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Management of the monitoring of the hospital environment: Microbial profile of the services of a regional hospital in the city of Meknes in central Morocco

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Abstract :

Management of the monitoring of the hospital environment, especially nosocomial infections, requires knowledge of the microbial profile and control of the bacterial ecology of the various hospital services. These clinicobiological investigations are of paramount importance in hospital decision-making. In Morocco, the surveys on microbial profile of the services of hospital are virtually nonexistent.

A retrospective study of the results of non-redundant microbiological analyses of various samples (urine, blood culture, pus, lumbar punctures, pleural ascites and puncture), from different units of a regional hospital in the city of Meknes in central Morocco, was conducted on a period of five years (2012-2016). The results of the analyses of 2652 samples taken revealed the isolation of 1495 bacterial strains. Gram-negative bacteria accounted for 65%, while only 35% were Gram-positive ($p < 0.001$).

The isolated bacteria are: Staphylococcus aureus (27%), Pseudomonas putida (21%), Acinectobacter spp (14%), Klebsiella spp (9%), Escherichia coli (8%), Pseudomonas spp and coagulase-negative Staphylococcus (4%), Pseudomonas aeroginosa (2%). Other bacteria (Neisseria gonorrhoeae, pneumococci, Proteus spp, Enterobacter Spp, Citrobacter Spp, Salmonella Spp, Haemophilus influenzae, Escherichia Hermanii, and Gram-positive bacilli) were also isolated at 11%.

The overall distribution of bacteria by service showed their predominance in the burn unit (57%) and in the intensive care unit (21%), while 22% involved other services ($p < 0.001$). Periodic monitoring of the hospital environment, especially high-risk services, is needed.

Keywords: Hospital environment, Management, Monitoring, Microbial profile, Retrospective study, Health risk, Meknes-Morocco.

INTRODUCTION :

A hospital is an establishment where both patients and healthcare professionals are exposed to healthcare-associated infections (HAI), named nosocomial infections (NIs) [1, 2]. These infections goes against treatments, causing unfavorable effects on the patients, such as death, delay of job comeback and increase of expenses [3]. The charges associated with the care of patients affected by HAI are important. They are characterized by extended hospital stays and a need for more care and health assistance, which increases patients, families and health systems' expenses [4]. In France, the total cost of HAI is estimated at about 2.5 and 6 billion Euros [5] . In 2010, in the United States of America, the average cost of an HAI was estimated at $ 14,669 for a 4-day hospitalization extension [6, 7]. In Morocco, a study conducted at Hassan II University Hospital (UH) in Fez showed the huge economic impact of HAI, which is estimated at 1,165,922.05 DH for fifty patients with a mean of 9.7 days of hospitalization extension [8].

According to the World Health Organization (WHO), nearly 1.4 million patients develop a HAI every day and 5 to 10% of patients in developed-country hospitals contract one or more infections [9]. In developed countries, HAI incidence is about 7%. In Europe, nearly 135,000 deaths per year are caused by HAI [10]. Besides, in developing countries, HAI incidence is approximately 25% [11]. They constitute the third leading cause of death in these countries [12]. In Morocco, many studies in University Hospitals have shown that incidence/mortality reached: 17.8% at Rabat University Hospital in 2007 [13] which decreased to 10.3% in 2010 [14]. It reached 6.7% at Fez University Hospital in 2007 [15]. In 2009, a study on HAI prevalence conducted by the Nosocomial Infection Control Committee (NICC) of Mohammed V Provincial Hospital in Meknes (PH), showed a prevalence of 2.9% [16]. In 2013, another study conducted in the same hospital revealed a prevalence of 9.4%; burn (100%) and trauma departments (25%) were the most affected by these infections [17]. Other surveys have highlighted the prevalence of HAI in surgical, medicine, pediatric, intensive care, gynecology obstetric and burn wards [18-20]. The causative agents of HAI, identified from a multicentric study conducted in 27 hospitals in Italy, Egypt, Tunisia, Algeria and Morocco were *Escherichia coli* (17.2%), *Staphylococcus aureus* (12. 5%),

Pseudomonas aeruginosa and *Klebsiella pneumoniae* (9.2%) [18].

