



Major Bacteria Species Surface Contaminants in Hospitals of Littoral Region, Cameroon

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Abstract: Globally, the levels of healthcare-associated infections (nosocomial infections) are important high, and especially those due to bacterial are significant and costly. Healthcare environments provide a worrying reservoir for spreading infections. According to the World Health Organization (WHO) Low and Middle-Income Countries may be particularly at risk, hence, the need to perform a timely assessment of surface contamination of bacterial origin in the major units of four different hospitals of the Littoral Region, Cameroon. A cross-sectional and descriptive study was conducted from December 2018 to May 2019. A simple random sampling was used to swap 10 selected equipment (treatment tables, operating tables, delivery tables, office tables, anesthesia equipment, surgical aspirators, oxygen concentrators, wheelchairs, patients and office chairs) and 10 materials (fans, patient bedside tables, patient bed rails, trolleys, door handles, negastoscopes, baby scales, air conditioners, Antiseptic container boxes, and covers) in the mornings after disinfection but before the start of work in each unit. After inoculation in four agar media consecutively (Eosine Methylene blue, Cled, Mannitol salt agar and the blood agar in segmented) and incubated in appropriate conditions, identification and confirmation were based on morphological characteristics of bacteria colonies, microscopy, and biochemical methods using API staph, strep, and 20ETM gallery Biomerieux. Of a total of 236 samples collected, 119 (50.4%) showed bacterial growth, 33 different species of which 62/119 (52.10%) were Gram-positive cocci, 57/119 (47.90%) Gram-negative bacilli. *S. aureus*, 45/119 (37.81%), *E. coli* 6/119 (5.04%), and *Acinetobacter spp* 4/119 (3.36%) were the most common contaminants. Patients' bedside tables, office chairs, and patients' bed rails were the highest contaminants respectively 14/119 (11.76%), 13/119 (10.92%) and 12/119 (10.08%). The Emergency units were the mainly contaminated area for Gram-positive cocci, 12/62 (19.35%) majority *S. aureus* 9/62 (14.51%) as most as Gram-negative non-Enterobacteriaceae 11/31 (35, 48%) with a predominance of *C. meningoseptica* and *M. heamolytica* both 2/31 (6.45%). Therefore for the Gram-negative bacilli Enterobacteriaceae family, the highest level of bacterial isolates was recovered in laboratory 7/26 (26.92%), in which *E. coli* was predominantly reported 4/26 (15.38%). However, *S. aureus* was the only species found in all hospitals and units. This high level of contamination in various key units in these hospitals is a serious risk of infections with leading to complicated and cost healthcare. This work will help clinical care and decision making to take appropriate actions to improve sanitation and ensure control measures to limit the spread of hospital-acquired infections.

Keywords: Bacteria Species, Contamination, Hospital Environment, Littoral, Cameroun

1. Introduction

Nosocomial infections (NI) are referred to as any systemic or localized condition that is caused by an infectious toxin or agent from the hospital [1]. This term is used interchangeably with the term Health-care Associated Infections (HAIs) and is also now known as Hospital-Acquired Infections. HAIs are infections acquired in the hospital by patients who are admitted for other reasons than the initial cause of hospitalisation, after 48 hours or more hospital admission or within 30 days after discharge [2-3]. NI remains a public health problem worldwide with the most significant causes of morbidity and mortality in healthcare settings [4]. In developed countries, NI affects between 5% and 15% of hospitalized patients in regular wards and remains underestimated in developing countries [5]. However in Africa some studies have shown that the overall prevalence can reach 25% [4-]. It can be found anywhere medical care is given (hospital, clinic, and patient's home) [5], generally, associated to poor hygiene. Most of the microorganisms are transmitted by hands and instruments contaminated that have come into contact with patients, with body fluids [7, 8]. Modern medical care has become more invasive and therefore associated with a greater risk of infectious complications. Hospital lengths of stay and health care expenditures are estimated annually treatment for NI to \$4.5 billion to \$11 billion and contribute to 88 000 deaths in the U.S. [3, 9].

Additionally, many pathogenic species has been found which are able to cause HAIs in health care settings. It has been documented that, the hospital environment (equipment, materials and work surface) are considered as reservoir and play a role in the prolonged maintenance of NI and transmission [10]. In several studies, bacteria are the most predominant infectious agents (85%) [7, 8, 11]. Laxity in applying basic hygiene actions (individual or collective) has increased the incidence of this phenomenon over the last thirty years. This has become so extensive that international and national authorities are getting more implicated in managing this problem [7, 9]. However, the population at risk are Patients, Health care-workers, staff and visitors [7, 12, 13]. Those more susceptible are those with disorders. Also new invasive diagnostics methods, antibiotics selection pressure, and poor personal hygiene are responsible of NI outbreaks [7]. In Low-and Middle -Income countries, recent analyses by World Health Organisation (WHO) has found that other factors include: inadequate environmental hygienic conditions, waste disposal; poor infrastructure; insufficient equipment; understaffing; overcrowding; poor knowledge and application of basic infection control measures; lack of procedure; lack of knowledge of injection and blood transfusion safety; absence of local and national guidelines and policies are warning risk factors of NI [14]. In 2011 WHO report an urgent need for HAIs surveillance and to gather data on the actual burden on a regular basis [15]. In some developed countries, the surveillance system exist and

provide regular reports on national trends of endemic HAI, such as the National Healthcare Safety Network of the United States of America or the German Hospital Infection Surveillance System and the Europe Link for Infection Control through Surveillance" (HELICS). In developing countries, the magnitude of the problem is even unknown largely and, furthermore control practices remain rudimentary [5, 15]. Often misunderstood or denied, there is a paucity of information on nosocomial infection in Subtropical Africa shows by a review of recent medical literature [16]. Now more than ever, specific surveillance is needed in order to enact early detection MDR agents and prevention strategies to curtail NI [1].

