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Surgical Site Infections at CHNU of Fann: Bacteriological Characterization and Antibiotic Susceptibility Profiles of the Isolates

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Abstract

Introduction: Surgical site infections (SSIs) are a common and serious complication in hospital settings, particularly following complex procedures such as thoracic and cardiovascular surgery. **Methods:** We conducted a six-month retrospective study (January-June 2023) in the Bacteriology-Virology Laboratory of CHNU de Fann, including 75 patients who developed a surgical site infection. Suspected clinical specimens were collected and analyzed to identify the causative bacteria and their antimicrobial resistance profiles. **Results:** The prevalence of SSIs in our cohort was high (68%, 51/75 positive samples). The mean age of patients was 40.25 years (range: 4 - 83). SSIs were particularly frequent in thoracic and cardiovascular surgery. Enterobacterales were the most frequently isolated pathogens (33 cases), predominantly *Enterobacter* spp. (16 cases) and *Klebsiella pneumoniae* (8 cases); most were extended-spectrum *β*-lactamase (ESBL) producers (54.54%). Non-fermenting Gram-negative bacilli were mainly represented by *Pseudomonas* spp. (17 cases). Gram-positive cocci were primarily *Staphylococcus aureus* (6 cases), most of which were high-level penicillinase producers. These findings highlight the urgent need to revise empirical antibiotic protocols and to strengthen prevention strategies in response to the high prevalence of ESBL-producing Enterobacterales.

Keywords

Infection, Surgery, Bacteria, Resistance

1. Introduction

Surgical site infections (SSIs) include all infections occurring at the surgical site within 30 days after the procedure, or within one year if an implant or prosthesis was placed [1]. Their classification, based on the nature and anatomical depth of the infection, comprises three main categories: superficial incisional infections, involving the outer layers of the skin and subcutaneous tissues; deep incisional infections, affecting tissues located beneath the fascial layer [2]; and organ/space infections, involving organs or anatomical spaces other than the incision, opened or manipulated during surgery [2] [3].

SSIs represent a major public health challenge due to their frequency and their human and economic impact [4]. According to the World Health Organization (WHO), they account for approximately 15% of healthcare-associated infections worldwide, underscoring their prevalence and persistent burden on health systems [5]. The consequences extend beyond the individual level: nearly one in three patients requires rehospitalization, one in five needs reoperation, and the average hospital stay is prolonged by five to ten days [6].

These infections may constitute severe surgical complications, disrupting wound healing and postoperative recovery. They hinder cellular regeneration, compromise suture or implant stabilization, and delay patient recovery [7]. Economically, they generate substantial costs due to prolonged treatment, additional procedures required to drain abscesses or remove infected implants, and increased antibiotic use [8] [9]. They also affect patients' quality of life, causing pain and discomfort associated with wound suppuration [8].

In this context, we undertook this study with the primary objective of characterizing the bacteria responsible for SSIs and assessing their antibiotic susceptibility profiles.

2. Methodology

2.1. Study Setting and Period

This was a retrospective cross-sectional study conducted over a six-month period, from January 1 to June 30, 2023, in the Bacteriology-Virology Laboratory of CHNU de Fann (Dakar, Senegal). All operated patients who developed a surgical site infection more than 48 hours after surgery, and whose pus samples were received in the laboratory for bacteriological analysis, were included.

2.2. Procedures

Samples were collected either by syringe aspiration when the suppuration was abundant, or by swabbing when it was minimal, after cleansing the surgical site with sterile physiological saline.

The bacteriological examination began with a macroscopic assessment evaluating the appearance, consistency, color, and odor of the fluid. Microscopic examination consisted of Gram staining for each sample to determine bacterial morphology, staining affinity for crystal violet and fuchsin, and the grouping pattern of cocci. Gram stain results guided the subsequent bacteriological processing, particularly the choice of culture media.

Each sample was inoculated onto nutrient agar (MH), cooked blood agar (CBA), Chapman agar (for staphylococci), EMB agar (Eosin Methylene Blue, for Gram-negative bacilli), and an enrichment medium, thioglycolate broth (TB). These media were incubated at 37˚C for 18 to 24 hours, with cooked blood agar incubated in a CO_2-enriched atmosphere.

In cases of positive culture, identification of Gram-negative bacilli was performed using conventional mini-galleries, Api 20 E strips, or the automated VITEK 2 Compact system. For cocci, catalase production and hemolysis on blood agar were assessed, with identification completed using Pastorex Streptococcus, Pastorex Staphylococcus, or automated methods. An antibiotic susceptibility test, either conventional or automated, was performed for each isolate according to CA-SFM (Antibiogram Committee of the French Society for Microbiology) guidelines.