Therefore, the study of bacterial ecology in a hospital is paramount for the monitoring of hospital-acquired infections. It enables a reduction of HAI cost through the collection of information on pathogenic microorganism distribution throughout departments with the aim to better control the risk of infection [21, 22]. This study was conducted in the purpose to establish the bacterial ecology of germs that circulate in the Mohammed V hospital of Meknes City and to identify the most affected departments. The result of this study will help schedule periodic inspections of hospital environment in the identified departments in order to take corrective and preventive actions against HAI. Thereby, these clinicobiological investigations are of paramount importance in hospital decision-making.

It should be noted that a few studies in the literature have been conducted on bacterial mapping in the hospital. A study was conducted at regional hospital in Kenitra (Morocco), in the purpose to determine the impact of the most common germs in different types of microbiological analyzes [23].

MATERIAL AND METHODS:

This study was conducted from January 2012 to December 2016 by using the archives of bacteriological analysis of samples from the hospital's departments.

Study site

This study was conducted at Mohamed V hospital in Meknes, Morocco. Located in the city center, it is the largest hospital of the former Meknes-Tafilalt region. According to the High Commission of Planning, it provides care for approximately 2,125,608 inhabitants. This hospital won in 2011 and 2012, the first prize of the quality competition organized by the Ministry of Health [24]. Its functional capacity reached 378 beds in 2013.

The study was based on the results of bacteriological samples from various units. The samples were analyzed in the medical laboratory of the same hospital. The laboratory is composed of four divisions: bacteriology, hematology, chemistry and virology.

The isolation of the germs was done on different culture medium. The identification of the bacteria was made on the cultural, morphological and biochemical characters, supplemented if necessary with a Gram stain, the search for cytochrome oxidase and catalase (peroxidase), the reaction of which results in a release of gas' bubbles. The number of microbial species guides the choice of the gallery to use. The latter allows the search for several biochemical characters by enzymatic reactions, which result in spontaneous color turns or revealed by addition of reagents.

The biologist of the hospital laboratory interprets the results of the samples according to the clinical data of the patients (materialized by medical prescription) and the technique used.

Variables of the study

A sheet which gathers the following variables was pre-established: the origin of the samples, the percentage of positive samples, the Gram stain and the distribution of germs by units.

The study was performed by analyzing the results of cytobacteriological examinations of urine (CBEU), blood cultures (BC), lumbar punctures (LP), ascites punctures (AP), pleural punctures (PP) and pus. The samples of pus come from different services and therefore different sites on the human body (dermis, surgical wound, nasal secretions, throat, tissue, abscess, purulent discharge ....)

Exploitation and data analysis

Data analysis was performed by Microsoft Office Excel 2010 (beta version) and Chi-square tests were performed for statistical significance.

RESULTS:

Distribution of samples according to their origin

A percentage of 44% of the 2652 non-redundant samples were analysed in the laboratory of Mohammed V Hospital in Meknes, were came from pus, 22.5% from blood cultures, 14.7% from cytobacteriological Examination of Urine (CBEU) and 12.5% were performed from pleural punctures (PP) (Table 1). Of the 1168 samples taken from pus, 90% (n = 1058) are spread over the burns unit (72%) and the intensive care unit (18%) (Table 2).

Percentage of positive samples

A percentage of 40% (n = 1062) of the samples have been found positive and 60% have been observed negative ones (n = 1590) (Figure 1). Of the 1062 positive samples, 32% (n = 342) are polymicrobial, distributed on pus, blood culture and CBU with respectively 97.7%, 1.7% and 0.6%.

Gram staining

Almost two-thirds (65%) of the isolated bacteria (n = 1495) belong to Gram-negative bacteria while only 35% are Gram-positive (Table 3). The chi-square test is equal to 143, which is much higher than the theoretical chi-square (10.828). The distribution of germs according to the Gram staining is statistically highly significant (chi-square = 143, df = 1, p-value < 0.001) (Table 3).

Distribution of positive samples by unitA percentage of 57% of positive samples concerns the burn unit (BU) while 21% in the intensive care unit. By using the chi-square test (chi-square = 488.8, df = 27, p-value = 0.001), we confirm that the distribution of positive results in these two units is highly significant (Figure 2). This distribution could be explained by the fact that pus represents 99% of the samples taken in the BU

The most isolated germs

The most frequently isolated bactria were: *Staphylococcus aureus* (27%), *Pseudomonas putida* (21%), *Acinetobacter* (14%), *Escherichia coli* (8%), *Klebsiella* (9%) and *Pseudomonas aeruginosa* (1%) (Figure 3). The chi-square statistical test proved that *Staphylococcus aureus* is the most common germ (chi-square = 4505, df = 37, p-value <0.001).

