



Risk Factors and Microbiological Control of Soils, Surfaces and Medical-technical Equipment at the Abomey-Calavi / So-Ava University Hospital Center, Benin

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Authors' contributions

This work was carried out in collaboration among all authors. Authors AS, HS, CCD and LBM designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors HA and HGK managed the analyses of the study. Authors FBM and AA managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Aims: The aim of our work was, on the one hand, to evaluate the risk factors for infectious contamination in hospital environments and, on the other hand, to carry out a microbiological control of surfaces at the Abomey-Calavi / So-Ava hospital in Benin.

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Methodology: The risk factors were evaluated using structured interviews based on the questionnaire. Fifty-five health care workers were surveyed and the questionnaire focused on: i) knowledge of care-associated infections and risk factors, ii) services most affected by care-associated infections and iii) origin of care-associated infections. For the microbial quality control of medical surfaces and materials, samples were collected by the dry swab method and the microbial isolation was carried out on Chapman and EMB agar plates. The biochemical analyses were carried out for the confirmations.

Results: Out of 55 respondents, the 93% think that bacterial germs are often involved in care-associated infections. In addition, 80% of respondents believe that the healthcare environment may be the source of care-associated infections. Regarding the microbiological quality of the surfaces, out of 96 samples collected, 77% were contaminated with *Staphylococcus* spp and 30% with Enterobacteria. Concerning units' contamination, the highest prevalence was observed in paediatrics with 92% of samples contaminated with *Staphylococcus* spp followed by the operating theatre (87%).

Conclusion: It is clear from our work that hygiene managers must carry out preventive and corrective actions for the respect of the principles of hygiene. It would also be important to conduct regular microbiological monitoring of surfaces to identify any contamination.

Keywords: Care-associated infections; microbiological control; *Staphylococcus* spp; hospital environment; Benin.

1. INTRODUCTION

Care associated infection is defined as any illness contracted at the hospital, caused by clinically and / or microbiologically recognizable microorganisms that affect the patient, either because of admission to hospital or care received. As an inpatient or outpatient, or hospital staff because of his or her activity, whether or not the symptoms of the illness appear while the patient is in the hospital [1]. Care associated infections have an influence on the morbidity and even the mortality of infectious diseases. In the United States, for example, Care associated infections are estimated to cause 9,000 deaths per year [2]. In Africa and some developing countries, the highest prevalence rate of these infections is estimated at 25.0% [3]. In 2009, the WHO [4] report provides examples in developing countries such as Albania (19.1%); Brazil (14.0%); Tunisia with (17.8%) and Tanzania with (14.0%). In Benin, a prevalence of 32% of Care associated bacterial infection was observed in the neonatology department of the departmental hospital of Zou and Collines [5]. Recently, the work of Afle et al. [6] on surface samples at the Abomey-Calavi / So-ava University Hospital Center (Benin) showed a predominance of *Staphylococcus aureus* strains (27.3%). In addition, care-associated infections are a major public health problem because they are of concern especially in high-risk services since the immune status of the exposed patients is a deficient immune field makes it easier for a microorganism to express its virulence and opportunistic pathogens to trigger infection [7].

In fact, the hospital environment represents a large microbial reservoir with risks of contamination of the nursing staff or patients and the acquisition can be done by a manual transmission, medical equipment or from an environmental reservoir [8]. As a result, the fight against care-associated infections requires the control of the microbiological quality of hospital surfaces to limit the damage. Moreover, many risk factors are at the root of cases of care-associated infections in less developed countries such as Benin, making it difficult to assess with certainty the share of surfaces and the hospital environment in the origin of these infections. In Benin, several studies have been carried out in the field of hospital hygiene and the present study entitled "Infectious risk factors and microbiological control of surfaces and medical-technical materials at the Abomey-Calavi / So-Ava Area University hospital centre (Benin). Integrates with the microbiological quality approach to shed more light on the inherent risk associated with care-associated infections.

