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Surgical Site Infection (SSI) in the National Referral General Hospital of Ndjamena (Chad): Survey about Risk Factors

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Abstract

The risk to develop an infection after surgery depends on several factors. Those factors may be interdependent or not, depending on the nature of the surgery and the general condition of the patient. The aim of the present study was to identify the factors involved in the occurrence of the Surgical Site Infections (SSI) in the ***National referral general hospital*** of N'djamena (Chad). We first realized an interview in the emergency services and in the general surgery of the hospital. The information collected allowed us to draw up survey sheets. An investigation was then conducted on 152 patients who had surgery and were hospitalized during the study period. The frequency of the SSI was 33.6% (51/152). The main risk factors that we identified were the duration of hospitalization, the category of the hospitalization room, the urgent aspect of the surgical intervention, the patient's nutritional status and the associated diseases with diabetes, which was present in 52.38% (11/21) of cases of associated pathologies. Analysis of the antibiotic prophylaxis administered to patients showed that ciprofloxacin was more effective in SSI prevention. Indeed, this antibiotic showed the fewest cases of infection with only 1.9% of patients having developed SSI. Our results show a very high frequency of SSI at the ***National referral general hospital of*** N'djamena. Poor hospital practices and factors associated to patients seem to be the most factors implicated in the SSI.

Keywords

Surgical Site Infections, Risk Factors, Nutritional Status, Associated Diseases,

Chad

1. Introduction

Surgical Site Infections (SSI) are generally localized infections. But these infections can spread to organs far from the surgical site sharing or not the same pathogen germ [1] [2]. It is a complication that arises after surgery. Therefore, they do not occur before surgery, nor even in incubation [3]. Host commensal flora is generally responsible for these infections due to the poor immunity of the host, but microorganisms circulating in the hospital environment can also be involved in this infection [4]. Bacteria involved in these infections exhibit antibiotic resistance profiles [5]. There are risk factors that are involved in these infections. These risk factors can be classified into modifiable and non-modifiable risk factors [6] and can be interdependent or isolated [7]. Hospital environment is conducive to the spread of these infections, especially when hygienic conditions are unfavorable [8]. Other factors such as the failure to respect asepsis practices seem to increase the risk of these infections [9]. A recent survey carried out by some African researchers in 25 African countries revealed that patients who undergo surgery in African hospitals are two times more likely to die from post-operative complications than those in other hospitals on other continents [10]. The SSI are therefore a major component of the post-operative complications in Africa.

Chadian hospitals, like other African hospitals, are also facing surgical site infections, but there is almost few research conducted on that topic. To our knowledge, very few studies have been carried out on the factors favoring infections in Chadian hospitals. The aim of this study was to determine the prevalence of SSI and the factors involved in the occurrence of those infections within the ***National referral general hospital of*** Ndjamena, in order to find a prevention strategy.

2. Materials and Methods

2.1. Setting and Population

This prospective study was performed from July to November 2018 in the surgery service of the ***National referral general hospital*** of Ndjamena. Analyses were done in the laboratory of the ***National referral general hospital*** of Ndjamena in collaboration with the Laboratory of Biochemistry and Applied Immunology (LaBIA) of the University Joseph KI-ZERBO. Patients hospitalized after surgery and undergoing antibiotic treatment were included in the study.

2.2. Data Collection

We first realized an interview with the staff of the emergency services and those of general surgery of the hospital. The information collected allowed us to draw up survey sheets. An investigation was then conducted on 152 patients who had

surgery and were hospitalized during the study period.

2.3. Data Treatment and Analysis

The data were analyzed using Sphinx 5, which is a tool for creating and analyzing online questionnaires, forms and surveys. It allows to design questionnaires, process and analyze data and present results. The chi-square test was used for comparisons and every value was considered statistically significant for $p \leq 0.05$.

3. Results

3.1. SSI Frequency

One hundred and fifty-two (152) patients underwent surgery during the period of our investigation, in the surgical and emergency departments of the Hospital. The patients were aged from 16 to 86 years with an average age of 36.1. Men were predominant in the study population (111/152) with a proportion of 73.03% giving the sex ratio of 2.7. Among the 152 patients who underwent surgery and were interned in the surgical and the emergency department of the Hospital, 51 patients presented SSI giving an overall incidence of 33.6%. The SSI patients' average age was 37.9 years; the minimum age was 22 and the maximum was 86. Among the SSI patients 78.43% (40/51) were men (Table 1), the sex ratio was 3.6.