The majority (98%) of *Pseudomonas putida* positive samples are from pus, which represents 44% of all samples. This could explain the importance of the frequency of this bacterium.

Table 1. Percentage of samples

Samples	Sampling technique	Number	Percentage
Pus	collection of pus	1168	44.0%
Blood	Blood Culture (BC)	598	22.5%
Urine	Cytobacteriological Examination of Urine (CBEU)	389	14.7%
Pleural Fluids (PF)	Pleural Punctures(PP)	332	12.5%
Ascites Fluids (AF)	Ascites Punctures(AP)	97	3.7%
Cerebrospinal Fluids (CSF)	Lumbar Punctures(LP)	65	2.5%
Unknown origin		3	0.1%
Total		**2652**	100%

Table 2: Distribution of samples' nature per units:

Units	Nature of the samples							Total
	CBU	**Blood Culture**	**Unknown**	**Ascites Fluids**	**Cerebro-spinal Fluids**	**Pleural Fluids**	**Pus**	
Cardiology	9	5	-	1	-	7	2	24
Surgery services	37	4	-	-	-	3	27	71
Infant surgery	4	-	-	-	-	-	1	5
Blood Transfusion Center	-	197	-	-	-	-	-	197
Dermatology	-	-	-	-	-	1	-	1
Endocrinology	55	8	-	-	-	4	20	87
Gastrology	2	3	-	34	-	8		47
Burns unit		6	-	-	-	-	850	856
Unknown	2	2	3	2	-	2	14	25
Medicine Services	144	148	-	51	15	25	8	391
Neurosurgery	3	1	-	-	-	-	10	14
Neurology	22	9	-	-	7	1	-	39
Nest	8	-	-	-	-	-	-	8
Pediatric	16	32	-	4	39	22	1	114
Pneumology	9	4	-	4	-	248	3	268
Penitentiary	47	6	-	-	-	1	9	63
Surgical resuscitation	-	-	-	-	-	3	-	3
Intensive care unit	26	172	-	-	3	6	208	415
Resuscitation of surgical emergencies	-	-	-	1	-	-	3	4
Trauma	1	-	-	-	-	-	10	11
Emergency	3	1	-	-	1	1	-	6
Urology	1	-	-	-	-	-	2	3
Total	389	598	3	97	65	332	1168	2652

