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SURGICAL SITE INFECTION: INCIDENCE AND MICROBIOLOGY, A PROSPECTIVE STUDY IN A GENERAL SURGERY DEPARTMENT

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Abstract: Background: Surgical site infections are a major complication of surgery and a potential indicator of causative organisms and the percentage of multi-resistant bacteria.

Materials and methods: This is a six-month prospective study in the general surgery department of Mohammed VI University Hospital. All subjects who underwent general surgery between 01 March 2018 and 31 August 2018 were included and monitored 30 days after the intervention. Risk factors such as age, ASA sore, type of intervention and duration of operation were collected. All infected patients benefited from samples for bacteriological study.

Results: During the 6-month period, 736 patients were included in the study. their ages ranged from 15 to 94 years, with an average of 48.5 years. A total of 39 SSIs was confirmed (incidence rate of 5.29%). The distribution according to the site of infection showed 27 superficial infections, 10 deep infections, and 2 space infections. Urgency, age, Altemeyer contamination class, type of intervention and duration of surgery were the main risk factors. The SSIs stratified rate on the NNIS index ranged from 2.7%(NNIS=0) to 12% (NNIS= 3) The causative organisms in order of frequency were: Escherichia coli, Staphylococcus aureus, Enterococcus faecalis, and Pseudomonas aeruginosa.

Conclusion: The high frequency of SSIs makes it necessary to reinforce the hygiene measures during the operative procedure, and to reinforce regular monitoring according to standardized procedures in the surgical departments.

Keywords: Surgical Site Infections, Risk factors, National Nosocomial Infection Surveillance, General surgery, Multiresistant bacteria, Quality of healthcare.

I. INTRODUCTION

Surgical site infection (SSI) represents a major public health problem, which can compromise the functional or vital prognosis. It is the third most common nosocomial infection, and it accounts for 15% to 20% of all hospital-acquired infections [1].

In order to identify and stratify patients at risk for SSI, the centers for disease control and prevention (CDC) established the National Nosocomial Infection Surveillance System (NNIS) in 1970. The term 'surgical site infection' was first introduced in 1992 to replace the previous term 'surgical wound infection '[2]. SSIs are defined as infections occurring within 30days after affecting operation (or within one year if an implant is left in place after the procedure) and affecting either the incision infections or deep tissue of the operation site. These infections may be superficial or deep incisional infections, or infection involving organs or body spaces [2].

The NNIS index ranges from 0 to 3 with increasing risk and is raised by 1 point for each of 3 SSI predictors [3]. First, American Society of Anesthesiologists (ASA) classification (range, 1-5) [4], as a measure of poor overall preoperative physical status of the patient. Second, wound contamination class >2 (range, 1-4), corresponding to a contaminated or dirty-infected operation. Third, duration of operation>75th percentile (P75) for the specific procedure group, associated with a greater risk of infection [3].

Despite the advances made in asepsis, surgical site infection continues to be, in various degrees, a cause of morbidity and mortality, leading to increase in cost of therapy. Kirkland et al. found that surgical patients with SSI were twice as likely to die, 60% more apt to be admitted to an intensive care unit, and greater than five times more likely to require hospital readmission [5].

Data from the united states centers for Disease Control National Nosocomial Infections Surveillance System (CDC NNIS) shows that SSIs are the second most frequently reported nosocomial infections, after the respiratory infections [6]. The National Healthcare Safety Network (NHSN) published these same proportions. In France, the national surveys of the prevalence of nosocomial infections in 1996, 2001 and 2006[7] showed that SSIs occupy the third place. They also occupy the first place in Finland [8], Cuba [9], Burkina Faso [10] and Egypt[11]. Our aim has been to report our experience of the epidemiological, diagnostic and therapeutic aspects of surgical site infections, in order to determine their incidence, to identify the risk factors, the causative organisms and the percentage of multi resistant bacteria, and to compare our own results with those from international, national or regional databases, and thus establish a systematic prevention strategy, with paid attention to multiple risk factors related to the patient, the procedure, and the hospital environment, within our general surgery department .For this study secondary data has been collected. From the website of KSE the monthly stock prices for the sample firms are obtained from Jan 2010 to Dec 2014. And from the website of SBP the data for the macroeconomic variables are collected for the period of five years. The time series monthly data is collected on stock prices for sample firmsand relative macroeconomic variables for the period of 5 years. The data collection period is ranging from January 2010 to Dec 2014. Monthly prices of KSE -100 Index is taken from yahoo finance.

