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Hospital environment and risk of nosocomial infections in the intensive care unit of Provincial Hospital El Idrissi of Kenitra in Morocco

Rajaa Amiyare[*], Ikram Afifi[**] and Mohammed Ouhssine[*]

**Laboratory of Biotechnology, Environment and Quality, Department of Biology, Ibn Tofaïl University of Sciences, Kenitra, MOROCCO*
***Provincial Hospital El Idrissi, Kenitra, (MOROCCO)*

ABSTRACT

The hospital environment is comprised of a set of components that may come in contact with the patients. Persons such as the staff and the visitors are an integral part of this environment. In order to protect them, it is essential to control the hospital environment by identifying the sources of infections. Nosocomial infections have always represented a public health problem. For this purpose, we have carried out a study of bacteriological surfaces in the intensive care unit of the provincial hospital Elidrissi of Kenitra in Morocco. The objectives were the identification of different multi-resistant bacteria (MRB) and the determination of their distribution according to the sampling sites. On 120 samples collected, 30 MRB have been isolated where the Cephalosporinase hyperproducing Enterobacteriaceae is the most bacteria species identified. Below the bacteria identified and its number:

- *Cephalosporinase hyperproducing Enterobacteriaceae (10 strains).*
- *Acinetobacter baumannii (7 strains).*
- *Stenotrophomonas maltophilia (5 strains).*
- *Staphylococcus aureus resistant to the methicillin (3 strains).*
- *Morganella morganii (2 strains)*
- *Pseudomonas aeruginosa (2 strains)*
- *Extended-spectrum betalactamase producing enterobacteriaceae (1. Strain)*

The emergence of those bacteria constitutes a potential risk; however, the monitoring of the multi bacterial resistance has become a necessity and requires the establishment of an adapted strategy of intervention in order to avoid the risk of nosocomial infections.

Key words: hospital environment, nosocomial infection, intensive care unit, multi-resistant bacteria,

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INTRODUCTION

The Care's units host patients whose survival is threatened by the abrupt onset of one or more mistakes of vital functions. The medical care support may involve risks of complications following the use of non-cleaned or poorly reprocessed medical instruments [1]. The hospital field is the contamination of medical devices by pathogenic bacteria which may be at the origin of more or less severe infections. The temporary implantation of vascular catheter, probe bladder, or with a probe tracheal may be associated with non-negligible infectious risks [2]. The World Health Organization (WHO) estimates that between 5 and 12 percent of hospitalized patients in the world

develop healthcare-associated infection (HAI) of which over 60 percent are associated with the implantation of medical or surgical device [3]. Any device implanted on a provisional or permanent basis, may become the site of a possible infection [4, 5, 24] particularly nosocomial infections that are the cause of morbidity and a high mortality [6, 7, 23, 34].

In the ICU, nosocomial infections are generally due to multi-resistant bacteria (MRB) of which Methicillin-resistant *Staphylococcus aureus* (MRSA), *Pseudomonas aeruginosa*, extended-spectrum beta lactamase (ESBL) producing Enterobacteriaceae, and Acinetobacter sp are the most offending [8]. Nowadays, the multi-bacterial resistance to antibiotics has become a reality following the lifestyle changes of consumers. The permanent need of the development of new antibiotics for the treatment of bacterial infections is evident [9, 10, 36]. It is asserted that the ICU is the epicenters of all nosocomial infections [12, 13, 17, 18].

The infections epidemiology by MRB changes considerably from one country to the other. For example in France, the frequency of infections in MRB in the ICU services including MRSA is one of the highest in Europe [14]. According to the national institute of health watch approximately 5% to 10% of hospitalized patients acquired one or more infections during hospitalization. In Europe, 25000 deaths per year are due to infections related to MRB. In Morocco, there is no national regulation requiring the reporting of nosocomial infections [15]. However, the fight against the MRB has begun to take place in recent years in some hospitals. As well, the first national survey on nosocomial infections was conducted in 1994. It has revealed a prevalence rate of 14 percent [16]. Since then, no other studies have been carried out on a national scale but on the other side investigations of regional prevalence are completed.

The present work has just followed the same strategy as mentioned. It has fixed as an objective, the identification of infectious bacteria involved in nosocomial infections of the Reanimation Department of the provincial hospital Idrissi of Kenitra. To do this, we drew upon the recommendations of the technical committee of the National nosocomial infections [19.20]. The strains adopted by this committee are: Methicillin-resistant *Staphylococcus aureus* (MRSA); cephalosporinase hyperproducing Enterobacteriaceae (CHPEB); Acinetobacter sp resistant to the ticarcillin (Acineto.sp); *Pseudomonas aeruginosa* resistant to ceftazidime (PARC); Enterococci resistant to glycopeptides (ERG); extended-spectrum beta lactamases (ESBL) producing Enterobacteriaceae.