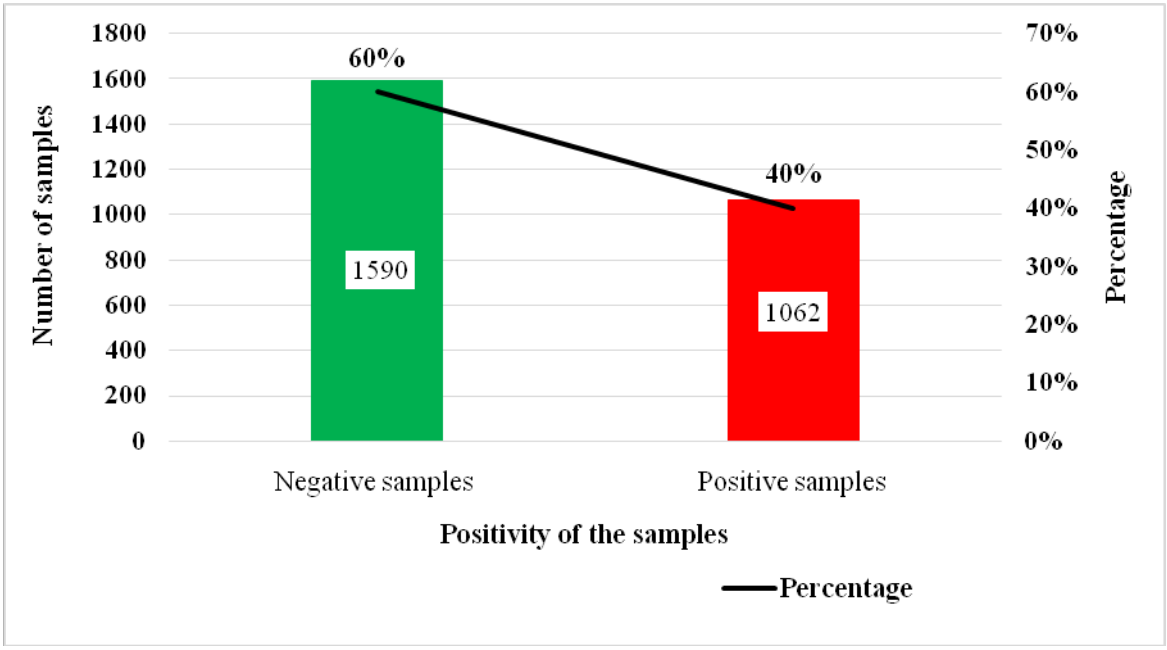

Figure 1. Percentage of positive and negative samples

Table 3. Distribution of isolates according to their Gram staining

Gram staining	Number	Percentage
Gram +	516	35%
Gram -	979	65%
Total	1495	100%

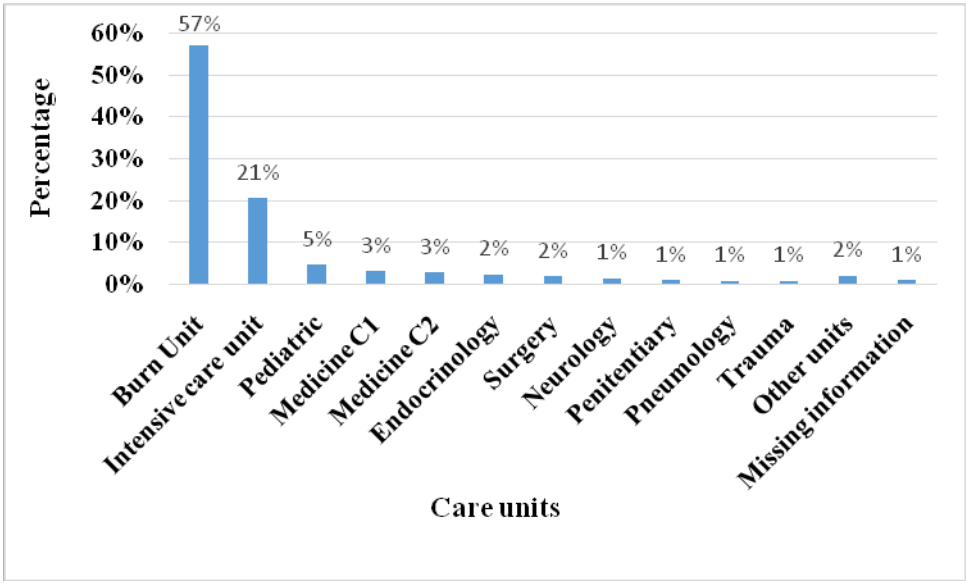

Figure 2. Distribution of positivity by units

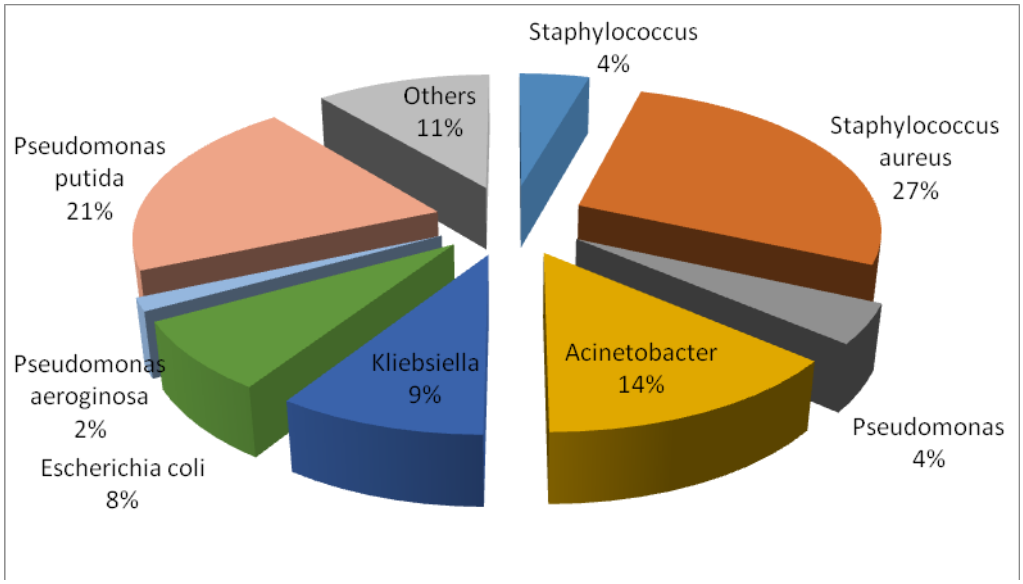

Figure 3. Frequency of bacteria

DISCUSSION

The hospital is a favorable environment for the diffusion of infectious agents and the acquisition of microbial resistance [25]. Knowledge of the bacterial ecology of a hospital is of paramount importance to control the risk of infection and ensure the management of these infections [26]. The study of bacterial mapping is also intended to establish the list of the main germs circulating in a hospital and their distribution according to services to implement preventive and curative measures to fight against hospital infections. The epidemiological surveillance, in time and in space, makes it possible to detect the reappearance of certain germs (methicillin-resistant staphylococcus, multidrug-resistant Pseudomonas, Acinetobacter or Klebsiella). In addition, the patient management service (resuscitation, surgery, etc.) can direct the bacteriological diagnosis towards certain species and / or most plausible resistance profiles [27, 28].

In this study, 2652 bacteriological samples were analyzed in the laboratory of Mohammed V hospital in Meknes for 5 years, while at the regional hospital (RH) of Kenitra, the sample number reached 3334 in a two-year period [23].

Regarding the nature (origin) of the samples, the study showed that 44% came from pus, 23% from blood

cultures, 2,5% from Cerebrospinal fluids (CSF), 15% from cytobacteriological examinations of urine 17% from Pleural Fluids (PF) and Ascites Fluids (AF). These results vary depending on the regions, in fact at RH of Kenitra, the samples were distributed between CBEU (56%), CSF (10.41%), PF + AF (9.96%), (3. 67%) for pus and only 1.99% for blood culture [23]. In Annaba, in 2008, blood culture samples represented 9% of the samples [29]. Regarding the percentage of positive samples, our study showed that 40% of the sample set were positive and 60% were negative whereas in Kénitra's regional hospital, only 14.75% of the samples were positive [23].