2. MATERIALS AND METHODS

2.1 Field Investigation

Our investigation took place from July to August 2018 in four departments (neonatology, paediatrics, maternity and operating room) most concerned by care-associated infections of the Abomey-Calavi / So-Ava Zone hospital using a questionnaire. It involved 55 voluntary hospital caregiver's selected using "convenience" sampling technique. Those sample sizes include

15 in neonatology; 15 in the maternity ward; 15 in paediatrics and 10 in the operating room. The data collection was done through interviews following a structured questionnaire. The questionnaire focused on the following main points: i) Knowledge on care-associated infections and risk factors, ii) Units affected by care-associated infections, iii) Origin of care-associated infections. The staff of the four investigated units consists of physician, midwife and nurses.

2.2 Sample Collection for Microbial Analysis

The field investigation was followed by a sampling of medical surfaces and materials. The samples were collected using the dry swab method according to ISO / DIS14698-1 standards. The target surfaces and materials were beds; soils; carriages; baby toilet tables; weighs baby; mattresses; cupboard; caesarean boxes. Practically, these swabs are passed on areas defined in close parallel streaks by rotating them slightly. Then the swabs were put back in their protective cases. Once collected, samples were carried immediately to the laboratory in cool condition (~4°C) and 5 ml of Mueller Hinton broth added to each sample and incubated at 37°C for 24 hours. Samples were repeated thrice on the same surfaces and materials.

2.3 Microbiological Analysis

After 24 hours of incubation, the cases of swabs that were cloudy, show bacterial growth and

have been chosen for the search for germs. For microorganism's identification, standard microbiological methods were used. Thus, the collected samples were sowed on specific media, namely Chapman agar and EMB agar [9] respectively for the detection of *Staphylococcus* spp and *Enterobacteria*. Thus, after inoculation on the two mediums, each Petri dishes was incubated at 37°C for 24 hours. Once isolated, bacteria were identified using classical morphological (gram staining and shape of bacteria) and biochemical characters (sugar fermentation, Oxidase, and Catalase test) related to the genus identification techniques [10].

2.4 Data Analysis

The data collected were processed using the Excel 2013 spreadsheet. GraphPad Prism 5 was used to perform the Chi-square test and make graphs. The test was considered statistically significant at $p < 0.05$.

3. RESULTS

3.1 Knowledge about Care-associated Infections

At the end of the data analysis, according to the units, it appears that 80% of the medical staff surveyed in the operating room have a knowledge of the term care-associated infection followed by 67% of the nursing staff of the maternity ward. Neonatology and paediatrics come with 60% (Fig. 1).

