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Original Article

The bacteriological profile of the burned patients in the center of burns in CHU Mohamed VI Marrakech (about 123 cases)

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Abstract: The bacterial nosocomial infection is one of the leading causes of morbidity and mortality for burned patient; we conducted a retrospective study of 123 patients hospitalized in the burns center CHUMED VI of Marrakechover a period of 3 years, from January 1st, 2013 to December 31st, 2016. The criteria for nosocomial infection were those of the Center for Disease Control in Atlanta in 1988. Incidence rates were calculated. The bacterial ecology of the department was described as also antibiotype. The predominancy of the population was male. The cumulative incidence was 103 infections per 1000 days of treatment. Regarding the characteristics of bacterial infections, infected sites were skin (69%), blood (18%), urinary tract (12%) and lungs (1%). The main organisms were: Staphylococcus sp. (37.7%), Pseudomonas aeruginosa (19.8%), Enterococcus faecalis and Proteus mirabilis (18.5%). Staphylococci were resistant méticillo-in 22% of cases. Pseudomonas and Acinetobacter were multi-resistant (66%). The establishment of the bacterial ecology of the service, helped us set the right rules of prescription of antibiotics, which was based on the infected site, the type of organism, its sensitivity, the molecule used and the pharmacokinetics particular patient burned. The two main organisms being Staphylococcus and Pseudomonas aeruginosa, antibiotics used in the Service will then beta-lactams, glycopeptides, fluoroquinolones and aminoglycosides. Finally, to control the epidemic risk posed by the emergence of resistant organisms is necessary to combine the practice of good antibiotic therapy and prevention.

Keywords: Nosocomial infection, burn, epidemiology, bacteriology

Introduction

Infection is one of the main causes of death in severe burns [1]. Few studies have been conducted to assess the incidence of nosocomial infections to these patients.

It constitutes a real public health problem, increases the cost of care, and generates heavy expenses for hospitals.

Nosocomial infection is defined as any infection occurring to the patients after more than 48 hours of his admission [2].

In our work, we will discuss only the bacterial nosocomial infections that occur to the burnt.

The purpose of this work is to expose our experience in the Burn Center in CHU Mohamed VI. Marrakech-Morocco.

Our aim is to describe the nosocomial infections in the burned patient and establish the bacteriological profile in order to determinate the proper behavior of the antibiotic therapy personalized to the service, essential to stop the emergence of resistant germs and thus improve the management and the prognosis of the infected person.

Materials and methods

Type of study

This is a retrospective study over a period of 3 years, starting from January 1st 2013 to December 31st 2016. About 123 cases admitted in intensive care and hospitalized for more than 48 hours in resuscitation department of burns.

Place of study

This work was carried out in the resuscitation department of the national burns center of CHU Med VI Marrakech-Morocco.

Table 1. Distribution of age groups in the studied population. From January 1st 2013 to December 31st 2016, in the burners center of CHU MED VI Marrakech

Age range	Number	Age Average/Standard deviation
17-20	16	18.4 ± 1.1
21-30	25	23.4 ± 2.6
31-40	25	34.16 ± 2.4
41-50	17	44.65 ± 1.9
51-60	19	52.6 ± 4.5
61-70	12	66.4 ± 2.14
71-80	6	73.4 ± 1.4
81-90	3	84.1 ± 2

TOTAL=123.

Target population and sampling

We included in this study all patients hospitalized for severe burns for more than 48 hours.

During the study period, 123 patients were hospitalized for burns, 63.8% of them were men and 36.2% were women; with a female sex ratio of 1.76. This relationship correlates with male literature with values ranging from 1.44 to 2.55 [3, 4]. This ratio is explained by the tendency of men to therisked behavior and to the exposed professions.

The average age of our population is 38.2 ± 15.5 years (**Table 1**). This value is close to the data encountered in the literature. It fluctuates between 15.8 and 48.2 years [3, 5-11]. The extreme ages of life usually present an unfavorable prognosis with particular mention in elderly subjects, in who even a modest burn may be life-threatening, as long as the healing capacity and the defense of the body against infections are reduced. Indeed, in these subjects, the skin becomes thinner and the germinating cells become more and more superficial and therefore easier to be destroyed by the burn and its healing becomes less and less effective following the reduction of the cutaneous microcirculation. The study conducted by Lionelle on the evaluation of 201 burns showed that age over 75 years adjusted to body surface area burned and infection are prognostic factors of mortality [12, 13].