For the distribution of germs according to the Gram status, it should be noted that 65% of the isolated bacterial species are Gram-negative bacteria while only 35% are Gram positive. In Sfax's University Hospital, 60% of 2979 bacterial strains were Gram-negative bacilli [30]. The results of this study are also consistent with those of the General Hospital of Douala in Cameroon where 76% of the identified bacterial strains are Gram-negative bacilli [31]. In Tlemcen, 50 Gram-negative bacilli (GNB) were identified from 46 samples [32]. At the University Hospital of Annaba, from a sample of 300 patients 64 GNB were identified [33]. According to another study conducted at Ibn Rochd University Hospital in Casablanca, GNB reached 73.5% and Gram-positive cocci (GPC) represented 26.5% of the isolated organisms, which is similar to our study's results [34]. In USA, a study over a period of 3 years, showed the prevalence of Gram-positive bacteria with 64% [35]. The latter result is consistent with that of the Adult Burn Center of Annaba (60% Gram-positive germs) [29].

The overall distribution of germs by unit showed their predominance in the burn unit (57%) and the intensive care unit (21%). Despite efforts to reinforce hygiene standards in hospitals, HAI persist in intensive care and burn units [36, 37]. These units are the most exposed to higher risk of HAI occurrence in comparison to the other units. This risk is higher because of the patient immune status, the exposure to various invasive devices and techniques and the severity of patients' conditions [37, 38]. This finding is consistent with the survey conducted at Mohammed V Hospital in 2013, which showed a prevalence of 100% in the burn unit [17].

In contrast, in the intensive care unit of burns at Mohammed V Military Hospital of Rabat, the incidence of HAI was 103 infections for 1000 days of treatment [39]. The same result was noticed at the Regional Hospital of Kenitra, where the HAI prevalence was higher in intensive care and surgical units (25%) [40]. In France, the prevalence of nosocomial infection was 14.1% in the intensive care unit [41].

