Research Article

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Surgical Site Infections in General Surgery at the Regional Hospital of Thies (Senegal): Epidemiological, Bacteriological Aspects and Risk Factors

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ABSTRACT

Introduction: *Surgical Site Infections (SSIs) are frequent and lead to serious consequences and in terms of morbidity and mortality, with an increase in the length of hospitalization and health costs. Developing countries are the most affected. The aim of our study was to describe the epidemiological, clinical, and bacteriological aspects of SSIs in general surgery at the RH of Thies.*

Methods*: This is a prospective study over a period of seven months (7 months) from September 1, 2018 to March 31, 2019 at the level of the general surgery department of the Regional Hospital of Thies. Bacteriological studies were carried out at the level of the Bacteriology unit of the National Public Health Laboratory of Senegal.*

Results: *The incidence of SSIs in our study was 9.9%. The SSIs rate was 15.3% among resident surgeons, 10% among junior surgeons, 6.8% among senior ones. The surgical intervention was classified as Altemeier stage 1 in 3.4% of cases (n = 1), stage 2 in 27.6% of cases (n = 8), stage 3 in 24.1% of cases (n = 7) and stage 4 in 44.8% of cases (n = 13). Twenty-two of the isolated stems (73.3% of cases) were multidrug-resistant bacilli. The extended spectrum beta lactamase (ESBL) phenotype was found in 22 isolates and 1 stem of K. pneumoniae was resistant to all antibiotics.*

Conclusion: *SSIs constitute a challenge because of their high frequency and the high resistance of germs to common antibiotics. Currently, the main mode of resistance of bacteria in SSIs is the secretion of ESBL. This phenomenon seems to be major in our regions where it is urgent to review the therapeutic protocols in practice in the services.*

Keywords
Infections, Surgical site, Risk factors, Bacteriology.

Introduction
Surgical site infections (SSIs) are mainly nosocomial ones. They concern a third of operated patients and are mainly linked to asepsis faults, a lack of sterilization of the premises and operating instruments, and a lack of a functional system for quality control of care in health structures, especially in Sub-Saharan Africa [1-3]. Although data for epidemiological monitoring are available in Europe and the United States of America [1], the situation is different in Africa. Indeed, African data on the situation of SSIs in health services are scarce. Yet, these SSIs constitute a major threat, especially in surgical services, due to their frequency but also to the increasingly growing resistance of the bacteria responsible for SSIs to antibiotics. The objectives of our study were to describe

the epidemiological, bacteriological, and therapeutic and risk factors associated with SSIs.

Materials and Methods

This is a prospective study over a period of seven months (7 months) from September 1, 2018 to March 31, 2019 at the level of the general surgery department of the Regional Hospital of Thies. It concerned all patients operated in the department during our study period who had a surgical site infection. Patients operated in other departments or other health structures were excluded from the study. The diagnostic criteria of the SSIs were those of the CDCs. Patient data were collected and recorded on Windows Excel 2010 file. The parameters studied were epidemiological, clinical and bacteriological. Once a surgeon made the clinical diagnosis of the infection, a double sample was taken at the same time and the two samples were packaged in triplicate. Everything was put into a rigid and transparent plastic container labeled "Biohazard" and sent to the Bacteriology unit of the National Public Health Laboratory (NPHL) in Thies.

For the bacteriological analysis, we successively carried out a macroscopic examination of the sample, then a microscopic examination with the Gram stain, followed by the inoculation of the culture environments. The culture environments we had that were available for inoculation were Chapman, Mueller-Hinton (MH), and Cooked Blood Agar (CBA).

The inoculated environments were incubated in an oven at 37 ° C., and placed under CO_2 in the cooked blood agar for 24 hours. If after this time the culture was positive and pure, we proceed to the identification of the bacteria by mini identification gallery.

The anti-bio gram was carried out according to the Kirby Bauer (disc method). In the event of Gram-negative bacilli being isolated, we systematically looked for an extended spectrum beta lactamase (ESBL) using the synergy test. A positive synergy test is materialized by a champagne cork image between the clavulanic acid amoxicillin disc and a third generation cephalosporin.

For the interpretive reading of the anti-bio gram, we first determined the sensitivity of the bacteria. For this, the diameters read on the box were compared to the values contained in the CASFM 2018 reference system and interpreted as Resistant (R), Sensitive (S), or Intermediate (I).