The average body surface area burned was 30.5 ± 30.3% with a range from 12 to 95%, which is similar to the results of Marco [1]. Other studies [8, 13, 14].

In our work, the number of patients with a percentage of SCB greater than 20% is 55%. This result is comparable to the data reported by Marco, Berrocal, and Zori [1, 3, 15].

Duration of hospital stay in our study was 45.1 ± 42.3 days, which is high comparing to the 19.8 days found by Marco [1] and to the 26 days conducted by Lumenta [16]. A good length of stay in the hospital, as indicated in the literature, is between 13 and 21 days [5, 17]. This length of stay in our work is explained by the severity of the burns presented in the center, the percentage of SCB is greater than 20% and the complications encountered during the stay due mainly to infections and the patient's status.

The incidence of nosocomial infections in intensive care is higher than the incidence in any other hospital department. The rate of nosocomial infections in intensive care units isbetween three and four times higher than those of non-resuscitation units. It ranges from 6% [18] to 51% [19]. These high rates of nosocomial infections in the intensive care units are explained by several risk factors: the severity of the pathologies, the long duration of hospital stays, the invasive procedures, and the emergence of resistant microorganisms. Chandrasekar et al. [20] shows that there are more nosocomial infections per patient in surgical resuscitation and in burn centers than in medical resuscitation. Some studies have shown the incidence of nosocomial infections in **Table 2** below:

Comparing the results of other studies to ours (**Table 2**), we note that the rate of burns with nosocomial infections is much higher than the others. However, the work of Wenzel [19] and Chandrasekar [20] does not report the duration of hospitalization or the severity of their patients. Taylor's study included patients with less severe burns and only primary sepsis, which may explain this difference. Similarly, Badetti's study [21] also takes into account patients who are less severely burned in the "cold" sector, and who do not require resuscitation care.

Wutrz [22] found a lower cumulative incidence, but the percentage of infected patients and an incidence density are near to those found by us in our study. The duration average of hospitalization of patients in his study is shorter (19.2

Table 2. Comparison of the impact of nosocomial infections

	Chandrasekar 1984	Wenzel 198	Taylor 1992	Cremer 1993	Badetti 1993	Wurtz 1995	Weber 1997	Our study
Cummulative Impact	64	30	70	34	49	69	30	37
Percentage of Infected Patients	-	13	34	40	27	35	13.6	37
Density of Incidence	-	-	32.8	2.25	20.8	32.3	16	20
IN rate per infected burned	-	2.33	2.25	2.36	1.79	1.38	2.33	3.7

Table 3. Comparison of nosocomial infections site by site (Infections per 1000 patient days)

	Taylor 1992 (n=116)	Cremer 1993 (n=140)	Bedetti 1993 (n=217)	Wurtz 1995 (n=52)	Weber 1997 (n=345)	Our Study (n=123)
Skin infection	27	28	6	2	11	70
Bacteremia Septicemia	8	21	9	4	12	17
Catheter infections	4	24	-	-	-	-
Pulmonary infections	22	5	11	42	2	6
Urinary infections	26	17	16	19	5	17

days versus 42.9 for us) and it takes in consideration only primary sepsis. Our study is comparable to the one of Cremer [23] in terms of the severity of the patients included, the sites monitored and the duration of hospitalization. Our impact results are quite similar to their results. The infection ratio is 3.7 in our study. It is higher than that of other studies, indicating a very high proportion of patients infected with multiple infections compared to other studies. The Weber study [25] is hardly comparable to ours because it publishes the implications of nosocomial infections in children. In our study, we did not discern the subgroup of patients corresponding to the children (15.5%) nor studied the incidence of nosocomial infections in this subgroup. We can simply note that Weber obtains cumulative effects and densities of incidence of nosocomial infections in children weaker than those of adults.

Cutaneous infections

In our study, the cutaneous site is the most frequent: it represents 69% of nosocomial infections. This is the least frequent in the study of Badetti [21] and Wurtz [22].

These results approximate those of Cremer [23] and Taylor [24], where cutaneous infections are most frequent encountered with higher incidence than other studies. The low incidence of skin infections found by Wurtz [22] (3% of nosocomial infections) is attributed to the commonprecocious surgically practice.