Studies on the effectiveness of interventions to reduce HAIs are limited, In Cameroon, few studies show the incidence of NI varies between 16.9–21.5% and Health care systems has not yet encouraged hospitals to expand practices focusing on the prevention and monitoring of infectious agents [4, 6]. This worrying situation needs to be questioned and targeted actions have to be carried out in order to help the population. Surveillance of hospital reservoir to prevent HAIs is central to provide high quality and safe healthcare, even in settings with limited resources where there are poor applications of best disinfection, sterilization and cleaning procedure [4, 8]. Our study has as objective to assess major bacteria species in various units of four hospitals of Littoral Region of Cameroon.

2. Materials and Methods

2.1. Study Site

The study site were selected bases to the following parameters: the different technical platform, attendance (social level and frequency), care offered (primary, secondary and central health care according to Cameroon health system) and units. Four hospital structure corresponding to the different level of organization (private and public sector) were selected: Saint Jean de Malte Hospital of Njombe (HSJMN), Military Hospital of Douala (MHD), New Bell District Hospital (NBDH) and Medical Health Center of Ndokoti (MHCN) of were used for the study.

2.2. Study Design

A descriptive, cross-sectional laboratory based study was performed. We collected swaps for culture from seven units (Medical, Operating Theatre, Laboratory, Surgical, Emergency and Maternity) specific environmental points (10 different equipment and 10 different materials) in the four hospitals between December 2018 to May 2019. For selection expected reservoir sample.

2.3. Sample Collection and Technique

In each health facility, simple random sampling technique was used to collect the sample. Consideration were given to equipment and material with constant hand contacts. This

included 10 equipment like: treatment tables, operating tables, delivery tables, office tables, anaesthesia equipment, surgical aspirators, oxygen concentrators, wheelchairs, patients and office chairs. 10 materials: fans, patient bedside tables, patients bed rails, trolleys, door handles, negastoscopes, baby scales, air conditioners, Antiseptic container boxes and Antiseptic container covers. Collection was done in the mornings after disinfection but before start of work in each unit. This was done by swabbing all selected equipment and materials using sterile swabs moistened in sterile normal saline. These swabs were placed in labeled caps with unit and type of equipment or material identification numbers and immediately transported to the microbiology laboratory for processing.

2.4. Laboratory Processing

Specimens were inoculated directly according to good laboratory practice on four agar media consecutively (three sectors petri disk with different medium Eosine methylene blue, CLED, Mannitol salt agar and the blood agar medium in one sector petrie disk) Microexpress® ISO 9001:2008 EN ISO 13485:2012. After inoculation, the three sectors media were incubated overnight at 37°C aerobically for 24 hours and blood agar medium anaerobically up to a maximum of 48 hours and inspected for bacterial growths. Identification of bacteria to species level was done using colony characteristics, Gram's staining technique, different biochemical tests comprising of; oxidase, catalase, coagulase, motility test, urease, indole and API Staph, API Strepto and API 20 E™ BioMerieux according to standard methods [17]. Review of the results was done by the microbiologist officer at the laboratory to ensure quality control.

2.5. Ethical Consideration

An ethical clearance were obtained from Institutional Ethics committee for research on Human Health of the University of Douala: N°: 1646 IEC-UD/06/2018/T. Also, all afferent administrative authorizations to carry out the project was obtained from the Director of the four hospitals (HSJMN, NBDH, MHD and MHCN).

2.6. Statistical Analysis

Data were recorded in Microsoft Excel 2013 and later transferred to SPSS version 23 software. Categorical variables; clinical factors was summarized using counts, percentages and proportions. Group comparisons for

categorical variables were done using the chi-square test (Fisher's exact test) to find any significance at $P < 0.05$.

3. Results

3.1. Result of Culture and Forms of Bacteria Isolated

A total of 236 specimens of different hospital equipment and materials were sampled and inoculated in specific media. Looking at the growth and general forms of bacteria isolated, it was observed that majority 119 showed positive bacteria growth, giving a prevalence rate of 50.42%. Among them, 62 (52.10%) were Gram positive cocci, 57 (47.90%) Gram negative bacilli. The above explanation is illustrated in the figure 1 below.

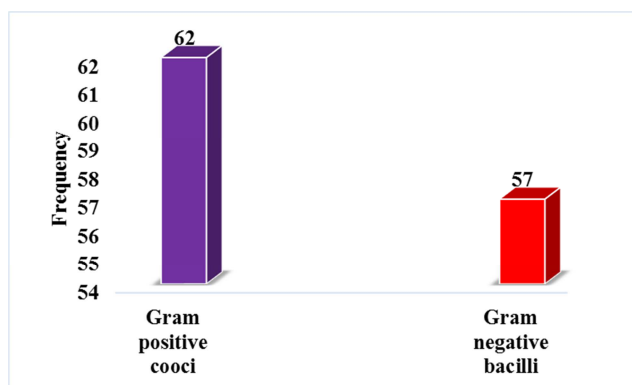


Figure 1. General frequency of forms of bacteria isolated.