It was after this that the resistance phenotype was determined. Bacteria, which showed resistance to at least three families of antibiotics, were considered multidrug-resistant. Among multidrug resistant bacteria, we also looked for the phenotype according to the type of germ.

The data statistical analysis was carried out in 3 stages: a univariate analysis with Microsoft Excel which made it possible to see the link between the SSIs and each variable taking into account the modalities of the latter, then a multivariate analysis by Multiple Correspondence Analysis (MCA) with the SPAD software to see those that may be associated with surgical site infections and finally, an econometric analysis with the STATA software to measure, beyond the proximity between the modalities, the effect of the modalities of each variable on the probability of being infected. To have more robust results given the limited number of infected patients in the sample, we used the results of the multivariate analysis to sort the variables to be retained in the probit model used.

Results

Two hundred and thirty patients were operated during our study period. These were 190 men (64.8%) and 103 women (35.2%).

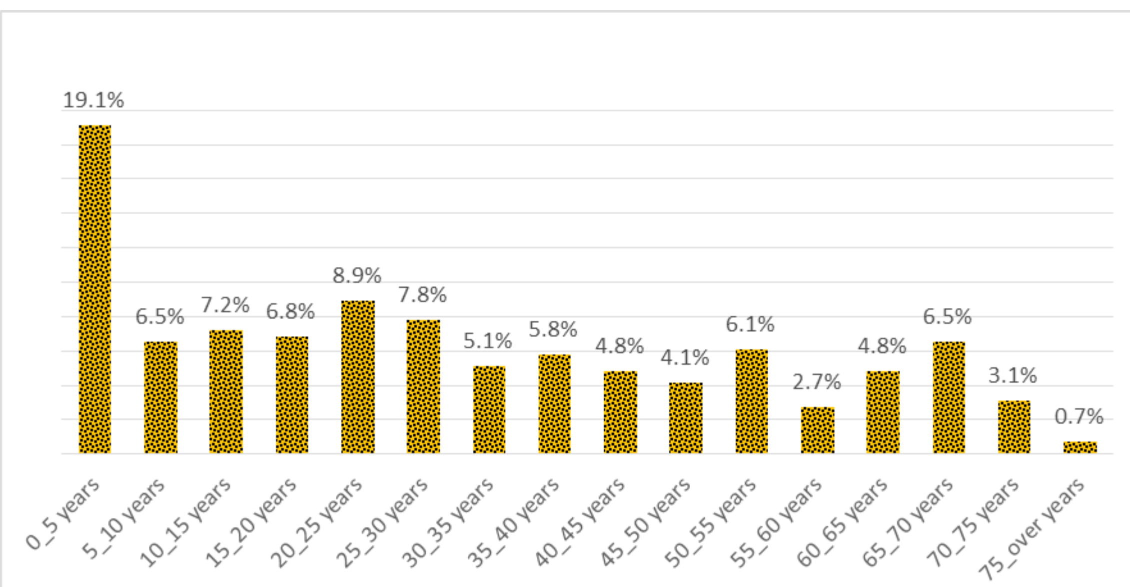

Figure 1: Distribution of the studied population by age groups.

