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Research Article

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Microbial Ecology of Hospital Surfaces of Maternities in the Public Hospitals of Lubumbashi in the Democratic Republic of Congo

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Abstract

Introduction: *in the health care milieu, germs can contaminate surfaces that are in contact with vulnerable anatomical sites. The study had as objectives to identify the nature of germs present on the hospital surfaces and to evaluate their resistance to antibiotics used in clinical practice in the maternity wards of public hospitals of Lubumbashi.*

Methods: *The cross-sectional descriptive study was conducted in seven maternities in January 2015. These maternities were chosen depending on whether they met the inclusion criteria. Data collection was performed by swabbing the surfaces in using ISO / DIS 14698-1. The sample analysis was achieved in the laboratory of the University clinics in Lubumbashi.*

Results: *On 77 sampled and analyzed surfaces, 47 surfaces i.e., 61% have made one or several germs. Candida albicans was the most isolated on 20 surfaces i.e., 43% followed by Escherichia coli on 17 surfaces (36%), Staphylococcus aureus on 4 surfaces (9%) and Pseudomonas aeruginosa, Klebsiella oxytoca, Enterococcus faecalis respectively on 2 surfaces (4%). Klebsiella oxytoca was found in the solution of Dakin reserved for disinfection in the operating room. The germs were multi-resistant to several antibiotics commonly used clinically in these maternities, including Amoxicillin, Ampicillin and the Augmentin (Amoxicillin + Clavulanate).*

Conclusion: *We found a significant presence of multi-resistant germs on the hospital surfaces. We need to improve the bio-cleaning and good political use of antibiotics and disinfectants.*

Keywords: Bacterial Ecology, Hospital Surface

Introduction

In the Democratic Republic of Congo (DRC), hospitals are intended to provide health care as a complement to the primary care package offered by health centers (HS) to all segments of the population. However, because of insufficient financial means, their maintenance is poor. As a result, there is a noticeable deterioration of hygiene conditions [1, 2]. In Lubumbashi, this degradation is more pronounced in public hospitals, where this study was conducted. Other studies in these types of health facilities have shown that not only hospitalized patients with infections or carriers of pathogenic microorganisms were potential sources of infection for other patients, [3, 4], but also that they could be for their immediate environment.

The hospital environment includes not only surfaces, water, air, linen, food and medical devices that are usually in contact with the patient – family carers and care staff – but also the waste produced in a hospital setting. In 2011, Mbutshu et al observed at Sendwe hospital that the conditions for biomedical waste management and housekeeping were poor [5], as there was no water (81.1%), the presence of unpleasant odors, the transport of waste to the destruction site was mainly done with the use of plastic buckets or ordinary bags held by hand or on the head, the final treatment of waste was incineration and open burning while the hospital produced about 92kg / day of biomedical waste that could contribute to outbreaks of nosocomial infections. For example, due to the non-observance of universal hygiene precautions, the rate of blood-borne accidents among health-care workers was 91.7% in rural hospitals, compared to 40.5% for urban hospitals) [6,7].

In healthcare, germs can contaminate objects, medical devices and substances that then come into contact with vulnerable anatomical sites. This is the case, for example, of water-borne bacteria (atypical mycobacteria), viruses and fungi [3, 4], which may come from another person present in the hospital or from the patient's flora. It may also be germs present on an object or in a substance recently contaminated by another human source of infection (environmental infection), which constitutes a problem with regard to the conditions of job insecurity in these hospitals [5, 6].

In low-income countries, postpartum infection accounts for over 10% of maternal complications; 4.4% of eternal deaths are attributable to it in DRC. The improvement of hygiene conditions at maternity in general and during childbirth in particular, is significantly associated with the reduction of postpartum maternal mortality [8-14].

The objective of this study was to identify the nature of the germs present on the hospital surfaces of maternity wards of Lubumbashi public hospitals and to evaluate their resistance to antibiotics used in clinical practice.

