Bacteriological assessment of the hospital environment in two referral hospitals in Yaoundé-Cameroon

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Abstract

Introduction: Many studies still show significant numbers of surgical patients contracting nosocomial infections each year globally with high morbidity and mortality. The aim of this study was to identify potential bacteria reservoirs that may be responsible for nosocomial infection in surgical services in the Yaoundé University Teaching Hospital (YUTH) and the Central Hospital Yaoundé (CHY). Methods: A cross sectional descriptive study was conducted from June to August 2012. Air, water, and surface samples were collected from two surgical services and subjected to standard bacteriological analysis. Results: A total of 143 surface samples were collected. Bacteria were isolated in all surfaces except from one trolley sample and a surgical cabinet sample. The predominant species in all services was coagulase negative Staphylococcus (CNS). The average number of colonies was 132.82 CFU/25cm². The bacteria isolated in the air were similar to those isolated from surfaces. From the 16 water samples cultured, an average of 50.93 CFU/100ml bacteria were isolated. The distribution of isolated species showed a predominance of Burkholderia cepacia. Conclusion: These results showed the importance of the hospital environment as a potential reservoir and source of nosocomial infections amongst surgical patient at YUTH and CHY, thus we suggest that Public health policy makers in Cameroon must define, publish guidelines and recommendations for monitoring environmental microbiota in health facilities.
Introduction

Despite significant scientific progress in the field of surgery, anesthesia and the use of antibiotics, estimates showed that an average of 2.5% of the 6 million surgical patients visiting US health facilities each year contract a nosocomial infection [1]. These lead to the increased burden on both the patient and society [1- 4]. Nowadays, the assessment of health facilities environment (air, water, surfaces) has become part of a good health care quality and safety policy, including the assessment of risk of infection in surgery where surgical acts are performed sometimes with high-tech tools [5]. The main objective of this study was to identify potential bacteria reservoirs that may be responsible for nosocomial infection amongst surgical patient at the Yaoundé University Teaching hospital and at the Central Hospital Yaoundé in Cameroon. Specifically, the bacteriological quality of the air, water and surfaces in these health facilities was assessed.

Methods

A cross sectional descriptive study was conducted from June to August 2012 in the surgical services of the YUTH and the CHY. Bacteriological analyses were done at YUTH Bacteriology laboratory and water filtration (membrane filtration) was done at the University of Yaoundé I Biotechnology and Environmental science laboratory. Sample collection was focused at the surgical cabinet, surgical intensive care unit, recovery room, dressing room and the surgical ward bathrooms where air, water and surface samples were collected. Surfaces included; operation table, anesthesia equipment, surgical aspirators, fan, wardrobe, office table, bedside table, vacuum cleaner, electric knife, box clamp, chair, trolley, sink, surgical blades, bed, table dressings, light box, bench, x-ray reader, clip, trays, door handle and loop. Sampling of surfaces was done by the use of sterile swabs. Trypticase soya agar was inoculated with sample, incubated at 37°C for 24-48 hours. The quantitative analysis was performed by counting all colonies on the filter paper and results were expressed in CFU/100 ml. Air samples were collected only in the area where surgical interventions were performed by spontaneous sedimentation method. In these areas, the air conditions are usually microbiologically better controlled. These samples were inoculated on Trypticase soya agar and incubated at 37°C for 24-48 hours. Morphological characteristics of bacteria colonies and biochemical methods using API20E (Biomerieux, France) were used to identify the different bacteria species. The different isolates were stored at -200°C in Brain heart infusion broth supplemented with 10% glycerol. Data analysis was done using Epi info version 3.4.3. Chi square test was used to compare categorical variables at a statistical significance level of 5%.

Ethical Consideration

Administrative authorizations were obtained from the Director of YUTH (Pr Maurice Nkam) and from the former Director of the CHY (Pr Bella Hiag A). Ethical clearance was not applicable in the context of this study.