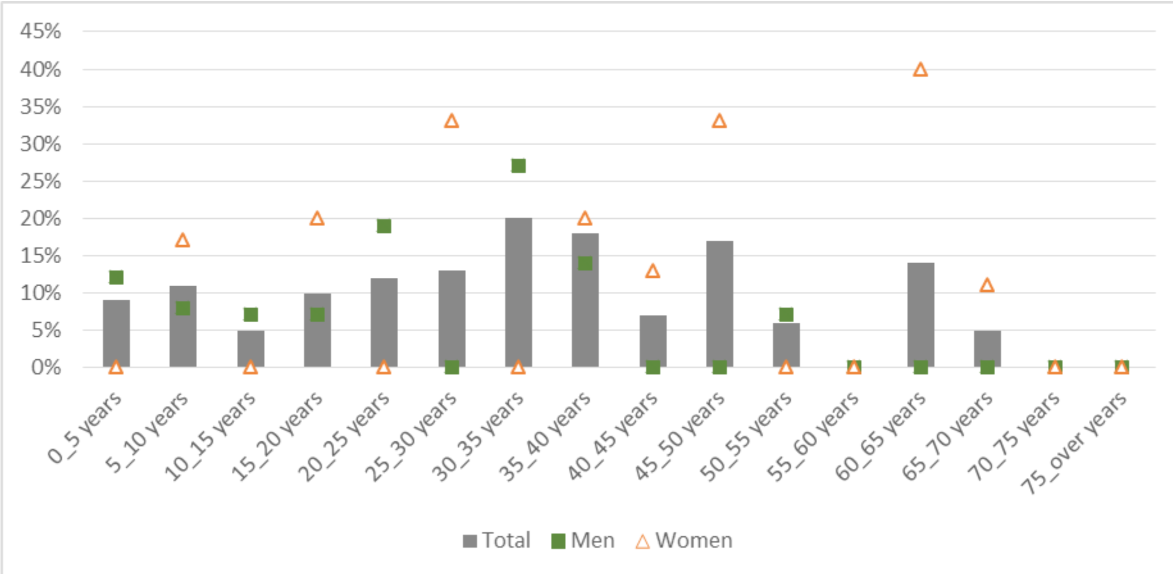

Figure 2: Infection rate by sex and age.

The mean age was 30.4 years with extremes of 3 months and 80 years and a median of 27 years. The 0 - 5 year age group was the most representative with 56 cases (Figure 1).

The patients were operated urgently in 125 cases (42.7%) and on a regular basis in 168 cases (57.3%). The main operating surgeon was a senior surgeon in 30% of cases, a junior surgeon in 49.9% of cases and a resident surgeon in 20.1% of cases.

All the patients in the sample systematically benefited from pre-operative antibiotic therapy.
The indication for surgery in patients was classified as Altimeter stage 1 in 137 cases (46.8%), stage 2 in 77 cases (26.3%), stage 3 in 22 cases (7.5%) and stage 4 in 57 cases (19.5%). Eleven patients in the sample had died, that means i.e. an overall mortality of 3.7%. Twenty-nine patients presented SSIs that is i.e. an incidence of 9.9%.

They were 16 men (55.2%) and 13 women (44.8%), that means i.e. a sex ratio of 1.2. The mean age of infected patients was 28.9 years with extremes of 3 months and 70 years and a median of 30 years.

The infection rate was higher with women (12.6%) than with men (8.4%) and the gap increased with age (Figure 2).

Twenty-six patients were operated urgently (89.7% of those infected) and 3 under a regulated program (10.3% of those infected), that is i.e. an incidence rate of 20 and 1.8% respectively. The three infected cases in the regulated program were all female subjects operated for a gynecological pathology. The SSI rate was 15.3% among resident surgeons, 10% among junior surgeons and 6.8% among senior surgeons.

The indications for operation in infected patients were peritonitis, bowel obstruction, appendicitis, uterine myomatosis, strangulated parietal hernia and complicated breast abscess. The frequencies are represented on table 1.

Table 1: Summarizes the indication for operation in infected patients.

Per-operative diagnosis	Frequency (n)	Percentage (%)
Peritonitis	10	34.5
Bowel obstruction	8	27.6
Appendicitis	5	17.2
Uterine myomatosis	3	10.4
Strangulated parietal hernia	2	6.8
Complicated breast abscess	1	3.5
Total	**29**	**100**

The surgical intervention was classified as Altimeter stage 1 in 3.4% of cases (n = 1), stage 2 in 27.6% of cases (n = 8), stage 3 in 24.1% of cases (n = 7) and stage 4 in 44.8% of cases (n = 13).

The mean time to start antibiotics was 39 hours in infected patients with extremes of 15 minutes and 360 hours and 0.3 hours in uninfected patients.

The mean time to onset of infection was six days with extremes of two and sixteen days. The infection was superficial in all patients.

The clinical signs in the 29 infected patients are summarized on the table 2.

Table 2: Clinical signs in the 29 infected patients.

Pulse			Respiratory frequency		Physical Signs
< 70	Normal	> 100	Normal	Polypnea	Purulent discharge
2	17	10	14	15	29

Mortality rate was 6,7% (2 cases) among these infected patients.

Analysis of the 29 samples showed 26 positive cultures, that means i.e. a yield of 89.6%.

These were 22 mono-microbial cultures and 4 polymicrobial cultures with 2 germs, for a total of 30 bacterial isolated stems. These were 22 mono-microbial cultures and 4 polymicrobial cultures with 2 germs, for a total of 30 bacterial isolated stems. They were all Gram-negative bacilli (Table 3). It was an enterobacterium in 24 cases and a non-fermenting Gram-negative bacillus in 6 cases. Escherichia coli was the stem mostly found in14 cases (46.7%).