The bacteriological profile drawn from this study showed a dominance of *Staphylococcus aureus* (27%), *Pseudomonas putida* (21%) Acinetobacter (14%), *Escherichia. coli* (8%), Klebsiella (9%) and *Pseudomonas aeruginosa* (1%). At the Regional Hospital of Kenitra, the frequently encountered germs were *Escherichia coli*, Klebsiella and *Staphylococcus aureus* with 34.24%, 21.34% and 20.59% respectively [23]. The prevalence of *Staphylococcus aure*us was also remarked in the burn unit of the Military Hospital of Rabat in 2006, 2007 and 2008 with 22.2%, 52.3% and 33.9% respectively [36]. At the same unit of the Military hospital in 2011 *Staphylococcus* were the most isolated bacteria during the first week of admission in samples of superficial pus [42]. The same result is observed at the adult burn center in Annaba, where the most dominant germs are *staphylococci* (58%) and *Pseudomonas* (20%) [29]. In Tlemcen, *Acinetobacter baumannii* and *Pseudomonas aeruginosa* were identified with 57.7% and 42.3% respectively [32]. Based on the results of this study, we can conclude that patients are exposed to a potential risk to contract HAI.

In fact, *Staphylococcus* sp. and *Pseudomonas aeruginosa* were the most incriminated bacteria in nosocomial infections in the intensive care unit of burns at the Military Hospital of Rabat [39]. At Mohammed V Hospital, the HAI-causative microorganisms belong to *Escherichia coli*, *Staphylococcus aureus*, *Pseudomonas aeruginosa* and *Klebsiella pneumoniae* [17]. It should be noted that *Pseudomonas aeruginosa* is the third leading cause of nosocomial infections in France [43]. The incidence of HAI related to *Pseudomonas aeruginosa* is higher in resurrection units than in other services. The overall incidence of *Pseudomonas aeruginosa* was 15.7 cases per 100 patients [44]. The main infection caused by *Pseudomenas aeruginosa* in terms of morbidity and mortality is ventilator-associated pneumonia [45]. *Acinetobacter baumanii* is one of the opportunistic bacteria involved in nosocomial infections development [46]. This germ causes different types of infections and leads to morbidity and mortality [47]. In Morocco, a study conducted at the University Hospital of Casablanca showed that *Acinetobacter baumanii* represents 50.53% of the strains incriminated in infections in the Intensive care units [48].

The hospital environment is highly contaminated by microorganisms from patients or the environment [49, 50]. This contamination varies depending on the periods, the establishment, the units, the patients and the care techniques [51]. The role of the environment in the occurrence of HAI is poorly documented except for environmental microorganisms (aspergillosis, legionellosis) [52]. Thus, identification of the environmental sources involved in HAI development is essential to control the risk of infection related to the hospital environment and to protect users. Environmental control is strongly linked to the application of hygiene measures, the improvement of medical staff behavior and the microbiological monitoring of air, water, surfaces and medical devices [51]. This monitoring should be preceded, in priority, by the identification and localization of units that are the most affected by the infections in order to get an overview of the hospital bacterial mapping.

Given the multitude of information on the samples' nature (pus, CBU, ...) and the study's services target (all of the hospital healthcare units), given diversity of isolated bacteria, given potential evolution of resistance's profile of bacteria between 2012 and 2016, a study of bacteria sensitivity will be subject of a separate manuscript.

CONCLUSION

In this retrospective study, the prevalence of positive samples is 40%, the burn and intensive care units are the most concerned by the positive samples. Regarding the Gram staining, most species are Gram-negative bacteria: *Pseudomonas putida*, Acinetobacter, *Escherichia coli*, Kleibsiella, *Pseudomonas aeruginosa* with 21, 14, 8, 9, and 2% respectively. However, *Staphylococcus aureus* (a Gram-positive bacterium) is the most isolated bacterium with 27%.

The circulating germs of the hospital constitute a real threat to the patients and health professionals. Mastering this risk requires implementation of suitable measures to anticipate cross-contamination between patients, visitors, health professionals, inert surfaces and medical devices. Therefore, a rigorous application of hygiene measures is essential. The epidemiological and periodic monitoring of the hospital environment in general and especially both units (intensive care and burns units) for the Mohammed V Hospital in Meknes are paramount.

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