Results

Surface assessment

Of a total 143 samples in which bacterial culture were processed, 83 came from YUTH and 60 from the CHY. Bacteria was isolated in almost all samples 141 (98.60%). The average number of colonies was 132.82 CFU/25cm². With regard to the classification of different hospital areas and surfaces, using the bio-contamination index values, 16 (11.18%) samples showed a reasonable number of colonies/25cm² with 5 of these from CHY whereas 11 were from YUTH. Out of a total of 148 bacteria isolate obtained, 85(57.43%) were from YUTH whereas 65(43.91%) were from CHY. Table 1 showed that the predominant species identified in each service was coagulase negative Staphylococcus.

Air assessment

Thirty six (36) air samples were collected and cultured, including 16 from the YUTH operation room and 20 from the CHY operation room. Thirty three (91.67%) samples were positive. A bacteria was
isolated from all samples from the CHY and in 81.25% of samples from YUTH. Thirty eight (38) bacteria were identified, amongst these 14 were from YUTH and 24 were from the CHY. Frequency of identified bacteria is shown in Figure 1.

**Water assessment**

Sixteen (16) water samples were collected and cultured, including 12 from the surgical service of YUTH and 4 from the surgical service of the CHY. Of the 16 cultures performed, 12 (75%) were positive. The average number of colonies was 50.93 CFU/100ml. The colony number was 22.58 CFU/100ml for samples from YUTH versus 136.00 CFU/100ml for samples from CHY. A total of 12 bacteria strains were identified, 8 from YUTH and 4 from CHY. Bacterial species identification frequency is shown in Table 2 below.

**Discussion**

The main aim of this study was to identify potential bacteria reservoirs that may be responsible for nosocomial infection amongst surgical patients at the Yaoundé University Teaching hospital and at the Central Hospital Yaoundé in Cameroon, to inform policy on the monitoring of the hospital environment in the light of control, prevention and the fight against nosocomial infections.

**Surface assessment**

The findings in this study showed that the surfaces of the hospitals are heavily contaminated by bacteria with only 1.39% negative. These results are similar to those obtained by Meunier and co-workers (2005) in a study carried out in Strasbourg where they obtained à 3% negative cultures [6]. The objects sampled host microorganisms. Many observations abound in the same direction and show that these objects in this environment are known to harbor microorganisms such as Staphylococcus, Enterococcus, Acinetobacter [7,8]. The results of the colony counts suggest that microbial colonization of surfaces in these two hospitals is far higher than standard surface biocontamination values [9]. One hundred and forty eight bacteria (148) were identified, with coagulase negative Staphylococcus (57.43 %) being the most predominant species in all the surgical services. These results are similar to those obtained by Tagnouokam in 2008, who found a predominance of CNS (55%) [10]. These findings also collaborate with several studies which showed that the various components of the hospital environment (air, water, surfaces, clothes, food, medical devices, waste) can accommodate many microorganisms specifically from human or environmental origin [11,12]. According to Kim and co-workers, (1981), the inanimate areas around patients are normally contaminated by microorganisms [13]. The presence of microbial contaminants on the surfaces is also favored by the formation of biofilms and the ability of these bacteria to survive for a long time in the environment [14].

**Air assessment**

This study showed clearly that, after performing culture and bacteria isolation on hospital air samples collected in areas where the atmosphere is under control, the level of infectious risk was acceptable in YUTH but above alert level in CHY according to the ASPEC guidelines [15]. This constitutes a significant risk factor for the occurrence of surgical site infections. These results also show that the level of aerobiocontamination at operating rooms varies from one hospital to another. Studies have shown that the air contamination was due to poor maintenance of the ventilation system or its operation disrupted by frequent opening of doors or sudden movements [16]. Moreover, the outside air naturally contains some bacterial flora in hospitals and these outside air microorganisms add to those inside and to inert tanks (water, surfaces, waste) [17]. This aero-biocontamination level observed in CHY denotes a lack of personal discipline that integrates training on hand washing and managing the operation room. Although air samples were collected during inactivity in the operation room, we isolated 25 bacteria, 65.79 % of which were coagulase negative Staphylococcus. These results are comparable with those obtained in England where a gold standard method (impactation) was used. Indeed, the authors in the British study reported that among the isolated bacteria, CNS (86%) was predominant [18]. It is also important to note here that the bacteria species identified in this study are frequently identified in bacteriological analysis of the hospital environment [19]. According to the frequency of bacteria species in each of the hospitals, CNS are the most frequently isolated bacteria. This aero-biocontamination level finds its main origin in human activity. The microorganisms found in the air or on the surfaces in the operating room could be from the endogenous flora of hospital staff and patients. These suggest that the microbial environment within the operation rooms permit us to understand the possible involvement of the air in the occurrence of infections in
surgical units. The works of Lidwell and co-workers (1983, 1985) have shown the relationship between the air quality in operation room and surgical wound infection occurring in prosthetic orthopedic surgery [20, 21].