MATERIALS AND METHODS

1- Study Site

The study was carried out in general surgery department of Mohammed VI university hospital in Marrakech, Morocco

2- Study Design

An analytical prospective descriptive study

3- Study Duration

The study was conducted in 6 months, within the period of Mars 2018 to August 2018. The investigation ended on September 31, one month after the last intervention.

4- Study Subjects

The study included all the patients hospitalized within the department of general surgery of Mohamed VI university hospital over the six months period, and have undergone a surgical intervention.

We have excluded from this study: patients transferred directly from another department to the operating room and returning directly to their department after the procedure. Patients who underwent invasive procedures for diagnostic purposes, and interventional radiology procedures. Ambulatory surgery patients.

5- Case Definition and Selection

An infected case-patient was defined as any patient who developed SSI following a surgical procedure performed during the study period. We used CDC National Nosocomial Infections Surveillance System criteria to define surgical site infections (2).

6- Data Collection

Data collected as part of ongoing SSI daily surveillance program were available on each study patient. Additional information was obtained by a systematic review of medical records, ER register, and anesthesia card. All patients who presented a SSI had bacteriological sampling. These data were processed and analyzed using the Epi-Info software 2017.

RESULTS:

During the study period, a total of 736 inpatient general surgical procedures were performed. We identified 39 SSIs accounting for an overall crude SSI rate of 5, 29%.

The average age of operated patients was 46.82 years, with extremes ranging from 15 years to 94 years, and a median of 48, 5 years. For infected subjects, the mean age was 50.2 years with a median of 49 years, and extremes ranging from 17 to 94 years. The age group> 60years was majority, with a percentage of 41%. The sex ratio for infected patients was 1.78, with a male prevalence of 64.1% (25 males versus 14 females), compared to sex ratio of 1.06 for uninfected patients.

Surgical site infection rate varies in different surgical procedures. Colorectal surgery was the most common site infection (Table 1). The distribution per infection site showed 27 superficial infections (69.23%), 10 deep infections (25%) and 2 space infections (5.1%). The rates increased with increased American Society of Anesthesiologists score (ASA score) . It was 7.8%for ASA 3 group. Infection rate in clean wound was 3.18% whereas in contaminated wound class, it was 7.4%. The incidence of SSI increased as the NNIS risk index score increased from 2.7% (NNIS=0) to 12%(NNIS=3).

Our study also demonstrated that emergency procedures were associated with increased risk for SSI with a rate of 6.3% whereas scheduled surgeries were only 2.5%. The time to onset of infection after the intervention ranged from 2 to 30 days, the average being 10 days. 80% of the patients were infected before the end of the 3rd week postoperatively. The average length of preoperative stay of infected patients was 4 days versus 1.44 days for uninfected patients. In sum, the total stay of infected patients (13 days) was significantly higher than that of non-infected (6 days).

Microbiology of SSI:

In our study, all patients with SSI had bacteriological sampling, of which 87% were positive. We used swabbing for superficial and deep infections, and collection of drain fluid for space infection. A germ was identified in 24 cases, a combination of two germs in 10 cases and 5 samples were sterile after 48 hours of incubation. Escherichia coli was the most frequently isolate (Figure1).

Regarding Antibiotic Sensitivity: Escherichia coli was sensitive to third-generation cephalosporin in 93% of the cases, and amoxicillin+ clavulanic acid in 69% of the cases. All isolates of Staphylococcus aureus, except one, were sensitive to methicillin and aminoglycosides. The gram-negative organisms isolated were multiresistant, with resistance mainly to ampicillin, cephalothin and tetracycline.

