room was the most concerned with a very high contamination percentage of 93%, followed by the Sterilization service 83% and only 43% for the Burns department. Several studies have reported contamination in the operating rooms [32, 33, 34]. The level of environmental contamination varies according to the care units and the care techniques used [3, 5, 23].

In our study, the most contaminated sites were Autoclave, surgical light, and anesthesia cart, followed by bedside tables, the mask of anesthesia, operating tables, instrument tables, and bed rails. This result could be related to the fact that the equipment and surfaces are often in contact with the care staff and patients. Indeed, Méité et *al*. [35] found that the most contaminated sites were those used by caregivers. Furthermore, medical devices and surfaces with frequent patient contact or caregivers can act as microbial reservoirs and allow infectious agents to contaminate them [36].

The results of our study showed that bacteria represent 98% of isolates against 2% of fungi. Our findings are similar to those of Berrada et *al.* [23]. Identification of fungi did not reveal the presence of either Aspergillus sp or *Candida albicans*. A study conducted in hematology departments (Paris) showed a predominance of Penicillium sp, Fusarium sp, and Mucorales [37]. Another study showed the similarity between *Aspergillus flavus* isolated from a surgical site infection and samples taken at an air conditioner used in the operating room [38].

The results of our study showed a predominance of Gram-positive bacteria [67%]. Lemmen et *al*. [39] and Berrada et *al.* reported similar results [23]. The desiccation resistance of Gram-positive versus Gram-negative bacteria [40] could explain this finding. Other studies have shown a high proportion of Gram-negative bacteria compared with Gram-positive [33, 35].

Bacterial identification determined *Coagulase Negative Staphylococci* at 45%. This bacterium colonized the medical devices of hospitals in Iran [41]. Surveillance of the biocontamination of surfaces and equipment carried in a hospital in Fez (Morocco) showed a percentage of 17% of *Coagulase Negative Staphylococci* (2015) [17] and 24% in 2016 [33]. These opportunist bacteria are a cause of nosocomial infections such as endocarditic for Immuno-compromised patients [42]. *Coagulase Negative Staphylococci* can form biofilms and can be resistant to antimicrobial agents [43]. In our study, *Methicillin-resistant Staphylococcus aureus* (*MRSA*) was isolated from equipment. In a Brazilian university hospital, *Staphylococcus aureus* was isolated from the surfaces close to the patient [1]. Currently, *MRSA* is responsible for 50% of *Staphylococcus aureus* infections in critical patients in the United States of America [44]. This bacterium represents one of the leading causes of Health-care Associated Infections [39]. *MRSA* can survive for long periods on surfaces and transmit to patients via caregivers' hands or the environment [45].

Enterobacteriaceae (*Escherichia coli, Enterobacter cloacae,* and *pneumoniae*) were present on 26% of analyzed surfaces. These species have acquired increasing importance as bacteria pathogens and can be involved in many nosocomial infections. Indeed, Klebsiella spp can cause diseases, including pneumonia, urinary tract infections, sepsis, meningitis, and diarrhea [46]. A study carried at Hassan II hospital (Settat Morocco) revealed the presence of *Klebsiella pneumoniae* at extended-spectrum beta-lactamases (ESBL) positive in the surfaces and equipment [27]. *Escherichia coli* can cause (i) the high incidence of morbidity and mortality, (ii) an increase in the associated costs of these various clinical syndromes, (iii) the pathogenic potential of different groups of *Escherichia coli* strains responsible for intestinal or extra-intestinal diseases and increased resistance to antimicrobials [47]. Concerning *Enterobacter cloacae,* some strains are ESBL producers, conferring resistance to the third- and fourth-generation cephalosporins [48]. In our study, *Pseudomonas fluorescens* represents 7% of isolates. A study was conducted in a hospital in Fes showing *Pseudomonas fluorescens* on hospital surfaces [13]. Pseudomonas sp is a bacterium that can cause many nosocomial infections [49]. It can survive on inanimate surfaces even for months [50]. According to our results, nosocomial pathogens colonized the surfaces and medical devices. Meunier *et al.* having observed a high level of HAI where they found that nosocomial microorganisms cover the medical devices close to patients [21]. The appropriate cleaning or disinfection of environmental surfaces [19] and hand hygiene [51] can reduce Health-care Associated Infections (HAI). Several studies have confirmed that cleaning and disinfection were frequently inadequate [52, 53]. Our study showed the presence of germs of interest nosocomial, which raises the question of the effectiveness of the disinfectants used in these services.

5. Conclusion

Our study demonstrably highlights that a wide range of *bacteria (Coagulase-negative Staphylococci, Escherichia coli, Enterobacter cloacae, Klebsiella pneumoniae*, MRSA, and *Pseudomonas fluorescens)* can contaminate the surface and medical device. These bacteria increase the risk of HAI. It is important and urgent to assess and strengthen infection prevention practices such as hand hygiene guidelines and recommendations for cleaning and disinfection of surfaces.

Conflicts of interest

The authors declare that they have no competing interests.

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