3.2. Type of Hospital Equipment and Material According to Forms of Bacteria Isolated

Looking at the forms of bacteria isolated from hospital equipment and materials, it was noted that the patient bedside tables, office chairs, patients bed rails and antiseptic container boxes showed growth with highest percentage respectively 11.76% (14/119), 10.92% (13/119), 10.08% (12/119) and 9.24% (11/119). Gram positive cocci were the major bacteria forms isolated; the office chairs and patients' beds rail showed the highest percentage (8.40%) (10/19), followed by the patients' bedside tables with 7.56% (9/119). Gram negative bacilli, were found on antiseptic container boxes (5.88% (7/119)), trolley (5.04% (6/119)) and treatment tables, fans and patient beside tables with 4.2% (5/119). These detailed result of the above explanation was tabulated and illustrated as shown in table 1 below.

Table 1. Type of hospital equipment and material according to forms of bacteria isolated.

Form of bacteria isolated Type of hospital equipment	Gram positive cocci	Gram negative bacilli	Total
Treatment tables	4 (3.36%)	5 (4.20%)	9 (7.56%)
Fans	3 (2.52%)	5 (4.20%)	8 (6.72%)
Door handles	2 (1.68%)	4 (3.36%)	6 (5.04%)
Patient bedside table	9 (7.56%)	5 (4.20%)	14 (11.76%)
Patient bed rails	10 (8.40%)	2 (1.68%)	12 (10.08%)
Trolleys	4 (3.36%)	6 (5.04%)	10 (8.40%)
Office chairs	10 (8.40%)	3 (2.52%)	13 (10.90%)
Wheel chairs	5 (4.20%)	0	5 (4.20%)
Antiseptic container covers	0	3 (2.52%)	3 (2.52%)

Form of bacteria isolated Type of hospital equipment	Gram positive cocci	Gram negative bacilli	Total
Antiseptic container boxes	4 (3.36%)	7 (5.88%)	11 (9.24%)
Baby scales	1 (0.84%)	0	1 (0.84%)
Anesthesia equipments	1 (0.84%)	1 (0.84%)	2 (1.68%)
Air conditioners	1 (0.84%)	1 (0.84%)	2 (1.68%)
Delivery tables	0	2 (1.68%)	2 (1.68%)
Oxygen concentrations	0	1 (0.84%)	1 (0.84%)
Patient chairs	5 (4.20%)	4 (3.36%)	9 (7.56%)
Operating tables	0	2 (1.68%)	2 (1.68%)
Surgical aspirators	0	1 (0.84%)	1 (0.84%)
Negatoscopes	0	1 (0.84%)	1 (0.84%)
Office tables	3 (2.52%)	4 (3.36%)	7 (5.88%)
Total	62 (26.3%)	57 (24.2%)	119 (100%)

3.3. Profile and Prevalence of Bacteria Isolated

Among the total 119 bacteria isolated, 33 different species were found to belong to 5 Gram-positive cocci and 27 Gram negative bacilli (13 Enterobacteriaceae and 15 non enterobacteria). In general as Gram positive cocci were mostly identified to be *Staphylococcus aureus* with 37.81% (45/119), followed by *Staphylococcus epidermidis* 8.40% (10/119), *Staphylococcus saprophyticus* and *Micrococcus spp*

both having 2.52% (3/119) and *Enterococcus faecalis* 0.84% (1/119). On the basis of Gram negative bacilli isolated, majority was non Enterobacteriaceae 26.05% (31/119) with a highest percentage of *Acinetobacter spp*, *Aeromonas hydrophilas* and *Pasteurella pneumotropica* equal having 3.36%5 (4/119), followed by Enterobacteriaceae family 21.85% (26 /119) where *E. coli* showed a highest percentage (5.04% (6/119)). Figure 2, Figure 3 below and Figure 4 shows a detailed illustration of the above explanation.

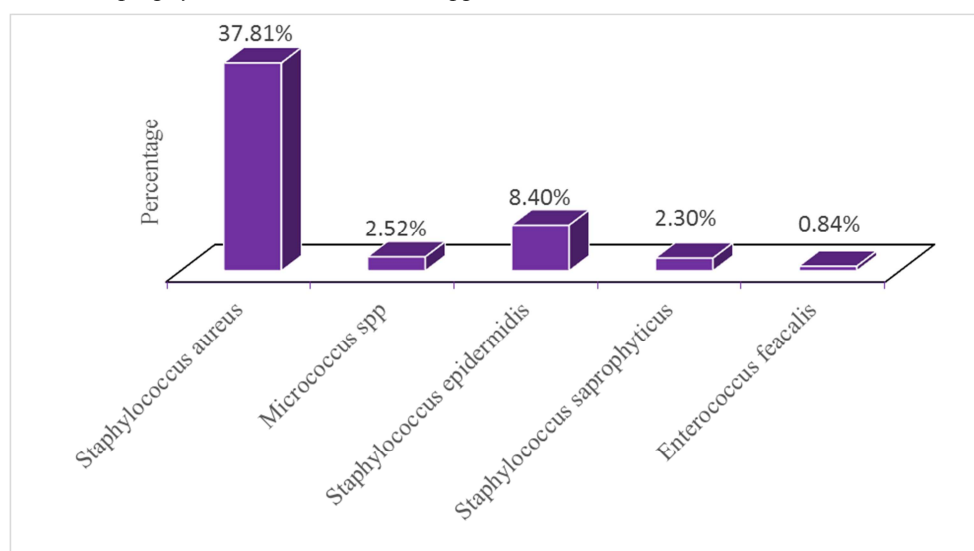


Figure 2. General prevalence of Gram positive cocci in the targeted hospital facilities.