In our study, the skin is the first infected organ due to: The burned area which is important; Manuportage and the asepsis rules that are sometimes forgotten and not yet systematic in the department; The cutaneous samples frequency of compared to other studies.

Bacteremia and septicemia

At the frequency level of, the blood side comes in second position after the skin one and before the urinary and pulmonary ones with implications close to the data of the literature. Indeed, our results are comparable and similar to those of the team of Weber [25] and Badetti [21]. In children, Weber [25] finds incidences of bacteraemia and septicemia close to ours. Our results can't be compared to the work of Wurtz [22] and Taylor [24] that only takes in consideration the primary septicemia. The virulence of the recovered germs that pass through the blood also explains this frequency (**Table 3**).

Urinary tract infections

The incidence of urinary tract infections is low (12%) compared to other studies: the urinary tract is changed twice a week and the urinary cytobacterial examination is used to monitor the occurrence of a possible infection. The Taylor [8] and Cremer [23] studies found higher incidence than ours, but did not specify the percentage of patients surveyed or the frequency of the examination of the urinary sampling. In the Badetti study [21], urinary infections are

Table 4. Percentage Comparison of Cumulative Incidence of Nosocomial Infections Site by Site

Majority of staphylococcus (%)	Majority of pyocyanate (%)
Taylor 1992 (37%)	Bandit 1988 (52.7%)
Baddetti 1993 (18.5%)	Hussain 1989 (47%)
Weber 1997 (28.4%)	Cermer 1993 (47%)

predominant with 34% of nosocomial infections compared with 12% in our study. Their cumulative incidence is twice higher as it includes patients in the "lukewarm" sectors less severely burned, hence the high proportion of patients surveyed. Wurtz [22] finds an incidence density higher than ours and a higher proportion of urinary infections among nosocomial infections (36%). In his study, 58% of the patients had a urinary sampling which would explain this high incidence, but he did not give information on the duration of the survey (**Table 3**).

Pulmonary infections

In our study, we found a single lung infection. There are very few patients with inhalation of fumes admitted in the center. So we cannot compare it with other studies. We will however mention the data of the literature concerning this point. Pneumopathies are generally a major cause of mortality and morbidity in burned patients. They are strongly related to the initial severity of the burn and occur preferentially in burns with inhalation lesions and in those who have benefited from mechanical ventilation. According to Miguel A. de la Cal [27], pneumonia is twice more common in a group of patients with inhalation lesions than a group without an inhalation lesion. It shows that the risk of pneumonia depends also of the severity of the burn by the immunosuppression that it causes. The burn induces a local and general inflammatory response which results in lesional edema in lungs (**Table 3**).

The Shirani team [28] explains that inhalation lesions can damage to the respiratory epithelium, decrease surfactant production, slow mucociliary transport, produce atelectasis and alter macrophage function, which, With the general immunosuppression of the burned, favors the development of infections of the respiratory tract. The incidence of pneumonia in our study is insufficient to be compared with other studies, however, the results of the other studies with the exception of Wurtz [22], which finds more than 50% of pneumonia among nosocomial infections, are given for information purposes. All pneumopathies described by this team occur on intubated patients and he explains that intubation is strongly linked to the risk of pneumonia. Wenzel [19] and Badetti [21] do not provide information on the severity of burns at admission or on the proportion of patients with inhalation lesions. Similarly, the Taylor team [24] studies less severely burned patients. The study of Cremer [23] finds abnormally low incidences, in view of the inclusion criteria of its study, possibly related to the negativity of the samples by the systematic administration of aminoglycosides by intratracheal route in case of respiratory burns . In children, Weber [25] finds the incidence of pneumopathies much lower than those found for adults, even in the inhalation lesions. This is due to the absence of pre-existing pulmonary pathology to the children.

The existence of 8 days (the "golden days") between burning and infection was already mentioned in 1993 [29]. Our study finds an almost identical delay for the first of nosocomial infections and the others one, point by point, as in the cremer study [24]. The very short average delay between the first infection Nosocomial and the secondone (10 days), proof that is more a context of multi-infections than ofearly recurrences.

