



Analysis of Risk Factors Related to Severity and Mortality Due to Nosocomial Infections in Burn Patients of the Military Hospital Mohamed V, Rabat, Morocco

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Authors' contributions

This work was carried out in collaboration between all authors. Authors SEK and AA collected the data, designed the study and wrote the protocol. Authors HJ and AS wrote the first draft of the manuscript. Author SK managed the analyses of the study. Authors MM, SS and AQ managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/ARRB/2017/37192

Editor(s):

(1) George Perry, Dean and Professor of Biology, University of Texas at San Antonio, USA.

Reviewers:

(1) Ronald Bartzatt, University of Nebraska, USA.

(2) Sayan Bhattacharyya, All India Institute of Medical Science, India.

(3) S. Thenmozhi, Periyar University, India.

Complete Peer review History: <http://www.sciencedomain.org/review-history/22028>

Original Research Article

Received 4th October 2017
Accepted 19th October 2017
Published 23rd November 2017

ABSTRACT

Aim: The aim of this work is to analyze the risk factors related to the severity and the mortality due to nosocomial infections in burn patients.

Methodology: This is a retrospective study based on 212 burn patients who were infected inside the Burn Department of Mohammed V Instruction Military Hospital in Rabat, during the period from January 2004 to December 2012.

Results: The results show that infections with *Staphylococcus spp* are the most frequent in burn

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patients with 39% of all cases. The upper limbs represent more than half of the infected organs with 56.6% of cases.

The binary logistic regression showed that patients burnt at the abdomen display 9-fold higher risk of severity than patients burnt at other organs. On the other hand, head infection multiplies by 4 the severity of cases, compared to infection of other organs.

Furthermore, we demonstrated that infections with *Acinetobacter baumannii* and *Proteus mirabilis* were positively and significantly associated with the severity of burns with risks of 4.2 ($p = 0.001$) and 3.6 ($p = 0.02$) respectively.

The results also show that mortality does not depend on the infected organs but depends on the infection causing germs. Indeed, the infection with *Acinetobacter baumannii* was positively and significantly associated with death (OR = 3.3, $p < 0.05$).

Conclusion: In conclusion, considered that nosocomial infections are the main cause of mortality in severe burn cases, all the means and strategies of fight should be oriented towards preventative measures.

Keywords: Burn patients; nosocomial infections; severity; mortality; Morocco.

1. INTRODUCTION

It has been found that nosocomial infections (NI) have been ravaging our hospitals for many years but still not widely recognized in comparison with the suffering and deaths they cause [1]. Burns have a double risk: local risk (cessation of healing, deepening of lesions, failure of transplants) and general one (septicemia). Infection is the leading cause of death in severely burn patients [2].

The frequency and severity of infections can be explained not only by breaks in the cutaneous barrier but also by the presence of marked immune depression, that affects both humoral and cellular immunity. It is related to the suppressive effects of certain mediators of inflammation massively poured into the circulation and is aggravated by undernutrition. The infections may have an endogenous origin, from the skin or the digestive tract, or exogenous by contamination from air, materials or nursing staff. The severity of these hospital-acquired exogenous infections, known as NI, fully justifies the hygiene and aseptic measures taken in the burn centers. Skin and soft tissue infections are the second infected site with 11% of infections [2]. Mortality and morbidity in burn patients are strongly related to the initial severity of the burn and occur predominantly in burn patients with inhalation lesions [3].

In developed countries, studies have shown that the prevalence of NI varies from 4.9 to 8.5% (France: 4.97% in 2006, Switzerland: 7.2% in 2004, Finland: 9% In 2005) [4].

In the Mediterranean region, a multi-center study conducted by WHO in 27 hospitals (Algeria,

Egypt, Italy, Morocco and Tunisia) showed that the prevalence of NI was 10.5%, even higher in mid-sized hospitals.

In Morocco, a national prevalence survey carried out in 1994 showed that the overall prevalence of NI is 8.1%. It depends on the level of technicality and specialty of hospitals structures: 4,1% in provincial hospitals, 7.7% in regional hospitals and 9.5% to 11.5% in university hospitals [5]. Several studies have found different prevalence: 17.8% (CHU Rabat, 2005), 10.3% (CHU Rabat, 2010) and 6.7% (CHU Fès, 2007) [6-8].