Furthermore, Antibiotic prophylaxis was done according to the recommendations of the French society of Visceral Surgery.

SSI's treatment and follow up:

In our series, 34 patients received outpatient treatment (90%), 4 patients were rehospitalized (10%), including 1 surgical revision for plaque infection; with a rate of 2.56%. No death was reported in the study.

Follow-up of patients after discharge from the hospital detected 14 cases of SSIs (36%). Of the 736 patients, 32% were followed for 30 days after the surgery, and 62% were followed for 15 days or more. In total, 73% of patients were reviewed after discharge. The lost to follow-up did not exceed 27%.

DISCUSSION:

1-SSI rate stud:

This prospective study enabled us to calculate the rate of surgical site infection in a Moroccan general surgery department. The interpretation of the results must take into account the specialty of the department and the type of hospital. In our study overall surgical wound infection rate was 5.29%, which was close to other Moroccan studies [12, 13, 14], higher than European studies [7,15] and lower than African studies [16, 17, 18, 19].

2-Sociodemographic characteristics:

The average age of infected patients was 50.2 years, with a median of 49 years. Similar results were observed in other studies [14, 20]. Advanced age is an important factor for the development of SSIs, as in elderly there is low healing rate, low immunity, increased catabolic processes and presence of co-morbid illnesses like diabetes, hypertension, etc…

The predominance of male patients was seen in this study with male to female ratio of 1.78, which was in concordance with various studies [12, 13, 18, 21]. This male predominance can be explained by the difference in the immune system between men and women [12].

3-Risk factors:

In our study, the incidence of SSIs increased with increasing ASA score, which was in concordance with Moroccan [12, 13]and French studies [20, 22, 23]. It is easily understood that a patient in poor general condition present a greater risk of infection [10]. The ASA score attempts to take into account a number of these patient-related factors, but probably incompletely[11].

Duration of operation was also a risk factor, confirming prior reports (7, 12, 13]. Several factors are mentioned to explain this increase in risk, such as a prolonged ischemia, severe tissue damage and surgical trauma due to increased and prolonged surgical site manipulation. All this increases the number of stitches and electrocoagulation procedures, and causes increased blood loss, decreased effect of prophylactic antibiotics and decreased resistance to local and general infection [10].

A greater percentage of SSIs occurred in wound classification 3. The risk of developing a surgical site infection is closely dependent on the degree of bacterial contamination of the operating site. In various literature studies, there is an ascending risk gradient between Alteremeier contamination classes of 1 to 4 [12, 13, 20, 22]. Furthermore, the incidence rate of SSI stratified on the NNIS score increases with the risk of infection, which corroborates with literature data (table 2).

The analysis of our series shows also a variation of SSI's rate according to the nature of the interventions, which corresponds to literature data (table 3). Emergency operation and long preoperative periods were also risk factors, as has described in various studies [12, 13].

4-Microbiology of SSI:

In this work, the bacteria involved were mainly gram-negative bacilli with a high proportion of Enterobacteria of which Escherichia coli was the most isolated bacteria (36%), followed by Staphylococcus aureus (18%). These results join the different studies made on this subject [7, 10, 12, 13, 18, 24, 25].

The relative frequency of these different bacteria depends on the type of surgery. Thus, gram-negative bacilli and anaerobic bacteria are more often responsible for SSIs that occur after lower digestive tract abdominal surgery, and particularly the colon, whereas bacteria usually present on the skin such as Staphylococcus are proportionally more often involved in SSIs following so-called clean intervention.

5-Sensitivity of germs to antibiotics:

Escherichia coli was sensitive to third generation cephalosporin in 93%, and amoxicillin+ clavulanic acid in 69% of cases, which is consistent with data from the literature [26, 27]. The number of MRSA among Staphylococcus aureus was 1(12.5%), compared to 7% in France.