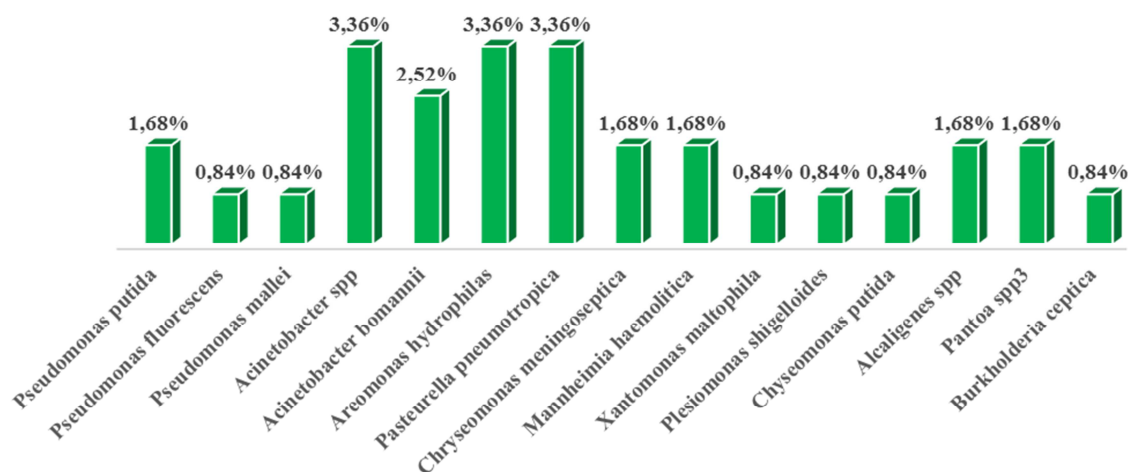


Figure 3. General profile and prevalence of Gram negative, non Enterobacteriaceae species in the hospitals facilities.

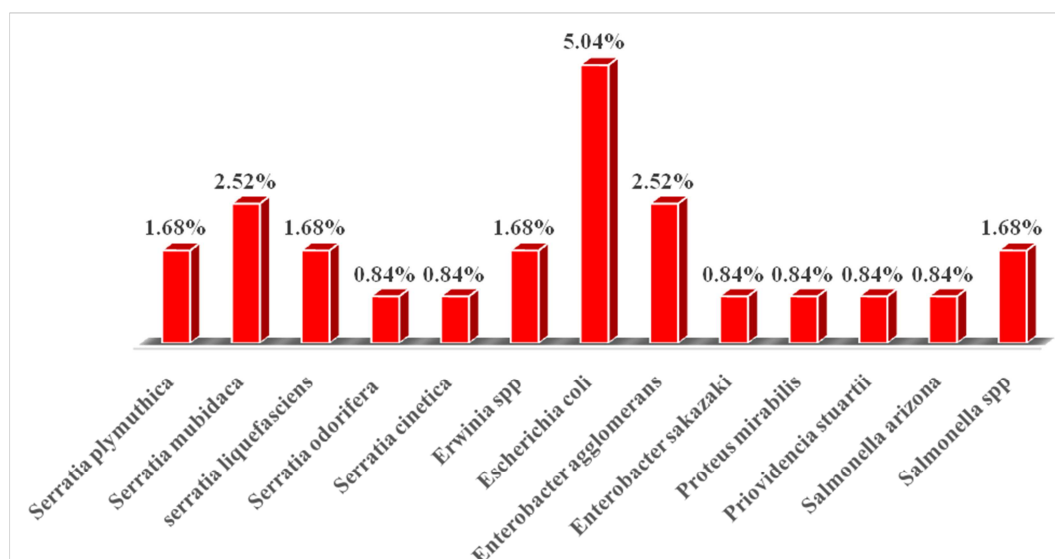


Figure 4. General profile and prevalence of Gram negative, Enterobacteriaceae species in the hospitals facilities.

3.4. Distribution of Bacteria Isolates Per Hospital Facilities

Out of 62 Gram positive cocci isolated, 26 (41.93%) were found in the MHD, followed by NBDH with 16 (25.80) with *Enterococcus faecalis* was the only. MHCN showed the lowest count of just 5 (8.06%), while, the predominant and only species found in all hospital was *S. aureus* with 72.58% (45/62). However, the rest of the other bacterial species isolated were found in some hospital and absent in others. For 26 Enterobacteriaceae distribution, out of the four hospital centers, HSJMN showed a highest bacterial contamination level 30.70% (8/26) with a majority of *Enterobacter agglomerans* 11.53% (3/26) as well as from the only center it was isolated. Followed by NBDH, MHCN, and

MHD having each one 23.07% (6/26), constituting most of *E. coli* both NBDH, MHCN and *Erwinia spp* in MHD where it was only isolated. According to 31 non enterobacteriaceae Gram negative bacilli isolated, NBDH hosted the highest proportion (32.25% (10/31)) mostly made up of *Pantoea spp* 6.45% (2/31) also only isolated there. Likewise, even if MHCN showed the lowest percentage 16.12% (5/31) of bacteria isolated it was the only center reported the growth of *Pseudomonas putida* as well as the most species with 6.45% (2/31). In addition just one strain of *Burkholderia cepacia* was isolated in MHD 3.32% (1/31) Tables 2, 3 and 4 below shows a detailed illustration of the above explanation.