Methods

Field of study

The city of Lubumbashi, chosen for this study, is located in the South-East of the province of Haut-Katanga of which it is the chief town. It covers 747 km^2 including 140 km^2 urbanized. Its population was estimated in 2006 at 1,500,000 inhabitants with a density of 10,000 inhabitants / km^2.

Concerning health, the city of Lubumbashi is subdivided into 11 health zones (HZ), each with a General Reference Hospital (GRH). There is also a hospital of university clinics. Each HGR has a minimum capacity of 200 beds, of which 15% is for the maternity ward.

Study Framework, Population and Material

The maternities of public hospitals were the study population. To be included in the study, maternity had to meet the following conditions: to be a maternity hospital of a public hospital of Lubumbashi reaching more than 60 deliveries a month. Given these conditions, we have finally included seven maternity hospitals. We carried out the descriptive transversal study. The data collection took place in January 2015. Using swabbing according to the ISO / DIS 14698-1 standard, we collected the samples from the hospital surfaces, in particular: the operating tables, the tables of Mayo, delivery tables, door handles for operating rooms, delivery and toilets, toilet flushes, incubators, baby scales, Dakin solutions (for the intermediate clamp) of the delivery room and operation.

The swab was performed in one day but with intervals of two to three days between the structures. The samples were taken and analyzed at the laboratory of Lubumbashi University Clinics. For each surface, two samples were taken. The swabs were seeded on bromocresol purple lactose agar, Chapman's medium, blood agar and chocolate agar, and incubated at 37 °C for 24-48 hours. The colony abundance was noted and gram-negative bacilli colonies were transplanted to a conventional gallery and API 20E, then identified according to standard keys and Bergey's manual of systematic bacteriology 1984 [15]. Each sample was repeated and identified 3 times.

In laboratory analyzes, to study the resistance of germs to antibiotics, we used the following codes: **R** to denote Resistance; **S**: the sensitivity and **I**: the Intermediate result. The variables studied were the nature of isolated surface bacteria and their resistance to antibiotics.

Statistical analysis

The Epi info version 7 software allowed us to analyze the data. We used the usual statistics to describe our sample and calculate the frequency measurements.

Ethical considerations

The protocol was validated by the ethics committee of the University of Lubumbashi.

Results

Biological data: Of 77 samples taken, the analysis showed that 47 (61%) had at least one germ. Candida albicans was the most isolated (20 surfaces or 43%) followed by Escherichia coli (17 surfaces or 36%), Staphylococcus aureus (4 surfaces or 9%) and Pseudomonas aeruginosa, Klebsiella oxytoca and Enterococcus faecalis with two contaminated surfaces (4%) [Table1].

Table 1: Distribution of isolated germs according to the surfaces of all the maternities of the public hospitals surveyed

Surfaces	Total hospitals	Surfaces Bearing germs n (prevalence%)	Proportion of germs per area					
			Candida albicans	*Entérococcus faecalis*	*Escherichia coli*	*Staphylococcus aureus*	*Pseudomonas aeruginosa*	*Klebsiella oxytoca*
			%	*%*	*%*	*%*	*0,0*	*%*
Delivery tables	7	6 (85,7)	*28,6*	*28,6*	*28,6*	*0,0*	*0,0*	*0,0*
Operating table	7	5 (71,4)	*71,4*	*0,0*	*0,0*	*0,0*	*0,0*	*0,0*
Mayo Table	7	5 (71,4)	*71,4*	*0,0*	*0,0*	*0,0*	*0,0*	*0,0*
Baby scales	7	5 (71,4)	*57,1*	*0,0*	*14,3*	*0,0*	*0,0*	*0,0*
Toilet door handles	7	7 (100,0)	*28,6*	*0,0*	*71,4*	*0,0*	*0,0*	*0,0*
Door handles delivery rooms	7	3 (42,9)	*0,0*	*0,0*	*42,9*	*0,0*	*28,6*	*0,0*

All toilet flushes had germs, and E.Coli was found on 85.7% (n = 77) of them. In order of frequency, the germs found on the delivery tables were Candida albicans, Enterococcus faecalis (85.7% area for each) and Escherichia coli (28.6%). In general, 71.4% of operating tables, Mayo tables, baby scales and incubators carried Candida albicans. Only incubators carried Staphylococcus aureus, Pseudomonas aeruginosa and Klebsiella oxytoca [Table 2 and 3].