Our study is marked by a clear predominance of Staphylococcus with 37.7% of nosocomial infections including 59% of staphylococcus aureus. Largely behind, we find Pseudomonas aeruginosa with only 20%. According to the data from the literature, we distinguish two groups: the first one is with a majority of staphylococci, and the second one is with a predominance of pyramid bacillus (**Table 4**). The early and frequent use of balneotherapy was mentioned to explain the emergence of Pseudomonas aeruginosa. Indeed, according to the Tredget study [30], in centers not practicing hydrotherapy, the overall mortality is significantly reduced; That associated with pyocyanic sepsis is eliminated. It has fewer nosocomial pyocyanic infections, and lower levels of pyocyanic resistance to aminoglycosides. Without balneotherapy, he noticed a decrease in Pseudomonas aeruginosa graft infections. According to Tredget [30], the pyocyanic bacillus survives easily in the aquatic environment because it requires few exogenous nutrients. Hydrotherapy may infect uninfected burned areas [31]. Cremer also finds a majority of Pseudomonas aeruginosa by the practice of early balneotherapy [31]. The reduction of "burning baths" to the benefit of bed dressings in the bed would curb this emergence. In our study, almost no balneotherapy is used, which could explain why pyocyanic comes in second position. In the Taylor study [24], the predominance of staphylococci is explained by an increase in the use of intravascular catheters and by the absence of balneotherapy before surgical coverage of burns. The second reason for the emergence of pyocyanic in our study is the increased use of antibiotics by the systemic route, eradicating staphylococcus aureus, formerly the majority, according to the Badetti study [21] in 1993, but leading to an increase in Pyocyanate which becomes multiresistant. Indeed, the work of Lari [32] shows a pyocyanic majority in bacteraemia and cutaneous infections. He explains it by using too many antibiotics such as gentamicin, amikacin and ciprofloxacin and the long hospital stay of patients. The introduction of ciprofloxacin into its center in 1993 showed an initial sensitivity of 90% to pyogenic pyocyanates, then to 55% in 1995 and to 18% in 1997. In Husain's study [33], only 27% Pyocyanates are sensitive to carboxypenicillin (Ticarcillin) and amikacin. According to Tredget [30], pyocyanic adheres to surfaces by its pili, limits the cellular penetration of antibiotics and secretes the alginate protecting it from antiseptics; It develops resistance by rearrangement of its DNA. The use of antiseptics in the hospital, as in Pandit's study [29] with saniquad, can stimulate the genetic rearrangement of the pyocyanic and increase its resistance. We do not have enough data in our study to know the sensitivity of Pseudomonas aeruginosa to the various antibiotics. On the other hand, golden staphylococci, isolated in our study, have a resistance to methicillin of 22% contrary to the studies of Cremer [23] (40% sensitivity) and Donati [34] (30% sensitivity) and Husain [33] (22% sensitivity). According to the study of McManus [34], the presence of pyocyanin is strongly correlated with the patient's advanced age, severity of burn and prolonged intensive care. These data apply to our study and in particular to the long hospital stay of our patients (the average is 43 days) and partly explain our high incidence of Pseudomonas aeruginosa.

In our study, enterococci came in third position, whereas in Badetti's study [21] they were in the majority. The increased use of third-generation cephalosporins in the past decade has been accompanied by the emergence of resistant enterococci [35].

Evolution

In our study, approximately 44% of nosocomial infections are considered serious, 8.4% of which are lethal. Gravity scores vary across sites, which represents 30% of the mortality in the department over all the period of: the authors find the rates of 11-64% [46, 47] mortality attributed to NI. But this causality relationship is based on very intricate criteria and it is difficult to compare with other studies.

Cutaneous infections: They are also often benign, but can be lethal in 16% of cases. We do not know if these lethal skin infections are pyocyanic, or if there is a context of multi-infections.

Blood site: It causes serious infections in 46.5% of the cases of which 23.5% are lethal. Most of our septicemia are staphylococcus aureus and pyocyanic, germs often causing toxi-infectious shocks. 23.8% of infected patients experienced septic shock. According to the Lari study [32], patients with Pseudomonas aeruginosa positive blood cultures show 18.5% mortality. According to the Griffe study [36], bacteremia does not increase the mortality of patients but increase their length of hospital stay.

Urinary tract: Urinary tract infections are often benign.