Table 2. Distribution of Gram positive cocci per hospital facilities.

Isolated Gram positive cocci	NBDH n (%)	HSJMN n (%)	MHCN n (%)	MHD n (%)	TOTAL n (%)
<i>Staphylococcus aureus</i>	12 (19.35%)	9 (14.51%)	4 (6.45%)	20 (32.25%)	45 (72.58%)
<i>Micrococcus Spp</i>	1 (1.61%)	0	0	2 (3.22%)	3 (4.83%)
<i>Staphylococcus epidermidis</i>	2 (3.22%)	6 (9.67%)	0	2 (3.22%)	10 (16.12%)
<i>Staphylococcus saprophyticus</i>	0	0	1 (1.61%)	2 (3.22%)	3 (4.83%)
<i>Enterococcus faecalis</i>	1 (1.61%)	0	0	0	1 (1.61%)
Total	16 (25.80%)	15 (24.19%)	5 (8.06%)	26 (41.93%)	62 (100%)

Table 3. Distribution of Gram negative bacilli enterobacteriaceae per hospital facilities.

Isolated Gram negative enterobacteriaceae	NBDH n (%)	HSJMN n (%)	MHCN n (%)	MHD n (%)	TOTAL n (%)
<i>S. plymuthica</i>	1 (3.84%)	0	0	1 (3.84%)	2 (7.69%)
<i>S. mublidaca</i>	1 (3.84%)	1 (3.84%)	0	1 (3.84%)	3 (11.53%)
<i>S. liquefasciens</i>	0	2 (7.69%)	0	0	2 (7.69%)
<i>S. cinetica</i>	0	1 (3.84%)	0	0	1 (3.84%)
<i>Erwinia spp</i>	0	0	0	2 (7.69%)	2 (7.69%)
<i>E. coli</i>	3 (11.53%)	0	3 (11.53%)	0	6 (23.07%)
<i>E. agglomerans</i>	0	3 (11.53%)	0	0	3 (11.53%)
<i>E. sakazaki</i>	0	1 (3.84%)	0	0	1 (3.84%)
<i>P. mirabilis</i>	1 (3.84%)	0	0	0	1 (3.84%)
<i>S. arizona</i>	0	0	1 (3.84%)	0	1 (3.84%)
<i>salmonella spp</i>	0	0	1 (3.84%)	1 (3.84%)	2 (7.69%)
<i>S. odorifera</i>	0	0	0	1 (3.84%)	1 (3.84%)
<i>P. stuartii</i>	0	0	1 (3.84%)	0	1 (3.84%)

Isolated Gram negative enterobacteriaceae	NBDH n (%)	HSJMN n (%)	MHCN n (%)	MHD n (%)	TOTAL n (%)
TOTAL	6 (23.07%)	8 (30.70%)	6 (23.07%)	6 (23.07%)	26 (100%)

S.phymutica=Serratia phymutica, S.mublidaca=Serreatia mublidaca, S.liquefaciens=Serratia liquefaciens, S.cinatica=Serratia cinetica, S.odorifrea=Serratia odorifera, E.coli=Escherichia coli.

E.agglomerans=Enterobacter agglomerans, E.sakasaki=Enterobacter sakasaki.

P.mirabilis=Proteus mirabilis, S.arizona=Salmonella arizona, P.stuartii=Providencia stuartii.

Table 4. Distribution of Gram negative bacilli non enterobacteriaceae per hospital facilities.

Isolated Gram negative non enterobacteriaceae	NBDH n (%)	HSJMN n (%)	MHCN n (%)	MHD n (%)	TOTAL n (%)
<i>P. Putida</i>	0	0	2 (6.45%)	0	2 (6.45%)
<i>P. fluorescens</i>	1 (3.22%)	0	0	0	1 (3.22%)
<i>P. mallei</i>	0	1 (3.22%)	0	0	1 (3.22%)
<i>A. baumannii</i>	1 (3.22%)	1 (3.22%)	0	1 (3.22%)	3 (9.67%)
<i>Acetobacter spp</i>	1 (3.22%)	3 (9.67%)	0	0	4 (12.9%)
<i>A. hydrophilas</i>	1 (3.22%)	0	1 (3.22%)	2 (6.45%)	4 (12.9%)
<i>P. pneumotropica</i>	1 (3.22%)	0	0	3 (9.67%)	4 (12.9%)
<i>C. meningoseptica</i>	1 (3.22%)	0	0	1 (3.22%)	2 (6.45%)
<i>M. heamoliticus</i>	1 (3.22%)	1 (3.22%)	0	0	2 (6.45%)
<i>X. maltophila</i>	0	1 (3.22%)	0	0	1 (3.22%)
<i>P. shigelloides</i>	0	0	1 (3.22%)	0	1 (3.22%)
<i>C. putida</i>	0	0	1 (3.22%)	0	1 (3.22%)
<i>Alcaligenes spp</i>	1 (3.22%)	0	0	1 (3.22%)	2 (6.45%)
<i>Pantoea ssp"</i>	2 (6.45%)	0	0	0	2 (6.45%)
<i>B. ceptica</i>	0	0	0	1 (3.22%)	1 (3.22%)
TOTAL	10 (32.25%)	7 (22.58%)	5 (16.12%)	9 (29.03%)	31 (100%)