Table 2: Distribution of isolated sprouts according to the surface area of all maternity wards of the public hospitals surveyed (continued)

Surfaces	Total hospitals	Surfaces Bearing germs n (prevalence%)	Proportion of germs per area					
			Candida albicans	*Entérococcus faecalis*	*Escherichia coli*	*Staphylococcus aureus*	*Pseudomonas aeruginosa*	*Klebsiella oxytoca*
			%	%	%	%	0,0	%
incubators	7	5 (71,4)	*0,0*	*0,0*	*0,0*	*28,6*	*0,0*	*14,3*
Toilet flushes	7	7 (100,0)	*14,3*	*0,0*	*85,7*	*0,0*	*0,0*	*0,0*
Handles operating room doors	7	2 (28,6)	*14,3*	*0,0*	*0,0*	*14,3*	*0,0*	*0,0*
Dakin Solution / Operating Room	7	1 (28,6)	*0,0*	*0,0*	*0,0*	*14,3*	*0,0*	*14,3*
Dakin Solutions / Delivery Room	7	0 (0,0)	*0,0*	*0,0*	*0,0*	*0,0*	*0,0*	*0,0*
Total	**77**	**47 (61 ,0)**	**42,6**	**4,3**	**36,2**	**8,5**	**4,3**	**4,3**

Klebsiella oxytoca was isolated only in the Dakin solution used for the middle clamp of the operating room [Table 3 and 4].

Table 3: Table of isolated germs by maternity of public and area hospitals surveyed

Surfaces	SNCC Hospital	RGH Katuba	RGH Kampemba	RGH Kisanga	RGH Sendwe	ULC	RGH Kenya
Delivery tables	*C. albicans*	*C. albicans*	*E. coli*	*E. coli*	*Entérococcus faecalis*	‡	*Entérocoques faecalis*
Operating Tables	*C. albicans*	*C. albicans*	*C. albicans*	‡	*C. albicans*	‡	*C. albicans*
Mayo table	*C. albicans*	*C. albicans*	*C. albicans*	*C. albicans*	*C. albicans*	‡	*C. albicans*
Baby scales		*E. coli*	*C. albicans*	*C. albicans*	*C. albicans*	‡	*C. albicans*
Toilet door handles	*E. coli*	*E. coli*	*E. coli*	*C. albicans* *E. coli*	*E. coli*	Entérococcus *faecalis*	*E. coli*
Door handles delivery room	‡	*E. coli*	‡	‡	*E. coli*		*E. coli*
	‡= no isolated germs, C. *albicans= Candida albicans*, *E. coli= Escherichia coli*, *P. aeruginosa= Pseudomonas aeruginosa*, *SNCC= Congo Railway Company, RGH=Reference General Hospital*						

Table 4: Table of isolated sprouts by maternity of public hospitals and by area surveyed (continued)

Surfaces	SNCC Hospital	RGH Katuba	RGH Kampemba	RGH Kisanga	RGH Sendwe	ULC	RGH Kenya
incubators	*P. aeruginosa*	*P. aeruginosa*	‡	*Staphylococcus aureus*	*Staphylococcus aureus*	*Klebsiella oxytoca*	*Staphylococcus aureus*
Toilet flushes	*Escherichia coli*	*E. coli*	*C. albicans*	*E. coli*	*E. coli*	*E. coli*	*E. coli*
Toilet door handles	‡	*C. albicans*	‡	‡	*Staphylococcus spp*	‡	‡
Dakin Solution S OP	‡	*Klebsiella oxytoca*	‡	‡	*Staphylococcus aureus*	‡	‡
Dakin Solution Delivery Room	‡		‡	‡		‡	‡
	‡= no isolated germs, *C. albicans= Candida albicans*, *E. coli= Escherichia coli, P. aeruginosa= Pseudomonas aeruginosa*, *SNCC= Congo Railway Company, RGH=Reference General Hospital*						

Sensitivity profile

These germs were multidrug resistant to antibiotics commonly used clinically in all these maternities. They were resistant to Amoxycilin (100%) Ampicillin (100%) and Augmentin (Amoxycilin + Clavulanic acid), [Table 5].