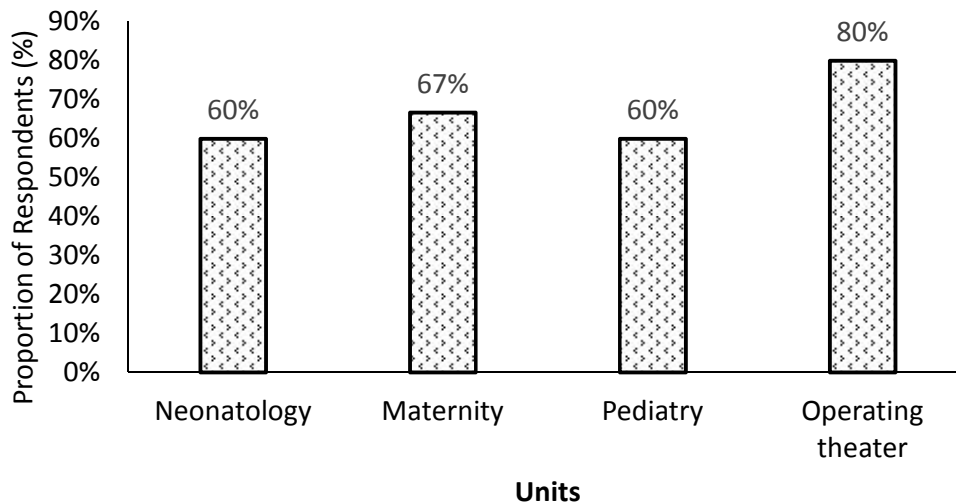


Fig. 1. Level of knowledge of care-associated infections

3.2 Knowledge of Germs Implicated in Care-associated Infections

Different types of microorganisms are involved in infections in health care facilities. Of the total health care staff surveyed, the 93% think that bacterial germs are most often responsible for care-associated infections. On the other hand, 36% think that viruses are involved in the cases of infections in hospital environment and 33% incriminate the mushrooms (Fig. 2).

3.3 Units Most Affected by Infections

According to our results, it is reported that care-associated infections are often observed in the

four units. However, 80% of respondents cited pediatric service to be often affected by care-associated infections cases followed by maternity (75%). Then comes the neonatology (71%) and the operating room (Fig. 3).

3.4 Origin of Care-associated Infections

Our results show that 80% of respondents believe that the healthcare environment may be at the origin of care-associated infections. On the other hand, 56% of the respondents think that the patients also can be at the origin and 20% think that the caring personnel too could be at the origin of these infections in hospital environment (Fig. 4).