P. putida=Pseudomonas putida, P. fluorescens=Pseudomonas fluorescens, P. mallei=Pseudomonas mallei.

A. baumannii=Acinetobacter baumannii, A. hydrophilas=Aeromonas hydrophilas,

P. pneumotropica=Pasteurella pneumotropica, C.meningoseptica=Chryseomonas meningoseptica,

M. heamoliticus=Manhemia haemolyticus, X.maltophila=Xantomonas maltophila,

P. shigelloides=Plesiomonas shigelloides, C. putida=Chryseomonas putida, B.ceptica=Burkholderia ceptica.

3.5. Distribution of Bacterial Isolated According to Hospital Units

In each of the four hospital facilities, we grouped the isolate according to hospital units. Out of the 62 Gram positive cocci, the Emergency unit and maternity showed both the highest bacterial growth 19.35% (12/62), while the pediatric units were the lowest with 8.06% (5/62). *Staphylococcus aureus* was the most common species and found in all units. However, the others of Gram positive cocci were found in some units and absent in others, except the single strain of *Enterococcus faecalis* isolated in medical ward 1.61% (1/62). Regarding the 26 Gram negative bacilli enterobacteriaceae family, the highest level of bacterial isolates were recovered in laboratory 26.92% (7/26), in which *E. coli* was predominantly reported (15.38% (4/26)) and the lowest organism isolated from operating units was a single strain of *Salmonella odorifera* 3.38% (1/26). Similarly, of the 13 species isolated in this enterobacteriaceae

family 5 note to be singly found 3.38% (1/26) in different units, they include: *Serratia cinetica* (Surgical unit), *Enterobacter sakasaki* (Maternity), *Proteus mirabilis* (Medical unit), *Salmonella arizona* (Pediatric unit) and *Providencia stuartii* (Laboratory). Furthermore, Gram negative bacilli were mostly by 31 identified non enterobacteriaceae. The Emergency units 35.48% (11/31) followed by Pediatric 19.35% (6/31) hosted the highest percentages respective by *Chryseomonas meningoseptica*, *Mannhemia haemolytica* both 6.45% (2/31) and *Aeromonas hydrophilas* 9.67% (3/31) respectively. In addition, likewise in the enterobacteria family, in this group, out of the 15 species isolated, 6 were singularly isolated in various units 3.22% (1/31) (*Pseudomonas mallei*, *Plesiomonas shigelloides* and *Chryseomonas putida* (Emergency unit), *Pseudomonas fluorescence* and *Burkholderia ceptica* (Operating unit), and *Xanthomonas maltophilas* (Maternity)). The detailed of these finding are illustrated in tables 5, 6 and 7 below.

Table 5. Distribution of Gram positive cocci per hospital units.

Isolated Gram positive cocci	Pediatric unit n (%)	Medical unit n (%)	Operating Theatre n (%)	Laboratory n (%)	Surgical unit n (%)	Emergency unit n (%)	Maternity n (%)	TOTAL n (%)
<i>Staphylococcus aureus</i>	3 (4.83%)	7 (11.29%)	6 (9.67%)	7 (11.29%)	5 (8.06%)	9 (14.51%)	8 (12.90%)	45 (72.58%)
<i>Micrococcus Spp</i>	0	0	0	1 (1.61%)	1 (1.61%)	1 (1.61%)	0	3 (4.83%)
<i>Staphylococcus epidermidis</i>	1 (1.61%)	2 (3.22%)	0	0	2 (3.22%)	1 (1.61%)	4 (6.45%)	10 (16.12%)
<i>Staphylococcus saprophyticus</i>	1 (1.61%)	0	0	0	1 (1.61%)	1 (1.61%)	0	3 (4.83%)
<i>Enterococcus faecalis</i>	0	1 (1.61%)	0	0	0	0	0	1 (1.61%)
TOTAL	5 (8.06%)	10 (16.12%)	6 (9.67%)	8 (12.90%)	9 (14.51%)	12 (19.35%)	12 (19.35%)	62 (100%)

Table 6. Distribution of Gram negative bacilli enterobacteriaceae per hospital units.