Table 3: Germs identified in surgical site infections.

Germs	Frequency (n)	Percentage (%)
Enterobacteria		
Escherichia coli	14	46.7
Enterobacter sp	6	20
Klebsiella pneumoniae	3	10
Proteus mirabilis	1	3.3
Non fermenting-Gram bacilli		
Pseudomonas aeruginosa	5	16.7
Acinobacter sp	1	3.3
Total	**30**	**100**

All infected patients were on triple antibiotic therapy combining amoxicillin - metronidazole - gentamicin at the time of infection diagnosis. Twenty-two of the isolated stems (73.3% of cases) were multidrug-resistant bacilli. The extended spectrum beta-lactamase (ESBL) phenotype was found in 22 isolates (Table 5) and one stem of K.pneumoniae was developing resistance.

Comments

Surgical site infections are one of the most common postoperative complications [4,5]. Their incidence is globally estimated between 2 to 12% depending on the series [4,6]. WHO considers that they affect a third of the patients operated in the world [1].

Regarding Sub-Saharan Africa, there is a lack of data on SSIs but the few regional series suggest that the incidence is much higher there than in developed countries [2,4,6-10].

The incidence of surgical site infections (SSIs) was 24% in a district hospital in Tanzania by Jan Fehr and coll [11].

Table 4: Status of antibiotic resistance of isolated bacteria.

	E. coli	*Enterobacter sp*	*K. pneumoniae*	*P. mirabilis*	*P. aeruginosa*	*Acinetobacter sp*
Amoxicillin	14(14)	RN	RN	1(1)	RN	RN
Amox - Ac. Clav.	14(14)	RN	3(3)	1(1)	RN	RN
Ticarcillin	13(13)	6(6)	RN	1(1)	3(5)	1(1)
Piperacillin	7(7)	4(4)	2(2)		0(2)	
Cefalotin	1(1)	RN			RN	RN
Cefalexin	11(13)	6(6)	2(3)	1(1)	RN	
Cefoxitin	8(14)	RN	1(3)	1(1)	RN	
Ceftazidim	8(14)	5(6)	2(3)	0(1)	RN	1(1)
Ceftriaxon	7(13)	5(6)	2(3)	0(1)	RN	RN
Aztreonam	8(14)	4(6)	2(3)	0(1)	0(5)	1(1)
Imipenem	4(14)	1(6)	1(3)	0(1)	0(5)	1(1)
Colistine	10(14)	2(6)	3(3)	1(1)	0(5)	1(1)
Chloramphenicol	3(14)	4(6)	1(3)	0(1)	RN	RN
Tobramycin	10(14)	4(5)	2(3)	0(1)	0(5)	1(1)
Amikacin	0(14)	1(6)	1(3)	0(1)	0(4)	0(1)
Netilmicin	0(1)				RN	RN
Gentamicin	3(14)	4(6)	2(3)	0(1)	0(5)	1(1)
Ciprofloxacin	4(12)	1(6)	1(3)	0(1)	0(5)	1(1)
Ac. Nalidixic	1(1)					
Norfloxacin	1(1)					
Cotrimoxazole	9(9)	4(4)	3(3)	1(1)	RN	RN
Levofloxacin	6(14)	1(5)	1(3)	0(1)	0(5)	1(1)
Fosfomycin	0(1)					

Table 5: Phenotypes of bacteria.

Germs	Penicillinase low level	Penicillinase high level	Penicillinase resistant to beta lacimatase inhibitors	Cephalosporins low level	Cephalosporins high level	ESBL
Enterobacteria						
Escherichia coli	0	0	1	0	0	13
Enterobacter sp	0	0	0	0	0	6
K. pneumoniae	0	1	0	0	0	1
Proteus mirabilis	0	0	0	0	0	1
Non refractory-Gram bacillus						
P. aeruginosa	-	-	-	-	-	0
Acinetobacter sp	0	0	0	0	1	1
Total	**0**	**1**	**1**	**0**	**0**	**22**

Indeed, the incidence of SSIs in developing countries is at least twice as high as in developed countries. A study by The Lancet's Global Surg Collaborative group of the Lancet found an incidence of 9.4% in developed countries while it was 23.2% in developing countries [4]. The incidence of SSIs also varies according to the surgical specialty. Indeed, compared to other surgical specialties, SSIs are more frequent in general surgery [2].These variations in incidence, depending on the level of development of the country and the surgical specialty, are explained by the factors favoring SSIs which are linked either to the surgical act, or to patients, or to the hospital environment [1-3,7]. These include the type and duration of the surgical intervention [12], the experience of the surgeon [13], the degree of surgical urgency, the advanced age of the patients and the bacterial ecology in the hospital [14].