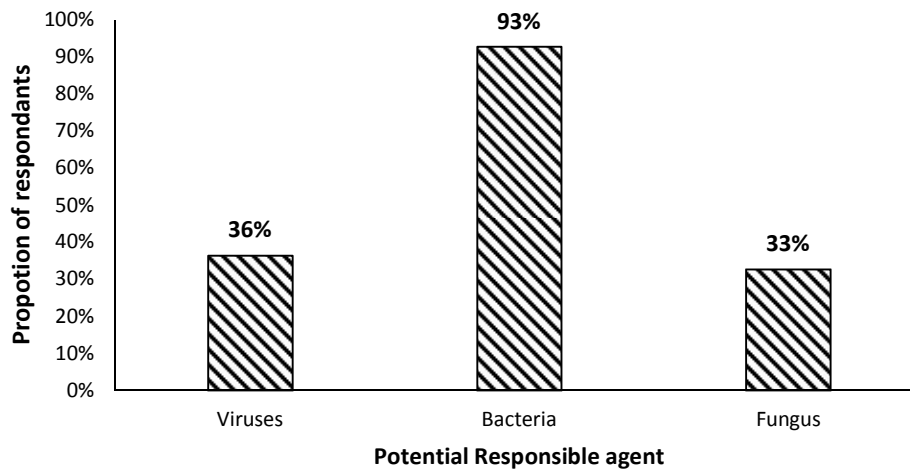


Fig. 2. Suspected microorganism involved in care-associated infections

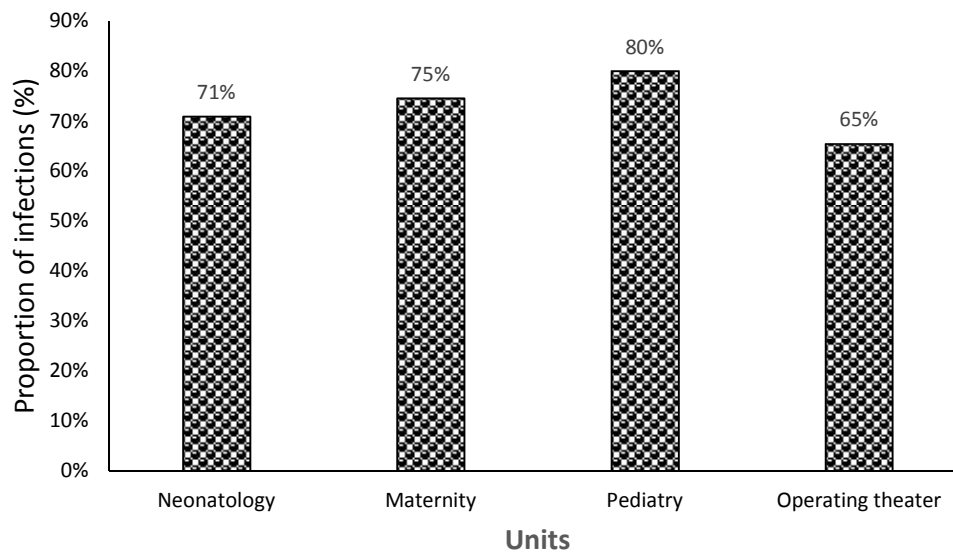


Fig. 3. Services affected by care-associated infections

3.5 Evaluation of the Work of Maintenance Workers

As for the work of maintenance workers, the assessment varies according to the units. Thus, 60% of the neonatal respondents do not appreciate the work of the cleaning agents as

well as the 47% of the respondents in the maternity ward. On the other hand, at the pediatric and operating theatre levels, 53% and 50% of the respondents, respectively, found that the work of the cleaning staff was good (Fig. 5). Nevertheless, in a general way their work is far from satisfactory.