Isolated Gram negative enterobacteriaceae	Pediatric unit n (%)	Medical unit n (%)	Operating theatre n (%)	Laboratory n (%)	Surgical unit n (%)	Emergency unit n (%)	Maternity n (%)	TOTAL n (%)
<i>S. phymuthica</i>	2 (7.69%)	0	0	0	0	0	0	2 (7.69%)
<i>S. mubidaca</i>	0	1 (3.84%)	0	1 (3.84%)	1 (3.84%)	0	0	3 (11.53%)
<i>S. liquefasiens</i>	1 (3.84%)	0	0	0	1 (3.84%)	0	0	2 (7.69%)
<i>S. cinetica</i>	0	0	0	0	1 (3.84%)	0	0	1 (3.84%)
<i>Erwinia Spp</i>	0	0	0	0	1 (3.84%)	0	1 (3.84%)	2 (7.69%)
<i>E. coli</i>	0	0	0	4 (15.38%)	0	2 (7.69%)	0	6 (23.07%)
<i>E. agglomerans</i>	0	0	0	1 (3.84%)	0	2 (7.69%)	0	3 (11.53%)
<i>E. sakazaki</i>	0	0	0	0	0	0	1 (3.84%)	1 (3.84%)
<i>S. arizona</i>	1 (3.84%)	0	0	0	0	0	0	1 (3.84%)
<i>P. mirabilis</i>	0	1 (3.84%)	0	0	0	0	0	1 (3.84%)
<i>Salmonella spp</i>	0	1 (3.84%)	0	0	0	0	1 (3.84%)	2 (7.69%)
<i>S. odorifera</i>	0	0	1 (3.84%)	0	0	0	0	1 (3.84%)
<i>P. stuartii</i>	0	0	0	1 (3.84%)	0	0	0	1 (3.84%)
TOTAL	4 (15.38%)	3 (11.53%)	1 (3.84%)	7 (26.92%)	4 (15.38%)	4 (15.38%)	3 (11.53%)	26 (100%)

Table 7. Distribution of Gram negative bacilli non enterobacteriaceae per hospital units.

Isolated Gram negative non enterobacteriaceae	Pediatric unit n (%)	Medical unit n (%)	Operating Theatre n (%)	Laboratory n (%)	Surgical unit n (%)	Emergency unit n (%)	Maternity n (%)	TOTAL n (%)
<i>P. Pituda</i>	0	1 (3.22%)	0	1 (3.22%)	0	0	0	2 (6.45%)
<i>P. fluorescens</i>	0	0	1 (3.22%)	0	0	0	0	1 (3.22%)
<i>P. mallei</i>	0	0	0	0	0	1 (3.22%)	0	1 (3.22%)
<i>A. bomannii</i>	1 (3.22%)	0	1 (3.22%)	0	0	1 (3.22%)	0	3 (9.67%)
<i>Acinetobacter spp</i>	0	1 (3.22%)	1 (3.22%)	0	1 (3.22%)	1 (3.22%)	0	4 (12.90%)
<i>A. hydrophilas</i>	3 (9.67%)	0	0	0	0	1 (3.22%)	0	4 (12.90%)
<i>P. pnemotropica</i>	2 (6.45%)	1 (3.22%)	0	1 (3.22%)	0	0	0	4 (12.90%)
<i>C. meningoseptica</i>	0	0	0	0	0	2 (6.45%)	0	2 (6.45%)
<i>M. haemolitica</i>	0	0	0	0	0	2 (6.45%)	0	2 (6.45%)
<i>X. maltophilas</i>	0	0	0	0	0	0	1 (3.22%)	1 (3.22%)
<i>P. shigelloides</i>	0	0	0	0	0	1 (3.22%)	0	1 (3.22%)
<i>C. putida</i>	0	0	0	0	0	1 (3.22%)	0	1 (3.22%)
<i>Alcaligenes spp</i>	0	0	1 (3.22%)	0	0	1 (3.22%)	0	2 (6.45%)
<i>Pantao spp</i>	0	0	0	0	1 (3.22%)	0	1 (3.22%)	2 (6.45%)
<i>B. ceptica</i>	0	0	1 (3.22%)	0	0	0	0	1 (3.22%)
TOTAL	6 (19.35%)	3 (9.67%)	5 (16.45)	2 (6.45%)	2 (6.45%)	11 (35.48%)	2 (6.45%)	31 (100%)

4. Discussion

4.1. Result of Culture According to the Profile and Prevalence of Bacteria Isolazted

Bacteria are the mostly pathogens causing nosocomial infections. Gram positive cocci and Gram negative bacilli keep and important place in medical bacteriology. Therefore, laboratory control play a key role in the assessment of this problem and must be used to identify common pathogens to their species level. In general our study revealed a total of 119 bacterial growth out of 236 swabs collected, giving an overall prevalence of bacterial contamination of 50.4%. Our findings is high than those found in Kawolo General Hospital in Uganda where among 136 swabbed samples, 61 (44.2%) presented bacterial contaminants [10]. These results are consistent in terms of type of bacteria found: 64/119 (52.10%) Gram positive cocci and 57/119 (47.90%) Gram negative bacilli (figure 1), compare to only 46 (75.4%) Gram-positive cocci and 15 (24.6%) Gram-negative bacilli respectively [10]. Besides, our study recovered 33 different

species, whereas more the Uganda study 14 different organisms were reported in Mbale Regional Referral Hospital. On the different surfaces and settle plate establishment in 4 various operating theatres were swabbed and cultured [11]. This difference can be explained by obvious fact like distinction in study area, sample size, target articles brief methodology. However our results presented a predominance of *S. aureus*, as the most infecting agent 45/119 (37.81%) followed by *E. coli* 6/119 (5.04%) and *Acinetobacter spp* 4/119 (3.36%) (Figures 2, 3 and 4). This results is similar to others findings, revealed that the high frequency of isolation were *S. aureus* and *E. coli* [18, 19]. Thus, our results suggest that these microbes in hospital environment may be the source of nosocomial infections, especially as these isolates are associated with HAIs. This can be supported by the fact two of our major isolates (*S. aureus* and *Acinetobacter spp*), belongs to the three of the priority pathogens on the WHO list for Global Antimicrobial Resistance Surveillance System (GLASS) reporting, namely *Klebsiella pneumonia*, *Acinetobacter baumannii* and *Staphylococcus aureus* to cause HAIs [20]. This shows poor application of best disinfection, sterilization and cleaning