Demographic (age, sex, originating service) and bacteriological data were entered into Excel and analyzed using Epi Info version 3.5.4.

3. Results

3.1. Demographic Characteristics

During the six-month study period, from January 1 to June 30, 2023, a total of 75 samples were received, of which 51 tested positive, corresponding to a prevalence of 68% (**Figure 1**).

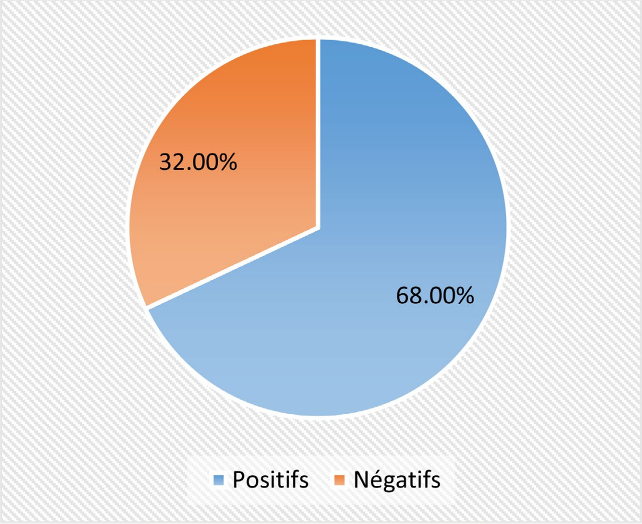

Figure 1. Prevalence of positive samples.

The mean age of patients was 40.25 years, ranging from 4 to 83 years. Age group analysis showed that suppurative infections were more frequent in patients over 60 years old (37.25%), whereas they were rare among children aged 0 - 10 years, with a rate of 1.96% (**Figure 2**).

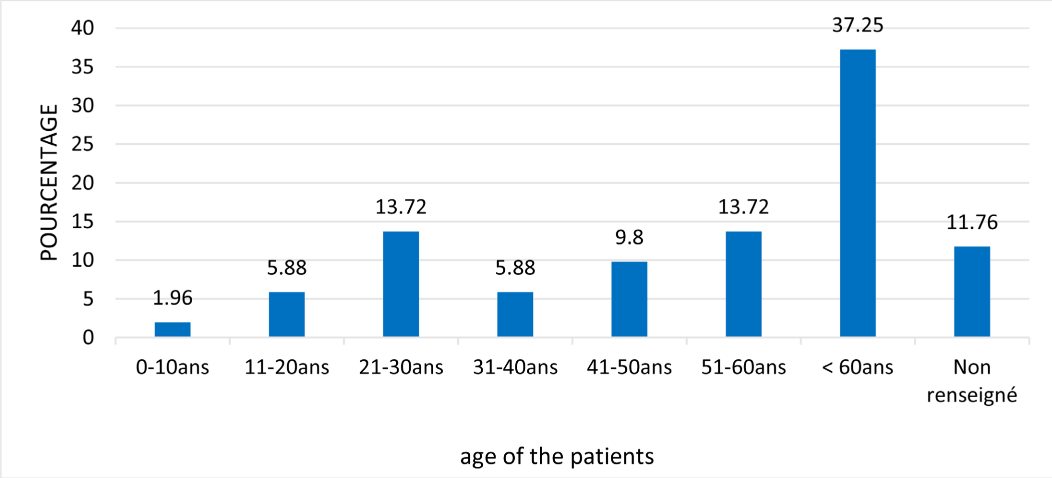

Figure 2. Distribution of patients according to the originating department.

3.2. Bacteriological Data

A total of 58 organisms were isolated from the 51 positive samples, including 7 samples that showed polymicrobial flora with two associated organisms. The bacteria identified belonged to four main families (Table 1). Among the isolated pathogens, the most frequently encountered were *Pseudomonas aeruginosa* (29.31%), followed by *Enterobacter* spp. (27.58%) and *Klebsiella pneumoniae* (13.79%) (Table 2). In the 7 polymicrobial cases, we identified 3 associations of *Pseudomonas* spp. with *Enterobacter* spp., 1 association of *Proteus mirabilis* with *Klebsiella pneumoniae*, 2 associations of *Escherichia coli* with *Staphylococcus aureus*, and 1 association of *Morganella morganii* with *Pseudomonas aeruginosa*.

Table 1. Distribution of isolated bacteria by family.

Family of bacteria	Number	Percentage (%)
Enterobacterales (fermenting)	33	56.9
Non-fermenting (Pseudomonadaceae)	17	29.31
Staphylococcaceae	7	12.07
Streptococcaceae	1	1.72

Table 2. Distribution of the different species.