In Morocco, there isn't sufficient data on the sensitivity of germs in surgical site infections, particularly in general surgery department. Chadli and al, on the other hand, did not reveal any acquired resistance among its isolates [12]. Bassole [10] found strong resistance to gentamicin and Tchalloabalo [18] found a high sensitivity to ceftriaxone. This variation can be explained by the fact that each hospital zone has its own microbial ecology with a variable degree of sensitivity or resistance to germs specific to his zone. Moreover, the marked diversity of pathogens potentially involved in these infections highlights the risk of inappropriate empirical therapy, which usually occurs in 13%-16% of intra-abdominal infections and could lead to increased mortality [27].

6-Strategies for SSI prevention:

a-Preoperative strategies:

Preoperative management in general surgery varies from center to another and is poorly codified. Risk factors should be assessed during surgical consultation and anesthesia.

Pre-existing infections at sites remote from the operation site should be identified and treated [28]. Obese patients should be encouraged to lose weight and smokers should be encouraged to stop smoking [28]. On the night before the operation the skin should be adequately cleaned with an antiseptic solution. However, hair removal should be avoided unless it is likely to interfere with the operation. If hair removal is necessary, clippers should be used rather than shaving [29]. Antimicrobial prophylaxis is primarily indicated in elective procedures in which skin incisions are closed in the operating room. The choice of agent should be based on the pathogens most commonly associated with the procedure being performed [28]. Furthermore, surgical personnel who have active infections or colonized with certain microorganisms have been linked to outbreaks of SSIs. Thus, it is important that health care organization implement policies to prevent transmission of microorganisms from personnel to patients [29].

b-Perioperative Strategies:

The CDC guidelines emphasize the importance of good surgical technique and aseptic precautions for the prevention of SSIs. Good surgical technique requires attention to the maintenance of homeostasis, removal of devitalized tissue and foreign bodies as completely as possible, and elimination of dead space at the surgical site. Gloves, facemasks, caps gowns and sterile drapes should be used to minimize transmission of potential pathogens to the wound. Surgical instruments should adequately sterilize according to published guidelines; flash sterilization should be reserved only for instruments intended for immediate use [28].

c-Postoperative strategies:

According to the latest recommendations of the French Hospital Hygiene Society [30], it is necessary to: monitor the wound daily, respect asepsis and hygiene rules during the change of dressing: hand hygiene by friction with a hydro-alcoholic product. The education of the patient and his entourage is justified by warming him of local and general warming symptoms.

The suction of the drains is carried out in a closed system (Redon drian); their manipulation is carried out with rigorous asepsis; injections of substances or drugs must be avoided; their ablation should be fast.

7-Monitoring:

Monitoring SSIs with feedback of appropriate data to surgeons has been shown to be an important component of strategies to reduce surgical site infections. A successful monitoring program includes the use of epidemiologically sound infection definitions and effective surveillance methods, stratification of SSIs rates according to risk factors, and data feedback.

CONCLUSION:

Surgical site infections are increasingly recognized as a measure of patient's quality health care. Given the great medical, social and economic impact of SSIs on the patient himself, his family and the care facility, prevention is the only way to limit this risk. The fight against SSIs is a priority in public health and the implementation of a policy of prevention, against infections risk in the operation room has become necessary and mandatory, marked by validated criteria and well-defined rules.

WHAT IS ALREADY KNOWN ON THIS TOPIC:

- Surgical site infections are the most common healthcare-associated infections among surgical patients.
- SSIs have been shown to increase health care costs, excess length of hospitalization, increase relative risk for intensive care unit admission and for readmission to the hospital, and continues to be a cause of morbidity and mortality .
- One-third of SSIs could be prevented by different effective monitoring and control strategies.

WHAT THIS STUDY ADDS:

- Determine the incidence of surgical site infections in a general Moroccan surgery department
- Identify the most common microorganisms, as well as the frequency of multi-resistant bacteria, especially given the great lack of these data in our country .
- Compare our own results with those from international, or regional databases, and establish a systematic prevention strategy within the surgery department .

COMPETING INTERESTS:

- The authors declare that they have no competing interest .