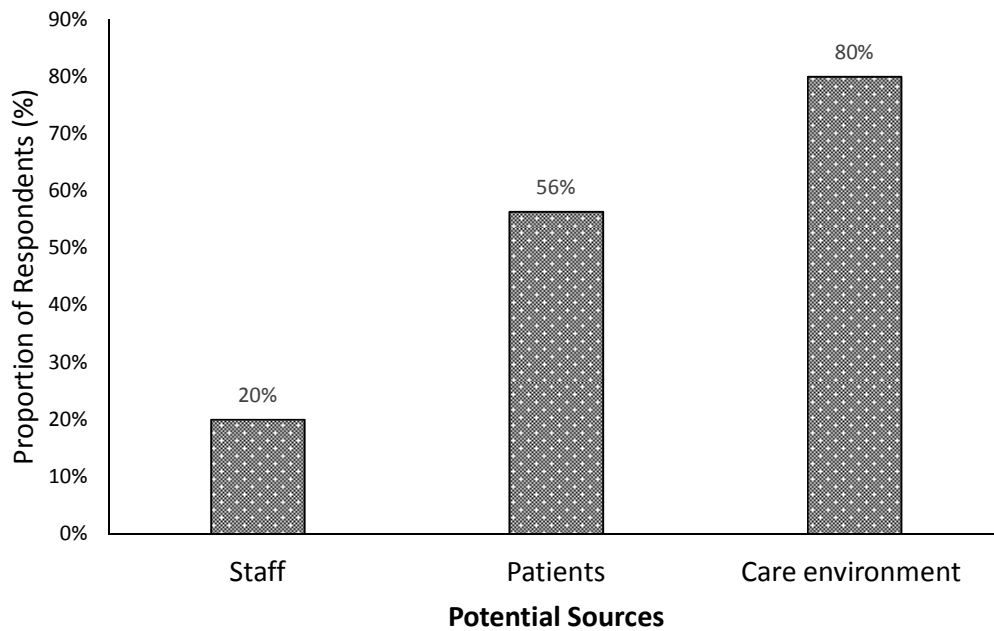


Fig. 4. Probable origins of care-associated infections

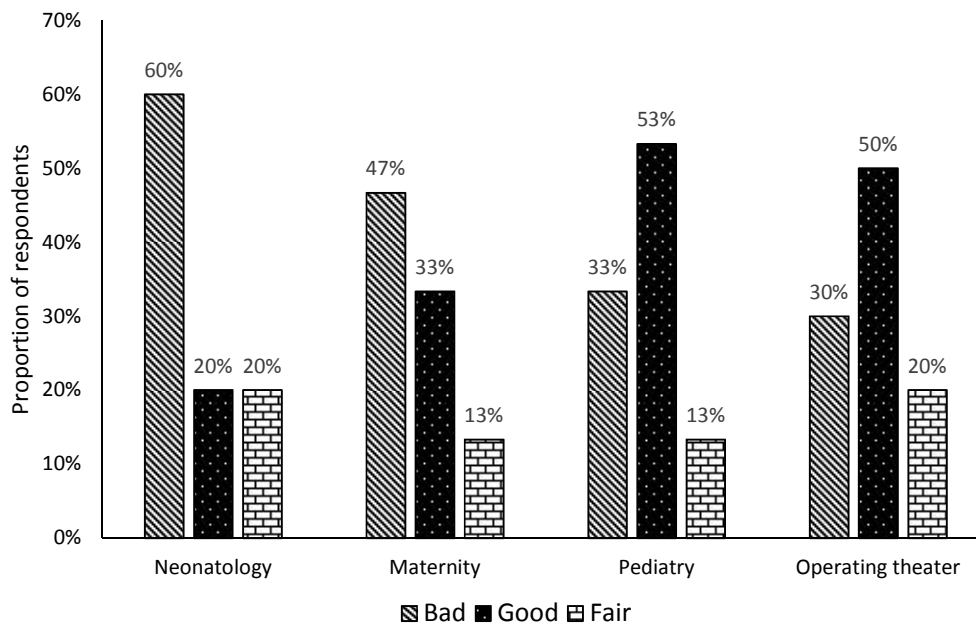


Fig. 5. Level of appreciation of the work of service agents by department

3.6 Risk Factors for Infections

Regarding risk factors, 65% of our respondents believe that bad handwashing may be one of the major factors of infectious risk in hospitals. Added to this is the lack of proper cleaning (58%). However, 53% say that lack of training in hospital hygiene could be a risk factor. Few (11%) believe that other factors (neglect of the rules of hygiene, the inadequacy of work infrastructures) are also not significant (Fig. 6).

3.7 Global and Service Contamination

Out of the 96 samples collected in the targets units, the microbiological analysis shows

a 77% contamination by *Staphylococcus* spp strains and 30% by *Enterobacteriaceae* (Fig. 7).

With respect to service contamination, there are varying proportions depending on the service. However, the highest prevalence was observed in pediatric patients with 92% *Staphylococcus* spp infection followed by the operating theatre (87%) and neonatology (78%). In addition, low prevalence was observed at the level of maternity (67%) and central sterilization (60%). With regard to enterobacterial contamination, paediatrics is still in the lead with a prevalence of 42% followed by neonatology 33% (Fig. 8).