Table 5: Responses of germs to antibiogram

Germs	Gentamicin	Augmentin (Amoxicilin+ clavulanic acid).	Ampicillin & amoxicillin	Ceftaxime	Ciprofloxacin	Clindamycin
Pseudomonas aeruginosa	100%S	75%R et 25% I	100%R	100%S	60%R et 40%I	100%S
E coli	62,5%R et 37,5%S	100%R	100%R	100%S	87,5%I et 12 ,5%R	100%S
Klebsiella oxytoca	40% R et 60%S	100%R	100%R	100%S	20%S, 40%I, 40%R	100%S
Enterococcus faecalis	100%S	100%R	100%R	100%S	100%S	100%S

Discussion

At the end of this study whose objective was to identify the germs on hospital maternity surfaces in Lubumbashi public hospitals and evaluate their resistance to antibiotics. It appears that there is a significant presence of isolated germs on the hospital surfaces of these maternities. At least one germ has been found on almost all hospital surfaces. Only Dakin's solution in the delivery room does not contain germs. Candida albicans was the most isolated germ on these surfaces, followed by Escherichia coli. Klebsiella oxytoca were found in the Dakin solution of the operating room, Escherichia coli were found on the toilet door handles, the delivery table and toilet flush and Pseudomonas aeruginosa, Klebsiella oxytoca and Staphylococcus aureus on the incubator.

Two studies have also observed that surfaces can potentially promote the transmission of microorganisms. The pathogenic germs found in these hospital surfaces may be bacteria present in stool or urine (Salmonella, Shigella, Coliform, Vibrio, Streptococci, Enterobacteria ...) which are responsible for nosocomial infections, particularly Staphylococci, Streptococci, Pseudomonas ...) [14]. All these bacteria are dangerous because they acquire resistance to antibiotics [16]. The isolated organisms in our study are also bacteria found in urine and stool with the exception of Candida albicans.

In terms of proportions, in our study, the following germs were identified: Candida Albicans (42.6%), Escherichia Coli (36.2%), Staphylococcus aureus (8.5%), Klebsiella oxytoca, Enterococcus faecalis, and Pseudomonas aeruginosa respectively all (4.3%). Saouide el ayne and allies found in their studies, the following germs: Bacillus (27%) and coagulase-negative Staphylococci (26%), followed by Staphylococcus aureus (20%) and Klebsiella pneumoniae (16%). Pseudomonas aeruginosa such as Enterobacter cloacae of 5% and Proteus vulgaris of 1% [12]. This small difference can be explained by the fact that in their study, they included all the traditional services of a hospital.

Nelson and allies meanwhile, they showed that the operating room phones are contaminated; the majority of isolated organisms were Staphylococcus coagulas negative (82.8%), Acinetobacter baumani (1.9%) or Pseudomonas aeruginosa (1.9%) [17]. Barbut and allies have blamed several factors for the occurrence of nosocomial infections, particularly hospital surfaces, in the absence of effective bio-cleaning [18]. The difficulties of the resources that these hospitals experience which lead thereafter to the mismanagement of hospital waste and the bad housekeeping are reasons for the proliferation of germs on these hospital surfaces [5].

Saouide el ayne et al. who worked on the entire hospital gave the following overall distribution of germs by service and their predominance in the intensive care units (28%), trauma (11%), emergencies (10%) and the operating room (8%) [12]. As maternity and surgery are not primarily in all of these studies, we believe that the areas of other services not included in our study could have a very high frequency of germs since this degradation of the infrastructures concerns all the units, and all the services of these hospitals, likewise for staff who have the same status and the same employer [1, 2].