**Water assessment**

Seventy five percent of water samples were culture positive. Considering the recommendations on the measurement of water biocontamination according to the ISO 19458 standard [22, 23], all the positive cultures had more than 1 CFU/100ml. This points out the fact that the use of water for standard care in these health facilities is a health risk and that ways must be identified to manage and control this risk. This result strongly suggests the role of water for standard health care in the transmission of nosocomial infections. Jebran and Mangiapan (1996); Rudnick and co-worker (1996) testify the correlation between the degree of water contamination and the occurrence of respiratory infections, mucocutaneous infections caused by Gram-negative bacteria such as *Burkholderia cepacia*, Klebsiella, Acinetobacter, Citrobacter, Serratia [24,25]. The study by Humphrey (1989) showed that the basic gestures such as nasogastric tubes care and bathing can create aerosols and thus are sources of hospital contamination [26]. Overall, comparing the findings in this study with those of Verdeil and co-workers (1990) conducted in Toulouse France clearly suggest a significant correlation between the contamination of the hospital environment and the recovery of bacteria on surgical patients [5].

**Conclusion**

The results from this study provide evidence for directly incriminating the hospital environment as a potential bacteria reservoir for nosocomial infections in the surgical patients at YUTH and CHY, thus we suggest that Public health policy makers in Cameroon must define, publish guidelines and recommendations for monitoring environmental microbiota in health facilities.

**Competing interests**

The authors declare no conflict of interest.

**Authors’ contributions**

K.H.G, E.G, M.T, V.N.N, D.N.T, C.D.M, F.X.MK and S.T designed the study. K.H.G, E.G, M.T, V.N.N drafted the first version. All authors have read and agreed to the final version of this manuscript and have equally contributed to its content and to the management of the case.

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**Tables and figures**

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| Figure 1: Isolated bacteria distribution from air samples according to hospital |

**References**

1. Horan T, Culver D, Gaynes R, Jarvis W, Edwards J, Reid C. Nosocomial infections in surgical patients in the United States January 1986-June 1992 National Nosocomial Infections Surveillance (NNIS) System. Infect Control Hosp Epidemiol.1993; 14(2):73-80. PubMed | Google Scholar

2. Lepoutre A, Branger B, Garreau N, Boulétreau A, Ayzac L, Carbonne A, et al. Réseau d’alerte, d’investigation et de surveillance des infections nosocomiales (Raisin) Surveillance nationale des maladies infectieuses 2001-2003. Institut de veille sanitaire. 2005; 11. PubMed | Google Scholar
3. Ponce de-Leon S. The needs of developing countries and the resources required. J Hosp Infect. 1991;18 (Suppl A):376-381. PubMed | Google Scholar

4. Wenzel R. The economics of nosocomial infections. J Hosp Infect. 1995; 31:79-87. PubMed | Google Scholar

5. Verdeil X, Bertrand M, Roche R, Lareng M, Pous J. Epidémiologie clinique et microbiologie des infections nosocomiales en chirurgie : étude prospective portant sur 3422 malades hospitalisés au CHR de Toulouse. Médecine et maladies infectieuses.1990; 20(5):222-228. PubMed | Google Scholar

6. Meunier O, Hernandez C, Piroird M, Heilig R, Steinbach D, Freyd A. Bacteriological sampling of surfaces: importance of the step of enrichment and the choice of the culture media. Ann Biol Clin (Paris). 2005; 63(5):481-6. PubMed | Google Scholar