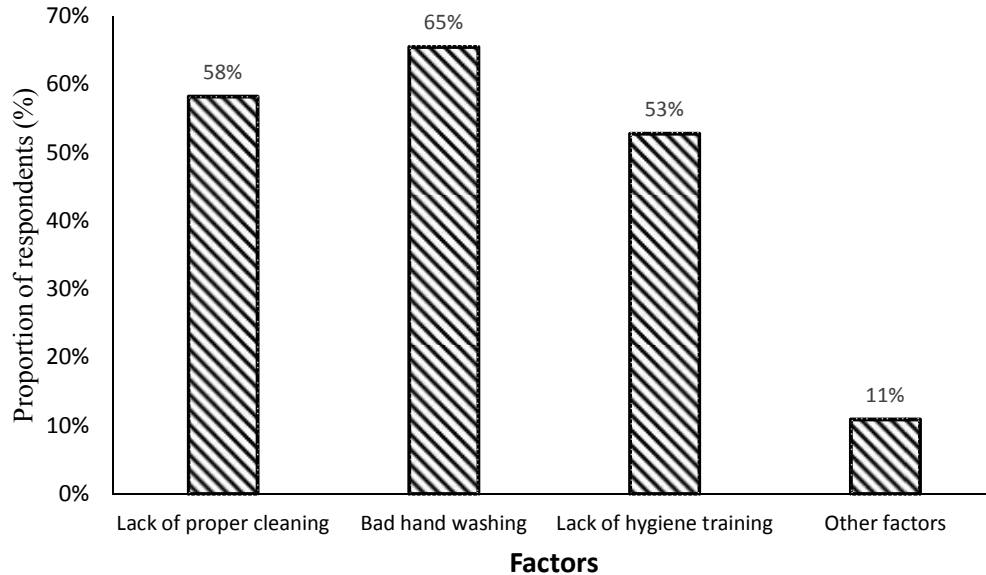


Fig. 6. Risk factors for care-associated infections

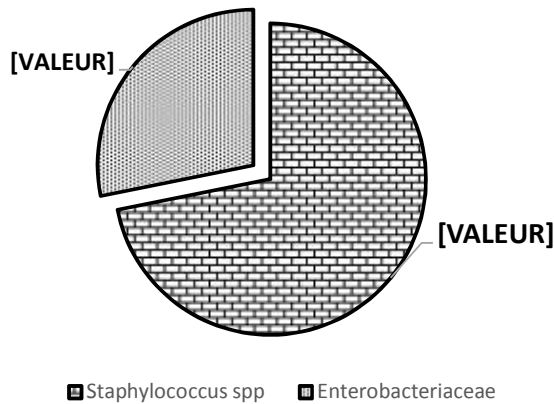


Fig. 7. Overall sample contamination

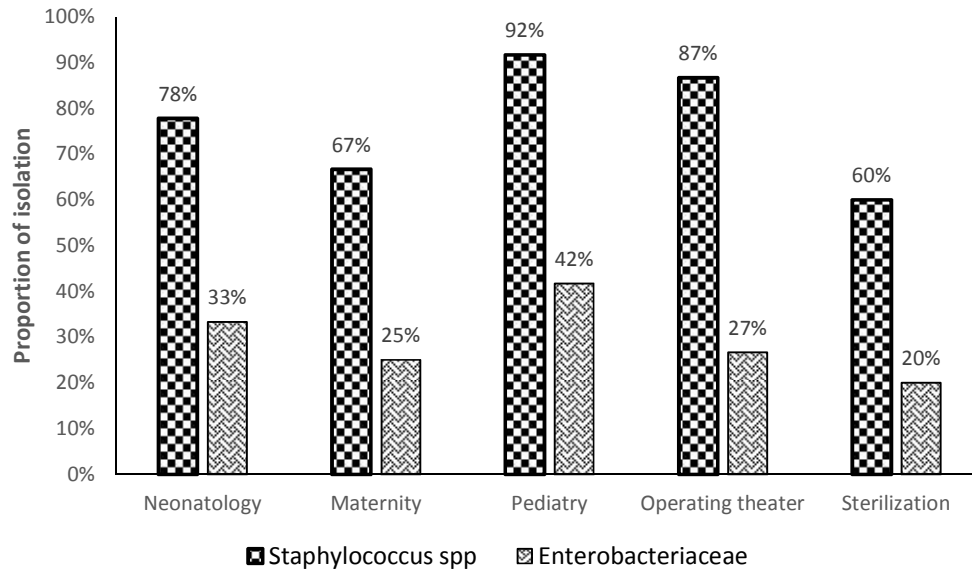


Fig. 8. Microbiological contamination rate by service

4. DISCUSSION

As participation in the survey is voluntary, the low rate of staff surveyed is due to the lack of willingness and availability of health workers to our cause. With regard to the level of knowledge of care-associated infections, the values of more than 50% in the services shows that more than half of the healthcare staff have the basic notion of hospital infections (Fig. 1).

Microorganisms of human origin or specifically environmental [11], more often contaminate the environment in health care facilities. Also, the large number (93%) who believe that bacteria are at the base of many cases of care-associated infections shows that suspicions weigh more on bacterial germs (Fig. 2). Moreover, this shows that in these services bacterial germs are responsible for many cases of infections most often. The work of Kakupa et al. [12] shows a high bacterial ecology in care-associated infections in University clinics in Lubumbashi and the Janson Sendwe Hospital in the DRC. However, viruses and fungi are not to be neglected in other cases of infections.