	Bacterial species	Number	Percentage (%)
Enterobacterales (fermenting)	*Enterobacter* spp.	16	27.58
	Klebsiella pneumoniae	8	13.79
	Escherichia coli	3	5.17
	Citrobacter spp.	2	3.44
	Salmonella spp.	1	1.72
	Proteus mirabilis	1	1.72

Continued

	Klebsiella oxytoca	1	1.72
	Morganella morgani	1	1.72
Non-fermenting	*Pseudomonas*	17	29.31
Staphylococcaceae	*Staphylococcus aureus*	6	10.34
	Staphylococcus saprophytocus	1	1.72
Streptococcaceae	*Streptococcus* spp.	1	1.72

Enterobacterales:

In this study, four resistance profiles were identified, dominated by extended-spectrum β-lactamase (ESBL)-producing strains (54.54%) and those exhibiting high-level penicillinase production (27.27%) (Figure 3).

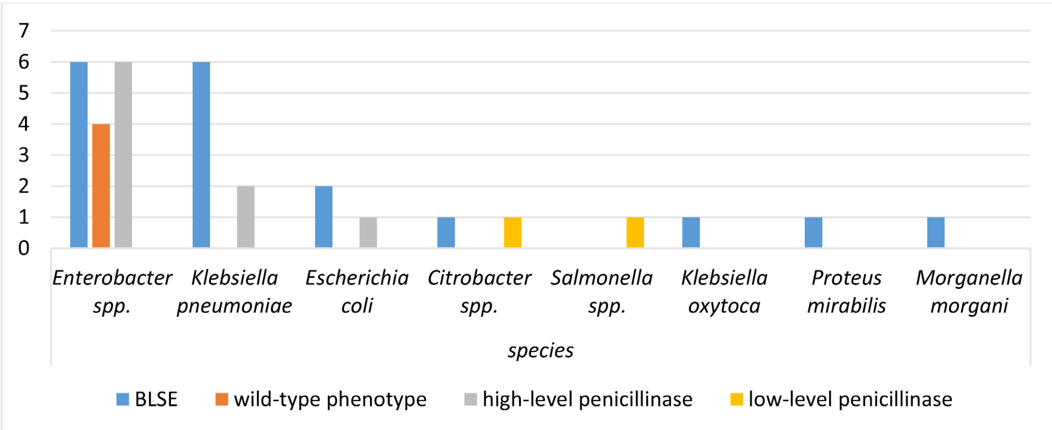

Figure 3. Antibiotic susceptibility profile of Enterobacterales.

Pseudomonas aeruginosa: Among the 17 isolates, two resistance profiles were identified. Most strains exhibited a wild-type phenotype (88.23%), while the remaining isolates were resistant to ceftazidime.

Staphylococcus aureus: Among the 7 isolates, 2 were resistant to β-lactams (MRSA), and 5 were high-level penicillinase producers.

4. Discussion

4.1. Socio-Demographic Analysis

In our study, the prevalence of SSIs was 68% (51 positive samples out of 75). This rate exceeds the results reported at the Hôpital Principal de Dakar in a visceral surgery department in 2009, where Ismail Hami documented a nosocomial infection rate of 10% [10]. Conversely, our results remain lower than those reported in India in 2020 by Batra Shivra *et al.*, who observed a positivity rate of 85.02% (1902 positive samples out of 2237 patients) [11]. They are also similar to findings from a study conducted at the Lumbini Medical College in Nepal, where 64.7% of the 400 samples analyzed were positive [12]. Overall, our positivity rate falls within the upper range of published values while remaining consistent with data in the literature.

It is important to note that SSI rates vary widely depending on the type of surgery, characteristics of the study population, surveillance methods (active vs. passive), and diagnostic criteria used. Recent systematic reviews emphasize the influence of sampling strategy—since only clinically suspected cases are usually sampled—leading to an overestimation of positivity rates.

The mean age in our study was 40.25 years (range: 4 - 83 years), comparable to findings from a Senegalese study reporting a mean age of 51 years [13]. However, Abdoulaye *et al.* reported a lower mean age (31.16 years) [14], while other studies show higher means, such as Fonkoue *et al.* with 44.4 years in a 2023 study on SSIs in orthopedic and trauma surgery in Yaoundé, Cameroon [15]. Conversely, a study in Burkina Faso in 2020 by Doutchi Mahamadou *et al.* reported a predominance among individuals aged 16 - 30 years (26.3%) [16].

These variations reflect differences in population characteristics, surgical contexts, and the fact that elderly patients often have more comorbidities, slower wound healing, and therefore a higher risk of surgical site infection.