7. Carling P, Parry M, Von Beheren S. Identifying opportunities to enhance environmental cleaning in 23 acute care hospitals. Infect Contr and Hosp Epidemiol. 2008; 29(1): 1-7. PubMed | Google Scholar

8. Oomaki, M, Yorioka K, Oie S, Kamiya A. Staphylococcus aureus contamination on the surface of working tables in ward staff centers and its preventive methods. Biological & Pharmaceutical Bulletin. 2006; 29(7):1508-1510. PubMed | Google Scholar

9. Guide du bio-nettoyage n°5670. Bio-décontamination des surfaces après nettoyage et désinfection. Editions hospitalières. 2009. PubMed | Google Scholar

10. Tagnouokam NP. Qualification et quantification de la flore bactérienne de l’environnement hospitalier (Air, eau et surfaces) du CHU de Yaoundé. Mémoire de Master microbiologie medicale FMSB : Université de Yaoundé I. 2008; 80. PubMed | Google Scholar

11. Bertou A, Chapuis C, Hajjar J. Relations entre contamination et environnement hospitalier. Hygiène S. 2000;8(3): 139-179. PubMed | Google Scholar

12. CTNIN. Enquête nationale de prévalence des infections nosocomiales 1996. Bull Epidémiol Hebdo.1997; 36:161-163. PubMed | Google Scholar

13. Kim K, Fekety R, Batt D, Brown D, Cudmore M, Silva J Jr, Walters D. Isolation of Clostridium difficile from the environment and contacts of patients with antibiotic-associated colitis. J Infect Dis. 1981 Jan;143(1):42-50. PubMed | Google Scholar

14. Talon D. The role of the hospital environment in the epidemiology of multiresistant bacteria. J Hosp Infect. 1999 Sep; 43(1):13-7. PubMed | Google Scholar

15. ASPEC G. Contrôles de l’environnement dans les zones à hauts et très hauts risques infectieux.1999.Paris. PubMed | Google Scholar

16. Squinazi F. Contrôle de la qualité microbiologique de l’air des salles d’opération. Inter bloc. 1990; 9(3) : 12-14. PubMed | Google Scholar

17. Weber D, Rutala W. Environmental issues and nosocomial infections. In R Wenzel, Prevention and control of nosocomial infections. 1997; 491-514. PubMed | Google Scholar

18. Charle E, Edmiston G, Seabrook R, Robert A, Cambria. L’épidémiologie moléculaire de la contamination microbienne dans l’environnement de la salle d’opération: Existe-t-il un risque d’infection? Chirurgie. 2005; 138: 573-582. PubMed | Google Scholar

19. Bosi C. Analyse bactériologique de l’environnement hospitalier. In J Freney, Renaud F, Cavallo J, Antoniotti G, Baffoy N, Guibnement-Coudras S, Hajjar J. Surveillance microbiologique de l’environnement dans les établissements de santé - Air, eaux et surfaces.Ministère chargé de la santé, DGS/DHOS, CTIN. 2002. PubMed | Google Scholar

20. Lidwell O, Elson R, Lowburry E, Whyte W, Blowers R, Stanley S, et al. Ultraclean air and antibiotics for prevention of postoperative infection A multicenter study of 8,052 joint replacement operations. Acta Orthop Scand. 1987; 58: 4-13. PubMed | Google Scholar
21. Lidwell O, Lowbury E, Whyte W, Blowers R, Stanley S, Lowe D. Airborne contamination of wounds in joint replacement operations: the relationship to sepsis rates. J Hosp Infect. 1983 Jun;4(2):111-31. PubMed | Google Scholar

22. Cotheros. L’eau dans les établissements de santé. Guide de recommandation de la DRASS Rhône-Alpes. 1995; 28. PubMed | Google Scholar

23. Norme Européenne NF EN ISO 19458. " Qualité de l’eau – Echantillonnage pour analyse microbiologique ". 2006. Google Scholar