MATERIALS AND METHODS

Specimens at the level of the intensive care unit of the Idrissi hospital of Kenitra have been carried out by the method of swabbing. The sterile swab is been moistened in an isotonic sterile fluid with a neutralizing solution (optional). For a flat surface, we move the swab on the defined area in parallel spaced ridges while turning slightly. On the same area, streaks are applied perpendicularly to the first (Standard of SO/DIS 14698-1). The conditions of specimens as well as the collection sites are recorded in the sampling registrar. Subsequently the swab submitted in its protective case and transmitted to the laboratory within one hour ±30 min.

Samples were collected at the sites the most exposed to contamination. The latter are defined according to the Guide of the bio-cleaning GPEM/SL # 5670, Recommendation # E 1-90 1994, and ISO/DIS ISO14698-1 standards. In total, 120 samples were carried out on 24 sampling sites for a period of four months. The table (1) shows the sampling sites as well as the number of samples collected.

At the laboratory, the procedures were performed under aseptic conditions. The swab is used directly for streaking culture medium in two sectors petri dishes (Chocolate and CLED). Streaking plates are carried out according to the quadrants technique which allows obtaining well isolated colonies. We have used the DNase and Chapman culture mediums for the identification of *Staphylococcus aureus*. We have subsequently highlighted the methicillin-resistance *Staphylococcus aureus* by applying oxacillin disk (5µg) to Mueller Hinton agar plate already inoculated by heavy inoculum at 30^0C.

For the identification of strains, we were interested in morphological, nutritional, metabolic, and cropping characters [22]. The enterobacteriaceae were identified by using API- test kit. The confirmation of ESBL strains is accomplished by synergy test involving the combination of amoxicillin-clavulanate (AMC) disks and third-generation cephalosporin. The test is characterized by a plug of Champagne.

Resistance detection is studied by using conventional disk diffusion method on Muller Hinton agar medium. The criteria for reading and interpretation were performed according to the guidelines of the Antibiogram Committee of the French Society for Microbiology [21].

Table1. Sampling sites

Sites	Number of samples	Sites	Number of samples
vital signs monitor	7	Intercommunication system	1
Trolley	10	Signboard for record	6
Tray stainless steel	4	Defibrillator	3
Drip-stand	4	Pneumatic Nebulizer	4
Scissors	4	Jar suction	11
Oxygen tubing	6	Tap	1
Ventilator tubing	13	Glucose Meter	2
Bed	8	Mobile lamp	2
Monitors' table	6	Electric syringe pump	4
tubing suction	14	Feeding pump	2
Door wrist	2	Phone	2
Garbage can	2	Manual resuscitator bag	3
Total	**120 samples**		

RESULTS

We have isolated 84 strains of which 36% are multi-resistant bacteria (MRB) and 64% remaining are of wild type strains. Our goal is limited in isolation of infectious agents known as responsible for nosocomial infections. In this study, we are interested only to MRB.

On 120 samples taken, 30 MRB have been isolated from the ICU. Cephalosporinase hyperproducing *Enterobacter cloacae* are the species most frequently; it has been represented by 10 strains. *Acinetobacter baumannii* has occupied the second position with 7 strains. The third position was for *Stenotrophomonas maltophilia* (n=5). Methicillin-resistant *Staphylococcus aureus* (MRSA), *Morganella morganii*, *Pseudomonas aeruginosa* resistant to ceftazidime, and Enterobacteriaceae ESBL were represented in the order by a number of strains of 3, 2, 2 and 1.

It is noted that the sites most exposed to contamination are: vacuum cleaner and respirator pipes, the bed arms, the scissors, the carts, scopes' table, the reservoir of aspiration, the scope support, the oxygen pipe and stainless steel tray. The sites attested sterile are not presented on table 2.

Table 2: Number and type BRM isolated in sampling sites

Sites	Number and type BRM isolated						
	Acineto .b	CHPEC	MRSA	PARC	ESBL	Steno malto	M.m
Trolley	1	0	2	0	0	0	0
Tray stainless steel	0	1	0	0	0	0	0
scissors	1	1	0	0	0	1	0
Oxygen tubing	0	1	0	0	0	0	1
Ventilator tubing	2	0	0	0	1	1	1
Bed	2	1	0	0	0	1	0
Monitors' table	1	1	0	0	0	0	0
Tubing suction	0	3	1	1	1	1	0
Signboard for record	0	1	0	0	0	1	0
Jar suction	0	1	0	0	0	0	0
TOTAL	7	10	3	1	2	5	2

The result shows that 58% are declared sterile and 42% remaining are considered as contaminated sites by MRB. We found that the infected sites are those who come into direct contact with patients. The small equipment used continuously by the staff (bed, scissors, tray, monitors' table....) are also concerned.