Most patients in our study originated from the thoracic and cardiovascular surgery department, representing 58.82% of cases, followed by neurosurgery (15.09%) and ENT (9.8%). This distribution reflects the high risk associated with complex, lengthy, and invasive surgeries, particularly those involving fragile or comorbid patients such as diabetics. Recent evidence confirms that thoracic and cardiac surgeries remain among the highest-risk procedures. Seidelman *et al.* (2023) showed that cardiovascular interventions, especially those requiring implantable devices, have higher-than-average SSI rates [17]. Likewise, a 2022 review in *Infection Control* & *Hospital Epidemiology* highlighted that complex procedures (cardiac, spinal, neurosurgical) carry increased risk due to operative duration, postoperative intensive care, and patient-related factors (age, immunosuppression, chronic disease) [18].

In neurosurgery, several recent studies report notable SSI rates, partly due to device implantation (plates, shunts, prostheses) and the proximity to critical structures. A 2021 meta-analysis confirmed that postoperative neurosurgical infections are frequently caused by multidrug-resistant hospital pathogens [19]. In ENT surgery, although overall SSI rates are lower, contaminated procedures (oral cavity, pharynx, tumor surgery) remain high-risk, especially in polymicrobial contexts or among vulnerable patients.

Thus, the predominance of SSIs in thoracic and cardiovascular surgery in our series aligns with recent trends: highly technical, invasive, and high-risk procedures remain the most exposed [20]. This underscores the need for strengthened preventive measures—including targeted antibiotic prophylaxis, stringent aseptic control, structured postoperative surveillance, and risk-adapted strategies. Additionally, some patients initially operated in surgical departments were later transferred to medical units (neurology, pulmonology, geriatrics) for management of associated conditions or postoperative complications.

4.2. Bacteriological Analysis

In this study, we isolated 58 organisms from 51 pus samples. Among these, 86.2% (44 samples) were monomicrobial infections, whereas 13.8% (7 samples) had polymicrobial flora. Gram-negative bacilli were largely predominant (86.2% of isolates). Among them, 33 Enterobacterales (56.9% of total isolates) were identified, with *Enterobacter* spp. being the most common, followed by *Klebsiella pneumoniae*. Several contemporary studies, particularly in surgical settings of low-resource countries, confirm this trend: Enterobacterales are among the most frequent agents of postoperative infections [15] [21] [22].

Pseudomonas spp. (notably *Pseudomonas aeruginosa*) were also well represented, consistent with findings from Sub-Saharan Africa where *P. aeruginosa* accounts for a significant proportion of SSIs [23]. The prominence of *P. aeruginosa* may be attributed to its nosocomial nature, ability to survive in moist environments (operating rooms, medical devices), and occasional inadequacies in disinfection/sterilization practices.

Other studies differ, reporting *Escherichia coli* as the most prevalent species, such as Niangaly El-hadj Laya (2023) and Hodonou *et al.* (2016) [24] [25]. These variations reflect geographical and contextual differences in SSI microbiology, influenced by local antibiotic prophylaxis practices, hospital hygiene, type of surgical wounds, and environmental microbial load. In specialized centers, for instance spinal surgery units, a recent study in France showed that early SSIs were monomicrobial in nearly 59% of cases, with a high proportion of Enterobacterales and *Pseudomonas*, whereas polymicrobial infections contained Enterobacterales in over 70% of samples [26].

The predominance of ESBL-producing Enterobacterales (54.5%) in our study aligns with recent findings showing that ESBLs represent a growing proportion of SSI pathogens, complicating empirical therapy. High ESBL rates necessitate increased use of carbapenems or β-lactam/β-lactamase inhibitor combinations, thereby raising the risk of subsequent carbapenemase emergence.

Most *Pseudomonas aeruginosa* isolates displayed a wild-type phenotype (more active therapeutic options available), but even the minority of resistant strains is concerning due to the species' remarkable ability to rapidly acquire resistance mechanisms.

Regarding *Staphylococcus aureus*, an Ethiopian study (2019-2023) found a 17.9% prevalence of MRSA among clinical isolates, highlighting its persistent significance in hospital environments, particularly surgical wards [27]. Similarly, surveillance in Taiwan region (2022-2024) reported annual MRSA rates between 42% and 49% [28]. In addition, numerous works demonstrate that penicillinase production remains a widespread mechanism of resistance, even in settings where methicillin resistance is also present [29].

5. Conclusion

Surgical site infections remain frequent and concerning, particularly in complex procedures such as thoracic and cardiovascular surgery. The high prevalence of ESBL-producing Enterobacterales underscores the need for targeted microbiological surveillance and strict preventive measures. These findings call for optimization of antibiotic prophylaxis, strengthened infection-control practices, and heightened vigilance among healthcare personnel to reduce the morbidity and mortality associated with SSIs.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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