In this context, the objective of this work is to analyze the risk factors related to the severity and mortality due to NI in burn patients of the Mohamed V Military Hospital in Rabat. Indeed, we will investigate the implication of some risk factors, such as the germs responsible for the NI and the affected organs, in causing severity and mortality of burn patients.

2. PATIENTS AND METHODS

The present study is based on 212 burn patients with NI, hospitalized at the burn service of Mohammed V Instruction Military Hospital of Rabat. This is a retrospective study carried out over the period from January 2004 to December 2012.

Data collection was based on patient records. The variables we investigated in this study were: burn sites, evolution of patient, Standard Burn Unit (UBS), and the germs responsible for infection. The results are expressed in terms of numbers and percentages for the qualitative variables.

The risk factors we analyzed were the affected organs, the number of affected sites, the nature of germs and the number of germs responsible for the infection.

As regards the statistical analysis, we used the relative risk to investigate the associations of death and severity with the number of infected sites and the number of germs responsible for the infection. Moreover, we used binary logistic regression to study the influence of germs and burn organs (independent variables) on severity and death (dependent variables). In this analysis, Wald test measures the significance B regression coefficient. The exponential of B regression coefficient represents the Odds Ratio (OR).

3. RESULTS

3.1 Repartition of Infected Sites According to the Number of Germs

The distribution of patients according to the number of germs shows that 67 patients are infected by a single germ (40%), 43 are infected by two germs (25%), and 35 by three germs (21%). It should be noted that among the 67 patients infected with a single germ, 47 have *staphylococcus spp*, that makes 70%.

3.2 Repartition According to the Germs

We established the profile of germs causing NI. The results show that *Staphylococcus spp* infections were the most frequent with 39%, i.e. 234 burn sites (Fig. 1). Infections caused by

Pseudomonas Aeruginosa come second with 18% of sites followed by *Acinetobacter baumannii* with 16% of the sites.

3.3 Repartition According to the Number of Infected Sites

The distribution of patients according to the number of infected sites shows that those with two infected sites are the most frequent with 54 cases (27%), followed by those with four sites (47 cases or 23%), and those with three infected sites (36 cases or 18%). It should be noted that *staphylococcus spp*, alone or with other germs, is the most encountered in all these categories.

3.4 Repartition According to the Infected Organs

The results show that the upper limbs represent more than half of the infected sites with 56.6%. 53.3% of burns occurred in the lower limbs, 48% in the head and 36.8% in the abdomen.

3.5 Analysis of Severity

The study of severity risks according to the number of germs shows that being infected by four germs at once multiplies by five the severity of burns (RR = 5.11 ; IC = 1.74 - 15). Moreover, the study of severity risks according to the number of sites revealed that the severity is significantly associated with infections in 5 burn sites (RR = 4.31; CI = 1.95 - 9.51) and with infections in 6 burn sites (RR = 5.26; IC = 1.35 - 20.50).

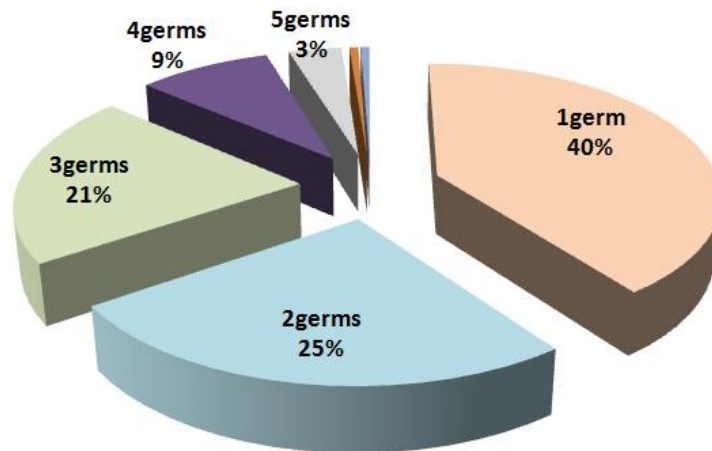


Fig. 1. Repartition of patients according to the number of germs responsible for infection