AUTHOR'S CONTRIBUTIONS:

Salma Amrani Idrissi , Khaled Rabbani and Sorra Nabila conceived of the presented idea.
Salma Amrani Idrissi developed the theory and performed the computations.
Soumia Nachate and Mohammed oujidi verified the analytical methods.
Mohammed Amine Bicane encouraged Salma Amrani Idrissi ti investigate and supervised the findings of this work.
All authors discussed the results and contributed to the final manuscript.

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Figure 1: Characterization of various bacterial isolates obtained from patients with surgical site infections. E-Coli was the most frequently isolated organism with 36%, followed by Staphylococcus aureus 18% Enterococcus faecalis 14% and pseudomonas aeruginosa 11%.

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Table 1: Surgical site infection's incidence rate by type of intervention

Procedure	Total Procedure	SSI		Deep incisional Or orange Space(%)
		NO	%	
Colon and rectal Surgery	130	14	10.76%	21%
Small intestine surgery	46	3	6.50%	100%
Appendicetomy	167	10	5.90%	10%
Liver surgery	44	2	4.50%	50%
Gastro duodenal system surgery	79	3	3.80%	33%
Cholecystectomy	139	5	3.50%	20%
Inguinal or crural hernia	131	2	1.50%	100%
Total	736	39	5.29%	30.76%

Table 2: Incidence of Surgical Site Infections According to the NNIS Risk Index : National and international Comparison

SSI in % according to the NNIS index	France					Algeria [24]	Morocco		
	CCLIN Paris-nord [25]	CCLIN Sud-ouest [21]	CCLIN Est [20]	Desjeux [23]	Astagneau and al [22]		Laatabi and al [13]	Chadli and al [12]	Our study
0	0.6%	0.7%	0.9%	2.7%	2.7%	0%	3.4%	2.7%	2.7%
1	1.7%	2.0%	2.7%	5.29%	6.6%	4.1%	4.6%	7.7%	5.29%
2	5.2%	6.0%	6.9%	12%	13.8%	11.8%	12%	10%	12%
3	13.5%	11.8%	11.1%	12%	29%	11.8%			

Table 3: Impact of SSI by type of intervention: international and national comparison

<table>
<tr><th>SSI rate according to the type of intervention</th><th>ISO Raisin 2015 [7]</th><th>CCLIN Paris-nord [25]</th><th>CCLIN Sud-est [21]</th><th>CCLIN Est [20]</th><th>Astagneau And al [22]</th><th>Amri and al [19]</th><th>Chadli And al [12]</th><th>Laatabi And al [13]</th><th>Our Study</th></tr>
<tr><td>Colon and rectal surgery</td><td>6.82%</td><td>8.2 %</td><td>9.9 %</td><td>15.5%</td><td>12.5 %</td><td rowspan="2">24 %</td><td>14.2 %</td><td>12 %</td><td>10.76%</td></tr>
<tr><td>Small intestine surgery</td><td>---</td><td>9.4 %</td><td>11.4%</td><td>8.7 %</td><td>9.5 %</td><td>10 %</td><td>9.5 %</td><td>6.5 %</td></tr>
<tr><td>Appendicectomy</td><td>2.03%</td><td>3.6 %</td><td>4.3 %</td><td>5.8 %</td><td>8.9 %</td><td>18 %</td><td>8.5 %</td><td>5.4 %</td><td>5.9 %</td></tr>
<tr><td>Liver surgery</td><td>---</td><td>4.4 %</td><td>9.2 %</td><td>0%</td><td>7.6 %</td><td rowspan="2">9.7%</td><td>5.5 %</td><td>5.5 %</td><td>4.5 %</td></tr>
<tr><td>Cholecystectomy</td><td>0.92%</td><td>0.8 %</td><td>0.8 %</td><td>0.9 %</td><td>2.3 %</td><td>4.8 %</td><td>3.7 %</td><td>3.5 %</td></tr>
<tr><td>Gastroduodenal system surgery</td><td>-----</td><td>3.6%</td><td>4.3%</td><td>5.8%</td><td>8.9%</td><td>18%</td><td>3.8%</td><td>6.25%</td><td>3.8%</td></tr>
<tr><td>Inguinal or crural hernia</td><td>0.82%</td><td>1.9%</td><td>0.5%</td><td>0.9%</td><td>2.5%</td><td>3.6%</td><td>1.2%</td><td>2.7%</td><td>1.5%</td></tr>
</table>