Pulmonary site: In the retrospective study of Shirani [28], pneumopathies increase the mortality by 25%. According to Tredget [30], inhalation is an important comorbidity factor and prolongs the hospital stay, increases the duration of mechanical ventilation with the risk of chronic respiratory insufficiency and increases the frequency of ARDS (Adult Respiratory Distress Syndrome). Finally, our only case of pneumonia was pyocyanic, a germ associated with a high morbidity and mortality as well as a greater frequency of septic shocks in the literature.

Antibiotic therapy for the burnt patient

For the resistance of the germs to the various antibiotics, it is difficult to compare our results with those of the literature. However, there are some concordances since less than 83% of the pyocyanates remain sensitive to cephalosporins, gentamycin, netilmicin and quinolones [37]. Staphylococcus is also increasingly resistant to beta-lactams, first-generation cephalosporins and gentamycin [38]. In 60% of cases, Acinetobacter has a multiresistance to antibiotics. The most severe consequence of burning with multiresistant germs is death, although the causes of mortality in the burnt are sometimes difficult to classify because many factors are often entangled. Infection is responsible for 11 to 64% of deaths according to various authors [39, 40]. Increasingly resistant antibiotic germs and the consequences of infection in the burnt encourage a rigorous anti-infectious strategy. As part of this fight against infection, it is necessary to act at different levels, first on the local level, by promoting the skin cover as quickly as possible, emphasizing the interest of directed debulation and above all On early excision [41, 42], attitude advocated in the service. The use of fluidized beds, as is the case in the service, realizes a real prevention against maceration and therefore infection. It is necessary to improve the natural defenses of the burnt by ensuring a positive caloric and protein balance and by the practice of vaccination, in particular anti-tetanus and antipyocyanic. The latter, more and more used, represents at the present time a therapeutic cure quite essential but not yet common practice in our training. Finally, the use of specific antiseptic or antibiotic treatments, whether locally or in general, is not without its drawbacks. Preventive measures have a big importance in this fight against nosocomial infection for the burnt.

Van Rijn [43] was able to significantly reduce the rate of nosocomial infection in a burn service by creating a unit of isolation and quarantine, thus demonstrating the interest of such structures. In the department, the main pathogens are Staphylococcus, Pseudomonas aeruginosa, also found by the majority of authors in the ecology of the burn [44]: the most frequently used antibiotic molecules therefore belong to betalactamins, glycopeptides, Fluoroquinolones and aminoglycosides, the rules of prescription of which have been cited above: Staphylococcus, 22% of the strains are meticilloresistant: two types are described and found in the ecology of the service: Resistance to all aminoglycosides, quinolones and macrolides; Resistance to macrolides and fluoroquinolone. Gentamycin remains sensitive.

For some teams, the empirical treatment of septicity is based on betalactamins associated with glycopeptides (vancomycin) [45]. In our department, vancomycin is the basis of treatment. Upon receipt of the antibiogram, one will associate with the vancomycin already established, or, amikacin, or another molecule in intravenous according to the sensitivity of the germ. This protocol is identical to that of the Hospital-University Federation of Infectious Diseases and Reanimation [46]. However, vancomycin does not act quickly, flucloxacillin could be used for the first 24-48 hours before receiving the antibiogram data. For Pseudomonas, the attitude of the department recommends imipenem as regards βlactamines, contrary to the literature [47] which proposes a protocol based on ticarcillin which they adapt according to the results of the antibiogram: If it is sensitive to ticarcillin, the treatment instituted will combine ticarcillin and amikacin.

If ticarcillin-resistant and ceftazidime-sensitive, the treatment will combine ceftazidime and ticarcillin. If it is ticarcillin and ceftazidime-resistant, specialized advice is desirable. Remember that 60% of the strains are multiresistant but sensitive to imipenem. For multiresistant Acinetobacter, it remains sensitive to imipenem at nearly 80%. Some teams report its sensitivity tocolistin, tested in the department.

Conclusion

In this work, we have attempted to describe the nosocomial infections in the center of the burns at the CHU MED VI Marrakech. Burning represents an excellent bacterial culture medium: the infection in the burnt is therefore an obligatory and inevitable phenomenon: to know the bacterial flora of the burn, we will be able to control this risk to the maximum. Vigilance with rigorous application of hygiene measures and epidemiological surveillance of bacteria is required at the scale of the burn unit and the hospital to better guide probabilistic antibiotic therapy.

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Disclosure of conflict of interest

None.

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