Seeking to understand the services most affected by care-associated infections, over 65% of respondents believe that paediatrics, maternity, neonatology are all affected by infections most often (Fig. 3). This could be explained by the fact that these services accommodate more immunocompromised

patients especially in neonatology where the immunological immaturity of premature infants represents a favorable ground for pathogenic germs. One could also mention a lack of supervision or the non-respect of the rules of hygiene in these services.

The environment seems to be at the origin of care-associated infections at the Abomey-Calavi / So-ava Area University hospital centre according to 80% of the health care personnel surveyed (Fig. 4). These opinions are based on the lack of proper cleaning or the use of inadequate bio-disinfectants. This is also confirmed by the assessment of the work of maintenance agents where there is a diversity of services and generally is poorly appreciated. This is a risk for patients since some, despite their deficient immune states lie down on the floor waiting for care. In addition, hospital surfaces are microbial reservoirs that can contaminate the hands of caregivers or patients directly [13]. This explains why bad hand washing seems to be a key factor facilitating the transmission of microbial germs between caregivers-patients in the eyes of our respondents. In epidemic times, contamination of staff hands is real in some areas of the hospital with certain bacterial species, such as *Staphylococcus aureus* and enterococci strains [14].

It is often difficult to evaluate the share of surfaces and technical medical equipment in the occurrence of care-associated infections since

these surfaces are cleaned or disinfected on a daily basis. In our study of 96 surface samples analyzed, 77% were contaminated by *Staphylococcus* spp (Fig. 7). Which also represents the global contamination of the samples and 30% by enterobacteria (Fig. 7). The high proportion of Staphylococci could be explained by the fact that they are widespread ubiquitous bacteria in nature (air, water, soil, food, furniture and equipment) [15]. It should be noted that the presence of *Staphylococcus* in each of these services is worrying because *Staphylococcus* strains are the basis of maternal-fetal infections, neonatal meningitis, enterocolitis and secondary infections [16]. In addition, the presence of *Enterobacteriaceae* testifies to extremely variable and man-made accidental contaminations. This rate of 77% is lower than the 98.60% obtained by Kamga et al. [17] in Yaoundé, Cameroon, and is greater than 65% by Afle et al. [6] at the Abomey-Calavi / So-Ava University Hospital Center in South Benin. To compare with Afle et al. [6] work, this difference could be explained by a deficit in hospital hygiene and inadequate maintenance of surfaces and materials. Moreover, these results suggest a strong implication of the surfaces in the risks of infections during the hospitalization.

In a health facility, the contamination varies from one service to another, patients, care and techniques practised. Service contamination shows that paediatrics is the most contaminated service with 92% of *Staphylococcus* spp and 42% of *Enterobacteriaceae* (Fig. 8). Paediatrics is followed by the operating theatre, which is 87% contaminated with *Staphylococcus* spp (Fig. 8). Afle et al. [6] have observed this high contamination of paediatrics. However, the rate of *Staphylococcus* contamination in the pediatric and operating theatre is very critical and this shows the non-compliance with the hygiene protocol. Indeed, the flora found on surfaces depends on several factors such as human activity that results in a supply of microorganisms by the patient himself, by caregivers and by visitors. In the absence of effective bio cleaning, the survival of these microorganisms on surfaces can be very prolonged [18].

5. CONCLUSION

Our study-highlighted hospital units that have care-associated infections, the level of appreciation of maintenance workers and the infectious risk factors affect the most. In addition, the results from surface and material samples

show high contamination by *Staphylococcus* spp and *Enterobacteria*, which represent a significant part in the cause of the care-associated infection. This shows that great efforts must be devoted to educating health workers and cleaning agents to the correct observance of hygiene rules and the use of adequate bio-detergents. The multiplication of these studies will improve the level of hospital hygiene in our hospitals. In perspective, we judiciously evaluate the level of toxicity and pathogenicity of the species found for a better contribution to the fight against care-associated infections.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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