The results of the univariate analysis in our study did indeed show the impact of these factors on our patients' risk of becoming infected. Indeed, these variables appeared statistically significant in the risk of occurrence of SSIs in patients. But a variable appeared to us in the interpretation of the final model of our probit analysis as being the major factor in the occurrence of SSIs: it is the environment. African series have shown that the high prevalence of SSIs in Sub-Saharan Africa is strongly linked to the environment [2-4,7,14]. We were not able to take samples in the various premises of our study setting, but given our working conditions and the results we obtained, the environment in our hospitals seems to play an important role in the occurrence of SSIs.

Larger data and a study of the bacterial ecosystem in the different work environments would have enabled us to confirm our hypothesis.

From a bacteriological point of view, the germs most frequently found in general and digestive surgery, are Gram-negative bacilli, especially enterobacteria [3]. But in the African series, the predominant germs vary depending on the hospital [13,15].

This difference in the distribution of the bacterial species responsible for SSIs in general surgery is linked to the bacterial ecology of hospitals because contamination of the operating site most often occurs intraoperatively either from the resident flora of the patient, or from the flora of the surgical team, either from contaminated instruments, or from the site of the surgical intervention [13]. If the digestive tract is opened, contamination of the operating site can also come from the endogenous digestive flora. In addition to its high incidence, today the major challenge with SSIs is the increasing resistance of germs to antibiotics [3]. We did not find in the literature global data on the level of resistance of bacteria in SSIs for the African continent, but increasingly high rates are reported suggesting a high bacterial resistance mainly by secretion of ESBL in our regions [2,16]. Germs have not changed globally over the past ten years, but their resistance to antibiotics continues to increase [17]. This is mainly due to improper use of antibiotics [18-20].

Indeed, it is, for example, clearly established that the development and spread of ESBL-secreting bacteria are linked to the massive and disproportionate use of beta-lactams [3].

Massive, long-lasting antibiotic therapy poorly indicated with ineffective doses in human and animal health created a selection on bacterial populations and favored the appearance of multi resistant stems. Currently, the continuous increase in ESBL-secreting enterobacteria is a major public health concern [21]. In our regions, this phenomenon is all the more serious as most of the treatments are empirical and many antibiotic protocols no longer seem to be adapted to the local bacterial ecology in hospitals. This bacterial resistance is so worrying globally that the WHO published in 2017 a list of twelve bacteria that it considered to represent a global threat with different levels of priority and designated these germs as priority agents for research and the development of new antibiotics [22].

Also, the introduction of hospital hygiene measures such as the use of hydro alcoholic solution and the isolation of infected patients would have had the opposite effect of promoting the increase in bacterial resistance and the incidence of ESBLs due to poor application of barrier gestures [10].

Thus, by finding germs, which would have become more tolerant to hydro alcoholic gels, Australian researchers at the University of Melbourne seem to corroborate this hypothesis [23]. But the French Society of Hospital Hygiene prefers to qualify by speaking of tolerance rather than resistance. In addition to the high bacterial resistance, the special feature in our hospitals is the cross transmission of ESBLs. Hospitals constitute a reservoir of multi-resistant bacterial stems and the conditions in which patients are hospitalized favor cross-transmission [13].

Also, patients carrying ESBLs constitute a source of dissemination of multi-resistant germs within the community.

Conclusion

SSIs are a real challenge because of their high frequency and the high resistance of germs to common antibiotics. Currently, the main mode of resistance of bacteria in SSIs is the secretion of ESBLs. This phenomenon seems to be predominant in our regions where it is urgent to review the therapeutic protocols in practice in the services and more generally, to organize the fight against nosocomial infections. Setting up nosocomial infection control committees and making them functional are priority actions in order to avoid and fight efficiently against the harmful effects of surgical site infections.

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