Figures:

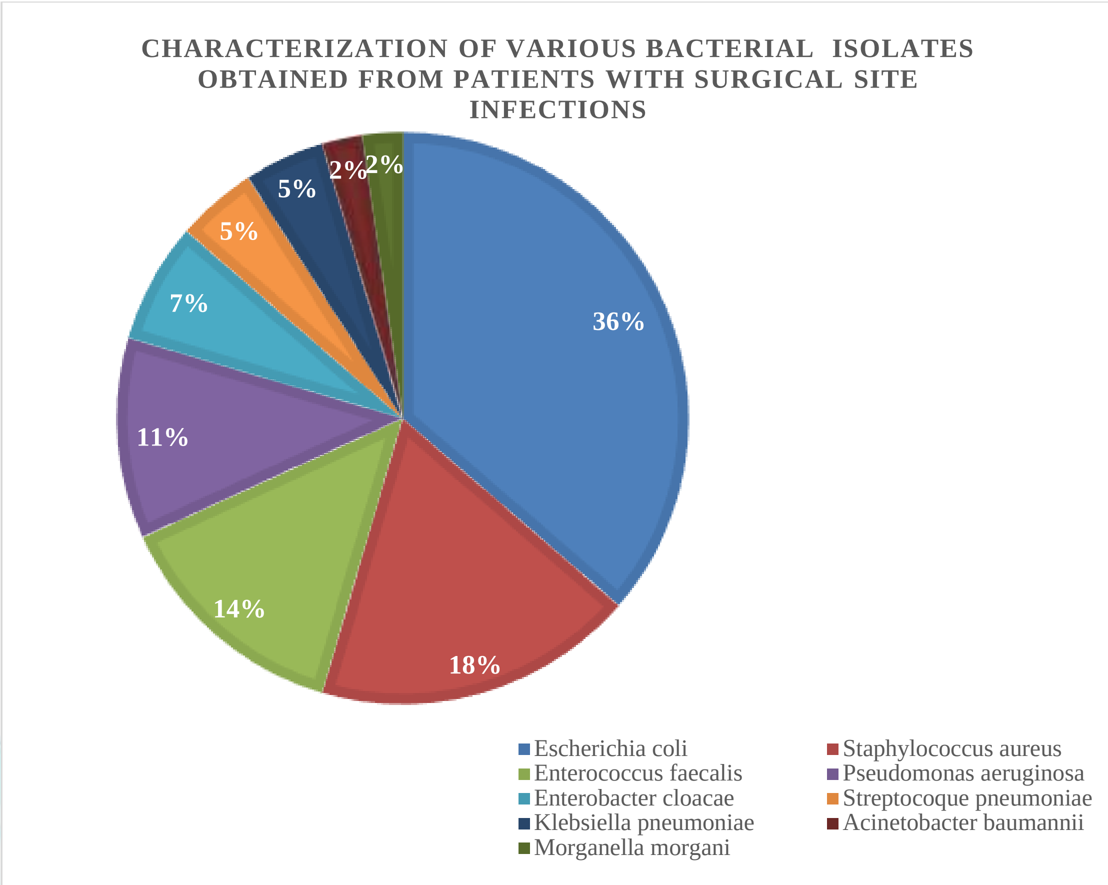

Figure 1 : Characterization of various bacterial isolates obtained from patients with surgical site infections. Esherichia Coli was the most frequently isolated organism with 36%, followed by *Staphylococcus aureus* 18% *Entrerococcus faecalis* 14% and *Pseudomonas aeruginosa* 11%.