3.2. Risk Factors Analysis

To determine the factors involved in the onset of infections, different factors were analyzed such as the duration of hospitalizations, the nature of the surgery and their urgent aspect (scheduled or not), the nutritional status of the patients, the category of the hospitalization room, the presence of associated pathologies, the order of wound dressings and antibiotic prophylaxis received after surgery.

3.3. Factors Related to Patient's Status

Patients' nutritional status

The patients' nutritional status has been identified on the basis of their Body Mass Index (BMI). That BMI have been defined by WHO and was obtained by dividing the patient's weight (in kg) by the square of his height (m). Analysis of

Table 1. Prevalence of SSI after surgery depending on gender.

	Sex		TOTAL
	Females	Males	
Presence of an SSI			
YES	26.8% (11)	36.0% (40)	33.6% (51)
NO	73.2% (30)	64.0% (71)	66.4% (101)
TOTAL	100% (41)	100% (111)	100% (152)

the relation between patients' nutritional status and the occurrence of an SSI presented in Table 2 shows a significant dependence with $p = 0.0103$.

Associated pathologies

We analyzed the pathologies associated to the occurrence of SSI. The most current pathologies in SSI patients were diabetes, hypertension, renal failure and infectious syndrome. These pathologies were presented respectively in 11/21 (52.3%), 5/21 (23.8%), 1/21 (4.7%) and 4/21 (19.2%) of SSI cases. Diabetes was the most frequent pathology among SSI patients. The analysis of the relationship between the associated pathologies and the occurrence of SSI is presented in Table 3. Our results showed that 100% (21/21) of patients with SSI had an associated pathology ($p = 0.01$).

3.4. Factors Related to Health Centers

Hospital stay duration

Patients who underwent surgery spent an average of 13.5 days in hospital, with a minimum of 4 days and a maximum of 21 days in hospital, for those who did not develop an SSI. The patients who develop an SSI spent an average of 37 days with a minimum of 27 days and a maximum of 77 days in hospital. Patients with SSI spent more time in hospital than other patients ($p = 0.05$) (Table 4).

Categories of hospitalization rooms

There are different categories of hospitalization rooms that are available after surgical acts. The first category rooms are single rooms with large space and air conditioning. These rooms are clean and there is no disturbing neighborhood. The second and third categories have two or three beds without air conditioning with promiscuity between patients. Most of the patients were hospitalized in the third category (114/152); only four (4) patients were hospitalized in the first category (Table 5). The SSI were more observed in second and third categories

Table 2. Comparison of the patients' nutritional status (Body Mass Index: BMI).

	Nutritional status of the patient (BMI)					TOTAL	*P*-value
	IMC ≤ 18	18 < IMC < 25	25 ≤ IMC < 30	IMC ≥ 30	unknown		
Presence of SSI							
YES	100% (11)	22.4% (17)	100% (4)	100% (2)	28.8% (17)	33.6% (51)	
NO	0.0% (0)	77.6% (59)	0.0% (0)	0.0% (0)	71.2% (42)	66.4% (101)	$p = 0.0103$
TOTAL	100% (11)	100% (76)	100% (4)	100% (2)	100% (59)	100% (152)	

Table 3. Presence of associated pathologies and the occurrence of SSI.

	Presence of SSI		TOTAL	*p*-value
	YES	NO		
Presence of associated pathologies				
YES	100% (21)	22.9% (30)	33.6% (51)	$p = 0.0001$
NO	0.0% (0)	77.1% (101)	66.4% (101)	
TOTAL	100% (21)	100% (131)	100% (152)	

Table 4. Hospital stay duration among patients with SSI.

Hospitalization duration per day	Occurrence of SSI		TOTAL	*p*-value
	YES	NO		
≤10	2.0% (1)	85.1% (86)	57.2% (87)	
]10 - 20]	43.1% (22)	13.9% (14)	23.7% (36)	
]20 - 30]	29.4% (15)	1.0% (1)	10.5% (16)	$p = 0.0005$
>30	25.5% (13)	0.0% (0)	8.6% (13)	
TOTAL	100% (51)	100% (101)	100% (152)	

Table 5. Occurrence of SSI according to the category of hospitalization rooms.

	Level of hospitalization			TOTAL	*P*-value
	Category 1	Category 2	Category 3		
Presence of SSI					
YES	0.0% (0)	17.6% (6)	39.5% (45)	33.6% (51)	$p = 0.02$
NO	100% (4)	82.4% (28)	60.5% (69)	66.4% (101)	
TOTAL	100% (4)	100% (34)	100% (114)	100% (152)	

while no infection was observed in patients hospitalized in the first category ($p = 0.02$).