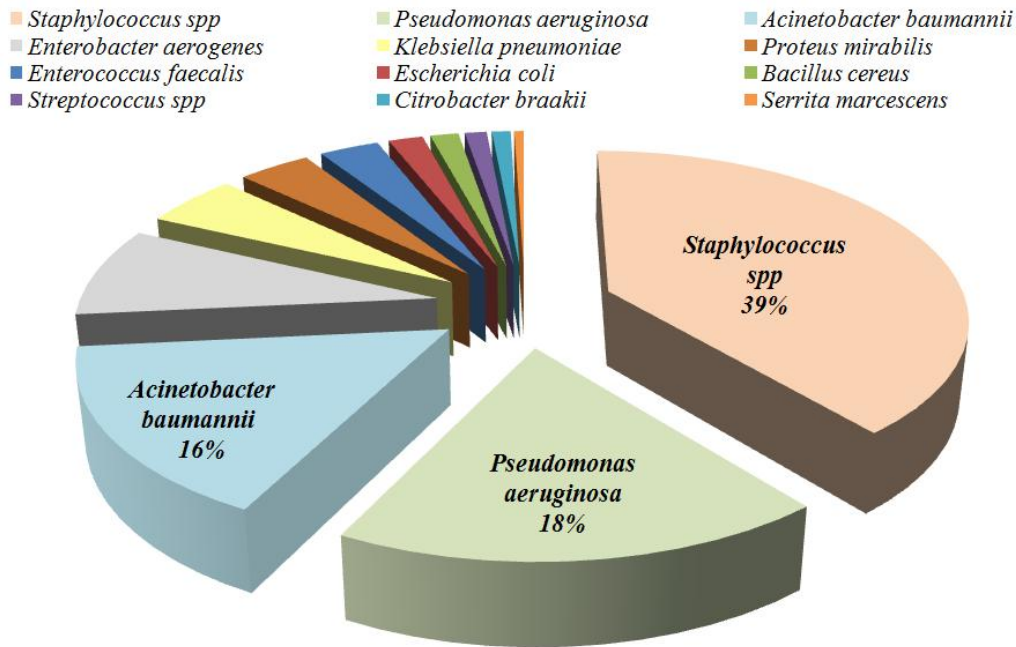


Fig. 2. Repartition of infected sites according to the nature of germs responsible for the infection

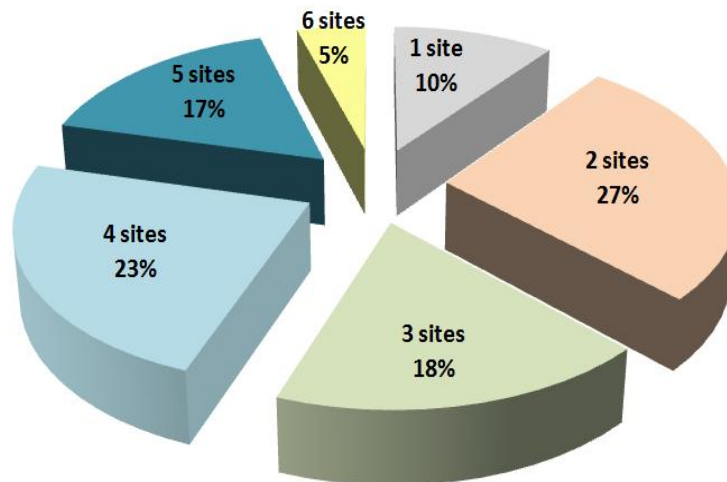


Fig. 3. Repartition of patients burned according to the number of infected sites

3.5.1 Association between severity and infected organs

The analysis of the association between the infected organs and the severity, using the logistic regression, are summarized in Table 1. According to these results, the head and the abdomen are strongly and positively associated with the severity of burns. Patients burned at the abdomen have a 9-fold higher risk of severity than patients burned at other organs ($p < 0.001$). On the other hand, the head injury multiplies the

severity by 4 compared to the other organs ($p < 0.01$).