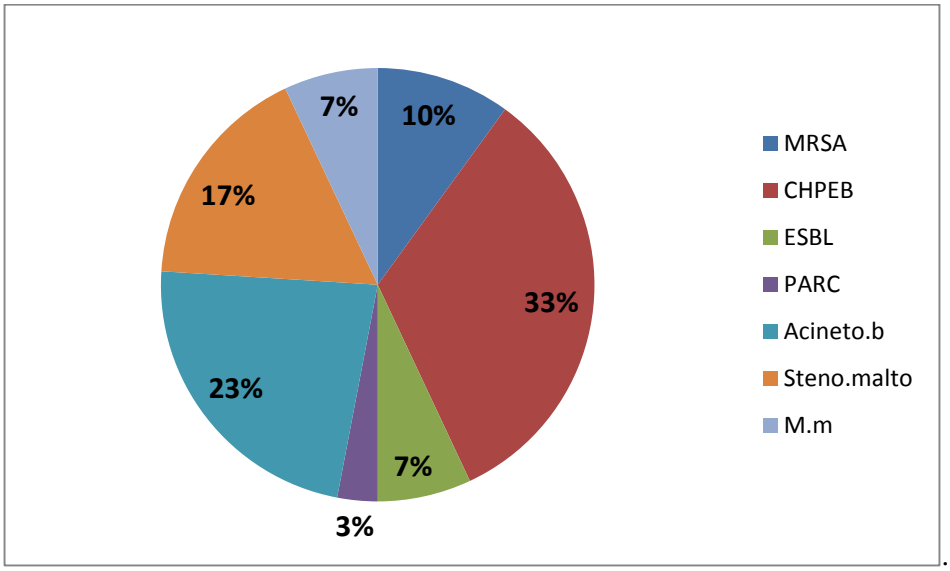

Figure 2. Distribution of MRB

The figure 2 shows that Cocci gram positive are represented by 10%. Bacilli gram negative remain largely predominant in the ICU. They are of the order of 90% with virtual predominance of Cephalosporinase hyperproducing Enterobacteriaceae. The latter represents 33% of the whole MRB. In the second position, *Acinetobacter baumannii* only represented with 23 %. *Stenotrophomonas malthophilia* has been met with 17 %. *Morganella morganii* and ESBL Enterobacteriaceae are represented with the same percentage 7 %. The last position in the total of MRB is occupied by *Pseudomonas aeruginosa* with 3 %. None of glycopeptide-resistant enterococci have been isolated.

DISCUSSION

In the hospital environment, it is often said “The problem is nosocomial infections. The operating staff in the sector and the literature does not cease talking about this issue. The amount of patients infected by emerging nosocomial infections increases every year. The challenge is to reduce the frequency of occurrence of this type of infection. The risk factors are the patient, the local (room architecture), equipment, staff, and the long-term care of patients. Thus, the objective of the present work is focused on the determination of the source of nosocomial infection. In our study 30 MRB have been isolated from the ICU of provincial hospital of Kenitra:

- Cephalosporinase hyperproducing *Enterobacter cloacae* (CHPEC) Is the species most frequent and major pathogen of concern. It has been isolated 10 times. Eight strains were resistant to third generation of cephalosporin (C3G) of which 3 has developed a resistance of the C4G. Two strains were resistant to Imipenem. This resistance is rarely considered. But it is to announce that we found a strain that has developed chromosomal class C beta-lactamase hyperproduction and permeability alteration by reducing the level of porin synthesis. Also, it is to be noted that the CHPEC was isolated at 8 sampling sites. This undermines the hygienic concept at the ICU room and justifies the widespread of MRB at its different levels.
- *Acinetobacter baumannii* (Acineto.b) resistant to the ticarcilline is the second MRB isolated from the ICU. It is represented by a number of 7. It is less virulent in normal individuals and very pathogenic in subjects whose immune system defenses are weakened. Its natural resistance and its ability to acquire new resistances to antibiotics greatly limit the therapeutic choice. We have found it at the level of four sampling sites. The respirator pipes are not default. 5 Strains have shown their sensitivity to aminoglycosides and colistin.
- *Stenotrophomonas maltophilia* (steno malto) also called Xanthomonas or yet *Pseudomonas malthophilia* is an opportunistic bacterium. It is often very difficult to eliminate it in case of pathology. This because of its multiple resistance. We have isolated *Stenotrophomonas maltophilia* from 5 collection sites.
- Methicillin-resistant *Staphylococcus aureus* (MRSA) is the fourth pathogenic bacteria isolated. It was represented by 3 strains. The species identified have a resistance to the oxacillin as shown in the figure below (figure