3.5. Factors Related to the Medical Act

Nature and urgent aspect of the surgical intervention

Analysis of the nature of surgery showed that patients with digestive surgery present more SSI than others ($p = 0.0041$) (Table 6). Among the patients concerned by this survey, only 20 had their intervention programmed whereas the other 132 were in an emergency case. SSI were more frequent in patients whose interventions were made in emergency ($p = 0.0167$) (Table 7).

Occurrence of SSI according to the order of bandages and antibiotic prophylaxis

Bandages are changed during the postoperative stay. Our results showed that most of the infections occur after the second bandage (Table 8). The order of the bandage was a factor involved in the occurrence of SSI ($p = 0.01$). In surgery department, each patient after the chirurgical act should automatically receive one of the four molecules used for the antibiotic prophylaxis. Those molecules were ceftriaxone, ampicillin, amoxicillin or ciprofloxacin. We showed that most of the patients have received ceftriaxone (40.2% (61/152)) and ampicillin (32.8% (50/152)). However, 43.3% of patients who have developed an SSI had received ceftriaxone, 39.2% ampicillin and 15.6% amoxicillin; only 1.9% had received ciprofloxacin (Table 9).

4. Discussion

The frequency of SSI found in this survey at 33.6%, is higher than those obtained

Table 6. Comparison of the nature of surgery practiced and the occurrence of SSI in operated patients.

	Presence of SSI		TOTAL	*p*-value
	YES	NO		
Type of the surgery				
Digestive	58.8% (30)	47.5% (48)	51.3% (78)	$p = 0.415$
Urinary	11.8% (6)	12.9% (13)	12.5% (19)	
Orthopedic	15.7% (8)	14.8% (15)	15.1% (23)	
Others	13.7% (7)	24.8% (25)	21.1% (32)	
Total	100% (51)	100% (101)	100% (152)	

Table 7. Comparison of the nature of the surgery (urgent or programmed) and the occurrence of an SSI in the operated patients.

	Character of surgery		TOTAL	*p*-value
	Urgent	Programmed		
Presence of SSI				
YES	37.1% (49)	10.0% (2)	33.6% (51)	$p = 0.167$
NO	62.9% (83)	90.0% (18)	66.4% (101)	
TOTAL	100% (132)	100% (20)	100% (152)	

Table 8. Occurrence of the SSI according to the order of bandages.

	Presence of SSI		TOTAL	*P*-value
	YES	NO		
Number of bandages				
1st	3.9% (2)	78.2% (79)	53.3% (81)	$p = 0.0001$
2nd	51.0% (26)	13.9% (14)	26.3% (40)	
3rd	41.2% (21)	5.9% (6)	17.8% (27)	
4th	3.9% (2)	2.0% (2)	2.6% (4)	
TOTAL	100% (51)	100% (101)	100% (152)	

Table 9. Antibiotic treatment and occurrence of SSI.

Type of antibiotics used	Proportion of patients	Presence of SSI
Ceftriazone	40.1% (61)	43.1% (22)
Ampicilline	32.9% (50)	39.2% (20)
Amoxicilline	17.8% (27)	15.7% (8)
Ciprofloxacine	9.2% (14)	2.0% (1)
Total	100% (152)	100% (51)

by other studies carried out in Morocco by Bouzid *et al.*, 2015 and in Central Republic of Africa by Bercion *et al.* 2007 [11] [12]. These studies found a preva-

lence of 16.0% and 18.0% respectively at Morocco and in central republic of Africa. The prevalence found in our study is also higher than that found by Nwankwo *et al.* 2016 in Nigeria and in the meta-analysis study carried out by Ngaroua *et al.*, 2016. Nwankwo *et al.* found a frequency of 25.2% and Ngaroua *et al.* found a frequency range between 6.8% - 26% depending on the country and the type of study [13] [14]. This high incidence of SSI could be explained by the lack of monitoring and prevention program of these infections in developing countries [12]. It could also be explained by the development of multi-resistant bacteria in the hospital, which infect surgical wounds despite the administration of antibiotic therapy [15]. The hygienic conditions in hospital and overcrowding in hospital rooms might explain the high frequency found in our study. This could be illustrated by the fact that all the patients presenting an SSI were hospitalized in the second and third categories with 45 patients out of 51 who were hospitalized in the third category. Interestingly no patient in the first category showed SSI even if there are minorities.