common in Sub-Saharan Africa where Nosocomial infections have long been neglected [4, 9, 21]. Moreover, These results are consistent with a study carry in teaching hospital in Northwest Ethiopia where clinical samples of 260 hospitalized patients suspected of having nosocomial infections where culture positive, 66.5% mostly to Gram-positive cocci (*S. aureus* 35%) and Gram negative bacilli (*E. coli* 15.3%) [18]. Elsewhere a study from Kawolo General Hospital in Uganda reported, *S. aureus* with the highest prevalence 46/61 (75.4%) [10]. On contrary our findings are different for some studies carry out in Cameroon (surveillance of nosocomial infections in YUTH) and Uganda (contamination of microbial pathogens in 4 operating theatre), where *Klebsiella spp* (27%), *Pseudomonas spp* (23.9) and *Bacillus spp* (17.5%) were found as common organisms respectively [6, 11]. This difference can be due to the type and level of target hospital, units, type of specimen (hospital environment & hospitalized patients) and sample size.

4.2. Type of Hospital Equipment and Material According to Forms of Bacteria Isolated

In general, compared to the material and equipment swabbed, patient bedside tables, office chairs and patient bed rails showed growth with highest percentage respectively 11.76% (14/119), 10.92% (13/119) and 10.08% (12/119) (Table 1). This is proximate with the results of Sserwadda *et al* in Uganda where patient beds had the highest bacterial contamination levels of 19% (12/61). This can be explained by the contamination of hands by the patients, visitors and during patient care as most authors have reported those medical workers' hands are the most probable means of transfer [10, 22]. However, it is different to a study carried out in 2018 by other authors in Uganda were instrument trolleys, operating beds, and door handles had the highest number of pathogens respectively 26%, 20% and 10% [11].

4.3. Profile and Prevalence of Bacteria Isolated According to the Four Hospital Facilities and Seven Units

Comparing the level of contamination of bacterial between the four hospital facilities and the 7 hospital units, in our study, we observed that the major hospital facilities and units contaminated varied according to various type and species of isolated bacteria. According to hospital facilities, for Gram-positive cocci, MHD (41.93%) mostly *S. aureus* 32.25%, Gram negative bacilli Enterobacteriaceae, HSJMN (30.70%) mainly *E. agglomerans* 11.53%, (Tables 2, 3, 4). Regarding hospital units for Gram-positive cocci, Emergency units and maternity (19.35%) majority *S. aureus* 14.51% and 12.90% respectively, Gram negative bacilli enterobacteriaceae, Laboratory (26.92%) frequently *E. coli* 15.38% and non enterobacteriaceae, Emergency unit mostly *C. meningoseptica* and *M. heamolytica* both 6.45% (Tables 5, 6 and 7). This has been confirmed by Saxenai *et al.* 2019 indicating the variability of organisms causing infections widely from one country to another; as well as from one

hospital to other and even among different services [23]. Nevertheless *S. aureus* was the only species found in all hospitals and units. This could be explained by the fact that it can be due to a resistant pattern such as MRSA, responsibly for an outbreak and spread in different services. This can be supported by a study that reported the presence and increase of MRSA in Many hospitals of several countries in Africa [24]. On the contrary our findings are different from the studies of Nouetchognou *et al* and Bashir *et al* who conducted in and Yaounde University Teaching Hospital in Cameroon and three tertiary hospitals, Kano state, Nigeria, where *Klebsiella spp* were the most frequently isolated bacterial nosocomial pathogens from all units and all studied hospitals respectively [6, 25].

There is a high level of contamination in our hospital environment. Such contamination is suggestive of a variety of factors which may include; poor decontamination and sanitation practices, ineffective disinfectants use and ineffective sterilization of medical care articles as stated by Sserwadda in 2018 [10].

5. Conclusion

HAIs remain today a public health problem with the presence and diffusion of germ in all hospital units, material and equipment. Our study clearly demonstrates that all hospital facilities, materials and equipment in all the units were contaminated with bacteria. Gram positive cocci were most isolated. *S. aureus* 45/62 (72.58%) found in all hospital facilities. The other bacterial species isolated were found in some hospitals, units and absent in others. Patient bedside tables, office chairs and patient bed rails showed growth with highest percentage. Thus, one of the key approaches that we need to prevent and control NI, is to recognize the level risk to pass on the on infections. The data from this study indicate the instruments contaminated with bacteria are a source and reservoir for horizontal transmission of HAIs. This situation is worrying and alarming for developing countries like Cameroon. Therefore, it is important to perform periodic assessment of hospital infection data and antimicrobial resistance pattern of the pathogens in order to prevent outbreaks and put in place control strategies.

Contributions of the Authors

TWJM, JCNA, AJ participated in the design of study. TWJM collected and conducted laboratory assay. TWJM and JCNA to data analysis, interpretation and manuscript design. All authors contributed to the review and approved the final version.

Conflicts of Interest

All the authors do not have any competing interest.

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