4). The resistance observed is due to a mutation of the penicillin-binding proteins (PBP) and this is what has given to the species a resistance to all Beta lactams. The methicillin resistant (MethiR) character is an indicator of intensively used antibiotype in medical bacteriology.

Figure 3. MRSA Antibiogram

- Two bacterial species were found to be extended-spectrum beta lactamases (ESBL). It is *Enterobacter cloacae* and *Stenotrophomonas maltophilia*.
- Two strains of *Morganella morganii* appointed initially by Proteus morganii were isolated at the level of the piping. It may also be involved in many infections in humans. The strains isolated show resistance to third generation cephalosporin. This resistance is of the high-level production of the chromosomal cephalosporinase AmpC type.
- *Pseudomonas aeruginosa* is known under the name of bacillus pyocyanique. It is part of the groups responsible for nosocomial infections (NI). It is often present in patients with a fragile health status. The emergence of new mechanisms of resistance makes the NI to Pseudomonas more and more difficult to treat. This strain has been isolated at the level of a pipe cleaner and has kept its sensitivity to the imipenem but it has developed a resistance to Ceftazidime, Cefsulodin, and Cefepime. The resistance to beta lactams among Pseudomonas often poses serious problems because it causes the resistance to most antibiotics. The resistance developed by Pseudomonas is usually associated with mutations leading to a hyper expression of the chromosomal class C beta-lactamase.

The ICU is widely contaminated. The number of species responsible for nosocomial infections is important. 30 strains belonging to 6 highly pathogenic species is an indicator of the lack of application of hygienic rules and aseptic technique, failure in the process of cleaning and disinfection manual or automatic, and/or a lack of staff hand hygiene. Indeed the failure of hygiene is the main cause of hospital infection [32, 33].

In our view the potential vectors of nosocomial infections are the high abundance of microbial populations in the ICU, the distribution of the same types of strains in different locations of the service, the severity of the pathologies of patients, the presence of the elderly, the increase in the number of personnel (doctors, nurses, and trainees). The same findings have been declared during the work [25.26, 30, 31, 34]. Other factors come to aggravate the situation; we include particularly the architectural design of the ICU (lack of room for the isolation of patients carrying MBR and the hospital in question is dated since 1933) and the increase in the average length of stay.

It comes out of the foregoing the usefulness of the training of the staff responsible for the treatment of equipment and surfaces on control of good practices of cleaning and disinfection. The personnel must develop its knowledge in compliance with the protocols and recommendations of health authorities and in compliance with the hygiene in the service [28.36]. At our level, we have initiated a program of study and research in collaboration with the ICU to study the effectiveness of disinfectant products used on different multi-resistant bacteria identified during this study.

CONCLUSION

The bacteriological study, of surface's samples taken in the intensive care unit (ICU) of the Provincial Hospital of Kenitra, has allowed declaring the existence of multi-resistant bacteria. It is of hyper-producing ESBL enterobacteriaceae of cephalosporinase, *Acinetobacter baumanii*, *Staphylococcus aureus* resistant to the methicillin, and *Pseudomonas aeruginosa* resistant to ceftazidime. The spread of these infectious agents between the often fragile patients may lead to nosocomial infections.

To combat the spread of these multi-resistant bacteria, it is necessary to develop procedure for cleaning and disinfection put enough staff and material resources of size at the disposal of the service, track and control the prescription of antibiotics, apply the rules of hospital hygiene, and detect and isolate the patients with MRB.

This study showed that the hospital must make efforts in prevention and respect of Good Hygiene Practices (GHP) in order to fight nosocomial infections to MRB. The compliance with the GHP should be accompanied by prior analysis of bacterial identification to better establish adapted and appropriate strategies of intervention and control. Indeed, microbiology laboratories should be an integral part of the surveillance system and prevention of nosocomial infections and hospital epidemic phenomena [29. 35].

The MRB control must be a daily struggle. It is a permanent teamwork where each has a very important place. If a person does not fulfill the measures, this can undermine the efforts of all. Also, the strength and the cohesion of the team are very important.

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