A study conducted on 32 curtains, 40 cell phones, 35 white coats in Colombia found a result such that out of a total of 159 surfaces sampled. 98.7% of surfaces had positive bacterial cultures with interesting resistance profiles [19]. Compared to this study, we note that ours did not include other surfaces such as curtains and mobile phones and their percentages of positivity of the surfaces analyzed were much higher.

In Méité et al study [20], in which 431 samples were taken, 58.5% of furniture surfaces, of which 46.4% were positive; 30.7% of bacteria were of human origin including 11.1% of Staphylococcus aureus, 11.8% of Klebsiella pneumoniae, 0.4% of Salmonella spp and 0.4% of Shigella spp. 13.3% of Staphylococcus spp or aureus were methicillin-resistant, 23.5% of Enterobacteria strains produced a broad-spectrum Betalactamase (BSB). The authors pointed out that the presence of multi-resistant bacteria of human origin on the surfaces of the hospital environment is a testimony to poor hygiene in health care facilities. Adriana found a high prevalence of methicillin-resistant Staphylococcus aureus, Clostridium difficile, Acinetobacter baumannii and Vancomycin-resistant Enterococcus [21].

Our results are not very far from these authors, because the isolated germs were multi resistant to the antibiotics commonly used in the clinical practice of the environment and the small difference is always related to the comprehensiveness of the services included in their research.

Another bibliographic survey examined twenty-one items and highlighted the presence of bacteria on monitors, bed racks, tables, faucets, telephones, keyboards and other objects. Of all these studies, it should be noted that hospital surfaces constitute a favorable environment for hospital germs.

The following bacteria were most isolated E. coli, K. pneumoniae, P. aeruginosa, Staphylococcus aureus and A. baumanii. Most strains were resistant to three families of antibiotics (beta-lactams, aminoglycosides and fluoroquinolones) [22-23].

It should also be noted that in our study, all isolated organisms are 100% resistant to ampicillin and amoxicillin; gentamycin and ciprofloxacin also experienced some 25% resistance to Escherichia coli and Klebsiella oxytoca. We note that our results are not far from other researchers and it should be confirmed that the ecology

of the hospital surfaces of public hospitals in Lubumbashi are contaminated with multidrug-resistant germs commonly used. Anarchic prescriptions without prior antibiogram and poor hygienic conditions are at the basis of the emergence of multidrug-resistant strains in Lubumbashi maternity wards.

Conclusion

This study shows that in Lubumbashi, in maternity wards of public hospitals, the environment is generally contaminated by several germs. Candida albicans, Escherichia coli, Staphylococcus aureus, Pseudomonas aeruginosa, Klebsiella oxytoca and Enterococcus faecalis were the germs found on the majority of maternity surfaces.

These germs were multiresistant to antibiotics commonly used clinically in all these maternities. They were resistant to Amoxycilin (100%) Ampicillin (100%) and Augmentin (Amoxycilin + clavulanic acid).

Bio-cleaning and good antibiotic and disinfectant use policies can improve hospital hygiene and reduce the risk of nosocomial infections.

Conflicts of interest

We have no conflict of interest.

What is known about this topic

- The scarcity of research on the microbial ecology of hospital surfaces in our environment in particular
- The germs of nosocomial infections are mostly bacteria that often have patterns of resistance to antibiotics
- The hospital environment conditions, medical exercise and individual factors are causing the occurrence of these infections.

What does your study bring back

- Knowledge of more germ-eating surfaces in maternity wards in Lubumbashi public hospitals;
- Identification of their susceptibility profile for antibiotics used in clinical practice in Lubumbashi;

Contributions of the authors

- **Mbutshu Lukuke Hendrick:** study design, protocol writing, data collection, data analysis, writing paper.
- **Makoutode Michel:** validation of the protocol and drafting of the document.
- **Mukengeshayi Ntambue Abel:** protocol validation, data analysis, writing paper.
- **Kapopo Mwewa Christelle:** data collection and data analysis.
- **Malonga Kaj Françoise:** validation of the protocol and drafting of the paper

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