It should be noted that the back injury, although rare, showed a significant association with severity (OR = 16.46, $p < 0.05$).

3.5.2 Association between severity and infecting germs

The Table 2 presents the results of the analysis of the association between severity and germs.

Acinetobacter baumannii and *Proteus mirabilis* infections are positively and significantly associated with the severity of burns with an Odds ratios of 4.2 ($p = 0.001$) and 3.6 ($p = 0.02$) respectively.

3.6 Analysis of Mortality

The study of the risks of death according to the number of germs shows that the patients infected by three germs at the same time have four-fold higher risk of death compared to other patients (RR = 4.2; IC = 1.5 - 11.9). Furthermore, the study of the risk of death according to the number of sites shows that patients infected at four sites at the same time have almost five-fold higher risk of death compared to other patients (RR = 4.7; IC = 1.7 - 12.8).

3.6.1 Association between death and infected organs

In this part of the study, we investigated the association between death and infected sites by the logistic regression method. The results of this

analysis did not reveal any statistical significance (Table 3). This implies that the evolution towards death does not depend on the infected organs.

3.6.2 Association between death and germs

Similarly, the association between death and germs responsible for NI was investigated using logistic regression. The results in Table 4 show that infection with *Acinetobacter baumannii* is strongly associated with death, this association is positive and statistically significant (OR = 3.3; $p = 0.05$). The association with other germs was statistically not significant.

4. DISCUSSION

The results of the present work show that infections with *Staphylococcus spp* are the most frequent in burn patients, followed by infections with *Pseudomonas aeruginosa* and *Acinetobacter baumannii* respectively. This result is comparable to those obtained by Thabet and al. in 2013 [9] and by Siah and al. in 2009 [10].

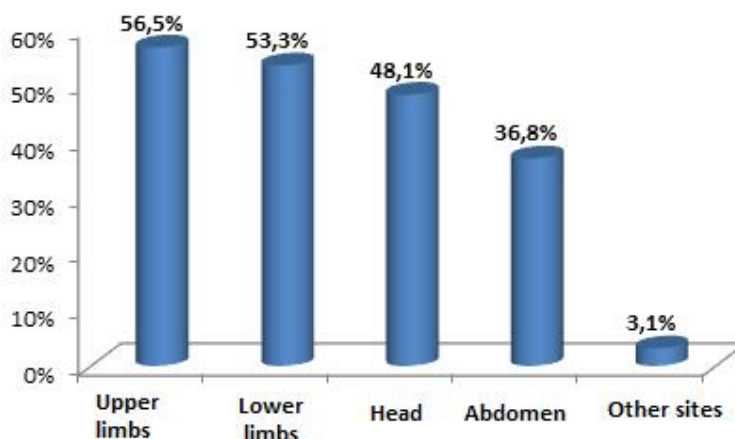


Fig. 4. Repartition of infected sites according to the infected organs

Table 1. Results of logistic regression of severity according to the infected organs

Organs	B	S.E.	Wald	Significance	Exp (B)
Head	1,404	0,487	8,309	0,004	4,071
Neck	2,055	1,467	1,961	0,161	7,805
Abdomen	2,158	0,463	21,698	<0,001	8,654
Right upper limb	-0,146	0,478	0,093	0,760	0,864
Left upper limb	-0,063	0,460	0,019	0,892	0,939
Perineum	0,478	0,799	0,357	0,550	1,613
Right lower limb	0,768	0,443	2,996	0,083	2,154
Left lower limb	0,702	0,452	2,405	0,121	2,017
Back	2,801	1,205	5,400	0,020	16,46

Table 2. Results of logistic regression of severity according to the nature of germs