24. Jebran G, Mangiapan G. Nosocomial pneumonia. Presse Médicale. 1996;25 (20): 944-950. PubMed | Google Scholar

25. Rudnick J, Beck-Sague C, Anderson R, Schable M, Miller J, Jarvis W. Gram negative bacteremia in open heart surgery patients traced to probable tap-water contamination of pressure monitoring equipment. Inf Contr & Hosp Epidemiol. 1996; 17: 281-285. PubMed | Google Scholar

26. Humphrey T. Microbial contamination of hospital showers and shower water; the affect of an automatic drain valve. J Hosp Infect. 1989 Jan;13(1):55-61. PubMed | Google Scholar

| Table 1: Distribution of isolated bacteria according to different units in each hospital |
|---------------------------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|
| Bacteria species isolated      | YUTH            |     | YUTH            |     | YUTH & CHY     |     | YUTH            |     | YUTH & CHY     |     |
|                                | Operation room  | Surgical covery room | Waking room | Ward | Dressing room | Operation room | Ward | Total | %   |
| Coagulase negative Staphylococcus | 17              | 2   | 3              | 25   | 2             | 23             | 13   | 85    | 57.43 |
| Gram positive bacillus         | 8               | 0   | 0              | 3    | 1             | 6              | 3    | 21    | 14.18 |
| Staphylococcus aureus          | 0               | 1   | 0              | 3    | 2             | 5              | 1    | 12    | 8.10  |
| Acinetobacter baumanii         | 0               | 2   | 0              | 2    | 0             | 3              | 1    | 8     | 5.40  |
| Klebsiella pneumonia           | 0               | 0   | 0              | 2    | 0             | 1              | 0    | 3     | 2.02  |
| Burkholderia cepacia           | 1               | 0   | 0              | 1    | 0             | 1              | 0    | 3     | 2.02  |
| Citrobacter freundii           | 1               | 0   | 1              | 0    | 0             | 2              | 0    | 4     | 2.70  |
| Flavobacterium spp             | 1               | 0   | 0              | 1    | 0             | 0              | 0    | 2     | 1.35  |
| Enterobacter cloacae           | 1               | 0   | 0              | 0    | 0             | 0              | 2    | 3     | 2.02  |
| Enterobacter sakazakii         | 0               | 0   | 0              | 1    | 0             | 0              | 0    | 1     | 0.67  |
| Kingella kingae                | 1               | 0   | 0              | 0    | 0             | 0              | 0    | 1     | 0.67  |
| Escherichia coli               | 0               | 0   | 1              | 0    | 0             | 0              | 0    | 1     | 0.67  |
| Providencia alcalifaciens      | 0               | 0   | 0              | 0    | 0             | 0              | 1    | 1     | 0.67  |
| Sphingomonas paucimobilis      | 0               | 0   | 0              | 0    | 0             | 1              | 0    | 1     | 0.67  |
| Alcaligenes faecalis           | 1               | 0   | 0              | 0    | 0             | 0              | 0    | 1     | 0.67  |
| Chryseomonas luteola           | 1               | 0   | 0              | 0    | 0             | 0              | 0    | 1     | 0.67  |
| Total                          | 32              | 5   | 5              | 38   | 5             | 42             | 21   | 148   | 100   |
Table 2: Isolated bacteria species in water according to each hospital

|                    | Acinetobacter baumanii | Alcaligenes xylosoxidans | Burkholderia cepacia | Citrobacter freundii | Kingella kingae | Klebsiella Pneumoniae | Coagulase negative Staphylococcus | Serratia liquefaciens | Total |
|--------------------|------------------------|--------------------------|----------------------|---------------------|-----------------|------------------------|----------------------------------|----------------------|-------|
| YUTH               | 1                      | 1                        | 2                    | 1                   | 1               | 1                      | 1                                | 0                    | 8     |
| CHY                | 0                      | 0                        | 2                    | 0                   | 0               | 0                      | 1                                | 1                    | 4     |
| Total              | 1                      | 1                        | 4                    | 1                   | 1               | 1                      | 2                                | 1                    | 12    |

Figure 1: Isolated bacteria distribution from air samples according to hospital