Analysis of risk factor in our study showed that age does not appear as a risk factor for the occurrence of SSI ($P = 0.2$). The slightly elevated rate of SSI (22/51 SSI cases) observed in patients aged 29 to 39 years could be explained by the type of surgery performed in these patients. Bouzid *et al.* 2015, have also reported similar observations in Morocco in 2015 [12]. Gender also does not appear to be a risk factor in this survey ($p = 0.36$) as reported by Bouzid and *al.* in his survey in Morocco. The lower frequency of SSI in women could be explained by the fact that women were in minority in the study population. This could be explained by the fact that there is no obstetric surgery in this hospital.

In opposition to gender and sex, nutritional status appears as a risk factor for the occurrence of SSI. Patients with a BMI < 18 and those who have a BMI ≥ 25 are exposed to the risk to develop an SSI. Other studies have also reported that the nutritional status may be a risk factor for SSI [13]. Nutritional status directly influences the disorganization of the immune system [16], creating therefore a deficiency of the immune system. Riana, 2009 in her work on nutrition and infections reported that malnutrition leads to general immune deficiency. That might promote the development and the proliferation of human commensal germs, and facilitate the occurrence of SSI [17]. Associated pathologies are also a risk factor for SSI. Among the associated pathologies, diabetes appears to be the main risk factor (11/21 case of associated pathologies). These results could be explained by the fact that the associated pathologies like diabetes create an immunosuppression, promoting the appearance of SSI [18] [19].

The high prevalence of SSI in digestive surgery could be explained by endogenous contamination due to the large commensal flora of the digestive tract. Digestive surgery wounds are easily accessible to the touch of the human hand. This can be done either by the patient himself or by his entourage. In addition, digestive surgery most often requires the installation of drainage. Changing or removing drains by nurses can lead to contamination [20] [21]. This is consistent with the observation that the occurrence of SSI was most observed between

the 2nd, 3rd and 4th dressing received after surgery. This result is similar to that found by Bouzid *et al.* 2015 in Morocco who reported that SSI occurs between the 2nd and the 3rd bandage changing [12]. In accordance with these data the duration of hospitalization appears to be a risk factor for SSI. Ours results are similar to those reported by Nwankwo *et al.* 2014 and Keita *et al.*, 2016 who reported that the duration of hospitalization is a risk factor for SSI. The same observations were also found by Cheng *et al.*, 2015 [14] [22] [23]. Many hypotheses could explain the association between the occurrence of an SSI and the duration of hospitalizations. The contamination may come through dirty hands during bandaging, the hospital environment, the patient's itself and the relatives who accompany the patient or even from the visitors.

The nature of the surgery was not a risk factor for the occurrence of SSI. But urgent surgical situations can promotes SSI as described in several studies [21]. In our investigation, emergency surgery was associated with the occurrence of SSI. There are many reasons that can explain this significant relationship found in our survey. In fact, patients seen in emergency situations are less prepared before surgery. On the contrary, those who are scheduled undergo very rigorous preoperative preparations in accordance with the recent WHO recommendations. This is in agreement with the fact that patients with scheduled surgery are those with clean surgery where the occurrence of SSI is low, as described in the literature [13] [24].

5. Conclusion

In our study population and among SSI patients, men were predominant and average age of patients was 37.9 years. Analysis of risk factor showed that, patients' nutritional status was significantly associated to the occurrence of SSI. In addition, 100% (21/21) of patients with SSI had an associated pathology. The factors related to health centers like hospital stay duration and category of hospitalization room have showed a significant association to the occurrence of SSI. The nature of the surgical intervention and their urgent aspect were also associated to SSI. The same observations have been made for the order of bandages with the majority of infections observed at the second bandage. Antibiotic prophylaxis analysis showed that ciprofloxacin was more effective in SSI prevention with only 1.9% of SSI in patients with ciprofloxacin treatment. In conclusion, our study showed a high frequency of SSI (33.6%). The main risk factors are human factors and hospital hygiene. It is therefore necessary to take concrete measures to limit these bad attitudes: first at the level of hospital staff, secondly at the level of patients and finally at the level of those who accompany patients and even visitors, to reverse the trend.

Author's Contributions

Study conception and design: HMA and ZC. Data collection and analysis: HMA. Coordination of the survey and correction of the manuscript: ZC and YEH. The

final version has been corrected by AS, AT and YEH.

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Conflicts of Interest

The authors declare no competing interests.

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