Germs	B	S.E.	Wald	Significance	Exp (B)
<i>Acinetobacter baumannii</i>	1,434	0,421	11,570	0,001	4,194
<i>Enterococcus faecalis</i>	-,287	0,722	0,158	0,691	0,751
<i>Enterobacter aerogenes</i>	0,310	0,490	0,400	0,527	1,364
<i>Escherichia coli</i>	0,041	0,872	0,002	0,962	1,042
<i>Klebsiella pneumoniae</i>	-0,031	0,600	0,003	0,959	0,969
<i>Proteus mirabilis</i>	1,268	0,563	5,073	0,024	3,554
<i>Pseudomonas aeruginosa</i>	0,461	0,413	1,249	0,264	1,586
<i>Serrita marcescens</i>	1,417	1,306	1,178	0,278	4,127
<i>Staphylococcus spp</i>	0,656	0,402	2,660	0,103	1,927
<i>Streptococcus spp</i>	-1,697	1,261	1,810	0,179	0,183

Table 3. Results of logistic regression of death according to infected organs

Organs	B	S.E.	Wald	Significance	Exp (B)
Head	1,051	0,636	2,735	0,098	2,861
Abdomen	0,710	0,557	1,621	0,203	2,033
Senior member	0,382	0,651	0,344	0,558	1,465
Top left member	0,815	0,655	1,551	0,213	2,260
Perineum	0,399	1,165	0,117	0,732	1,490
Right lower limb	0,084	0,570	0,022	0,882	1,088
Left lower limb	0,959	0,601	2,547	0,111	2,608
Back	1,149	1,268	0,821	0,365	3,156

Table 4. Results of logistic regression of death according to the nature of germs

Germs	B	S.E.	Wald	Significance	Exp (B)
<i>Acinetobacter baumannii</i>	1,200	0,586	4,190	0,041	3,321
<i>Citrobacter braakii</i>	1,894	1,426	1,765	0,184	6,646
<i>Enterococcus faecalis</i>	0,087	0,942	0,009	0,927	1,091
<i>Enterobacter aerogenes</i>	0,428	0,651	0,433	0,511	1,535
<i>Escherichia coli</i>	0,055	1,266	0,002	0,965	1,056
<i>Klebsiella pneumoniae</i>	0,146	0,808	0,033	0,856	1,157
<i>Proteus mirabilis</i>	1,171	0,720	2,648	0,104	3,225
<i>Pseudomonas aeruginosa</i>	-0,164	0,626	0,069	0,793	0,849
<i>Serrita marcescens</i>	2,443	1,351	3,270	0,071	11,510
<i>Staphylococcus spp</i>	0,401	0,582	0,475	0,491	1,493
<i>Streptococcus spp</i>	-0,293	1,303	0,051	0,822	0,746

In addition, the results show that the upper limbs, the lower limbs and the head are respectively the most affected organs. These findings differ slightly from the results obtained in previous studies in which the head was the most frequent location of burns followed by the upper and lower limbs [11].

In the study of severity according to burn sites, we demonstrated that the infection of the head

and the abdomen is strongly and significantly associated with the severity. Indeed, the localization of the burn on the body is an essential data to evaluate its severity. A burn that touches the neck, face, joint, hands, feet or genitals is considered more serious given the risk of sequelae on the functioning of the person. A burn in the neck and face may cause difficulty in breathing and require the use of a mechanical ventilator [12].

On the other hand, the present study showed that infections with *Acinetobacter baumannii* and *Proteus mirabilis* are positively and significantly associated with the severity of the burns. These two germs are both Gram-negative bacilli and several studies have shown that deep wounds are more affected by gram-positive cocci and gram-negative bacilli than superficial ones [13-15].

In the following part of the study, *Acinetobacter baumannii* was found to be significantly associated with death in the present study. Indeed, although it is not always responsible for infections and may be normally present on the skin or the mucous membranes of the patients, this bacterium is the cause of various and sometimes severe infections in frail patients [16]. This association may also be due to the fact that *Acinetobacter baumannii* has a high potential of resistance to antibiotics [17-18].

5. CONCLUSION

In the light of the results of the present work, several recommendations could be made; the most important is that health authorities in our country should direct their strategies towards the fight against *Acinetobacter baumannii* in hospitals. In addition, more intense management should be given to patients with burns at the neck and the abdomen.

Nevertheless, in view of the seriousness of the nosocomial infections, the main cause of mortality in severe burns, all the strategies implemented should be oriented towards the prevention measures.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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