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Surgical Site Infections at the General Referral Hospital of Niamey, Niger

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Abstract

Introduction: Surgical site infections (SSIs) are a significant cause of morbidity, driven by surgical practices and the increasing prevalence of antimicrobial-resistant pathogens. This study aimed to estimate the prevalence of SSIs at the General Referral Hospital of Niamey in 2023, characterize the affected patients, and analyze the isolated pathogens and their antimicrobial resistance profiles.

Methods: A retrospective descriptive study was conducted on 1,625 medical records from digestive surgery, trauma orthopedics, neurosurgery, and intensive care units in 2023. SSI cases were identified using the national clinical criteria, and microbiological data were extracted from laboratory reports. Data were extracted from registers, medical records, nursing care files, and laboratory databases. Data validation and reliability assurance were performed through double data entry, completeness and consistency checks, and data collector training.

Results: The SSI prevalence was 1.7% (28 cases), predominantly in trauma orthopedics and neurosurgery (36%). Among the 26 isolates, gram-negative bacilli represented 69%, mainly Escherichia coli (27%) and Pseudomonas spp. (15%). Gram-positive cocci accounted for 31% of cases, with Staphylococcus aureus (27%). Antimicrobial susceptibility testing (24 isolates) showed high resistance to third-generation cephalosporins (40–80%), presence of ESBL-producing Enterobacterales, and one MRSA isolate. Carbapenems remained highly effective (>90%), whereas fluoroquinolones exhibited moderate activity (40–60%).

Conclusion: The predominance of multidrug-resistant gram-negative bacteria underscores the need to strengthen infection prevention and control measures, optimize antibiotic prophylaxis, and enhance microbiological surveillance within surgical units.

Keywords: Surgical site infections, prevalence, Staphylococcus aureus, Escherichia coli, antimicrobial resistance.

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Introduction

Surgical site infections (SSIs) are defined by clinical criteria, such as the presence of purulent discharge at the wound or drain insertion site or the development of extensive cellulitis originating from the wound.[1] SSIs are classified into three categories: superficial incisional infections, affecting the skin and subcutaneous tissue; deep incisional infections, involving muscles and fascia; and organ/space infections, which affect internal organs or body cavities.[2,3] Contamination may occur during surgery from exogenous sources (equipment, air, healthcare staff) or endogenous sources (the patient's own flora).[4,5]

The pathogens responsible for SSIs vary according to the type and location of the procedure and the antibiotics used.[3] These infections are a major cause of morbidity and mortality worldwide, particularly in developing countries and sub-Saharan Africa. Incidence rates reported in hospitals across the region range from 6.8% to 26%.[6–8] Economic and social constraints further hinder prevention efforts.[9,10]

SSIs represent approximately 11% of nosocomial infections and affect 3–7% of surgical patients, with a median onset of approximately ten days post-operation.[11] Their impact extends beyond patient health to hospital operations and public healthcare costs: one in three patients with an SSI is readmitted, one in five requires reoperation, and hospital stays are prolonged by five to ten days.[2] Rigorous epidemiological surveillance is essential to reduce these infections.[2,12–14] Despite this, prevention remains inadequate due to a low perception of severity among healthcare workers. Hospital staff often underestimate the problem and do not feel responsible for nosocomial infections.[15] This study, conducted at the General Referral Hospital of Niamey in 2023, aimed to identify SSI cases in the departments of digestive surgery, trauma-orthopedics, neurosurgery, and intensive care; describe the characteristics of operated patients; assess SSI prevalence and distribution across departments; and identify the causative pathogens and their antimicrobial susceptibility profiles.

Methods

Type and setting of the study

This retrospective, cross-sectional descriptive analysis was based on the medical records of patients hospitalized between January 1 and December 31, 2023, at the General Referral Hospital (GRH) of Niamey. Data collection was conducted over a three-month period (March 1 to May 30, 2024) in four hospital departments.

Study population

The study population consisted of all patients admitted in 2023 to the following departments:

- Digestive Surgery
- Trauma-Orthopedics
- Neurosurgery
- Intensive Care Unit (ICU)

These departments were purposively selected because of the higher risk of surgical site infections (SSIs), as documented in previous studies.

Inclusion Criteria

- Patients hospitalized in the selected departments during the study period.
- Medical records containing sufficient clinical and/or biological information to confirm or rule out SSI diagnosis.

Exclusion Criteria:

Records with incomplete or missing data on surgical procedures or infection indicators

Sampling

- Patient Selection: An exhaustive sampling approach was applied, including all 1,625 medical records from the four departments in 2023.
- Department Selection: Purposive sampling was used to select departments with high SSI prevalence and severe complications

Data collection techniques and tools

Data were extracted using a document review method from the following sources:

- Hospitalization registers
- Patient medical records
- Nursing care files
- Laboratory database

A standardized data collection form was developed to ensure uniformity and completeness of the data. The form captured:

- Demographic data
- Clinical and surgical details
- SSI occurrence and characteristics
- Microbiological results and antimicrobial susceptibility

Case definition

SSI cases were classified according to the Burkina Faso Ministry of Health Surveillance Guide (2019) as follows:

- Presence of purulent discharge, abscess, or cellulitis within 30 days post-operation (or 3 months if prosthesis implanted), OR
- Clinical signs of infection (fever >38°C, pain, redness, heat, and tenderness) plus intentional wound reopening by a healthcare professional.

Quality assurance and data validation

To ensure data reliability:

- Double Data Entry: Two independent reviewers extracted the data, and discrepancies were resolved through consensus.
- Completeness Check: Records were screened for missing key variables (e.g., surgery date and infection indicators).
- Consistency Check: Cross-verification between medical records and laboratory reports.
- Training: Data collectors received prior training on SSI definitions and data abstraction procedures.

Ethical Considerations

The hospital administration approved this study. Patient confidentiality was maintained by anonymizing the identifiers in all datasets and reports.

Results

Sociodemographic characteristics

The study analyzed 1,625 medical records of patients hospitalized in 2023, with a sex ratio of 1.1, indicating a slight male predominance in the study population. The mean age was 48 years (range, 9–83 years), reflecting a predominantly adult population but also including pediatric and elderly patients. Additionally, 93% of the patients had received formal education, suggesting a generally high literacy level within the sample.

Prevalence of surgical site infections and departmental distribution

Among the 1,625 medical records reviewed, 28 confirmed cases of surgical site infection (SSIs) were identified, corresponding to a prevalence of 1.7%. The most common clinical manifestation was purulent discharge, observed in 82% of cases (n = 23), followed by operative abscesses in 14% (n = 4) and intentional wound opening in 4% (n = 1).

In terms of departmental distribution, SSIs were most frequent in neurosurgery and trauma orthopedics, with 10 cases (36%), followed by digestive surgery, with 7 cases (24%), and intensive care, with 1 case (4%).

Causative pathogens

Of the 28 SSI cases, 23 underwent biological sampling, yielding 26 bacterial isolates.

- Most frequent pathogens:
  - *Staphylococcus aureus*: 27%
  - *Escherichia coli*: 27%

Gram-negative bacilli accounted for 69% of isolates, indicating their predominance (Table 1)

Antimicrobial sensitivity of responsible germs

Of the 26 identified pathogens, 24 underwent antimicrobial susceptibility testing.

Resistance patterns varied widely, with gram-negative bacilli showing higher resistance to beta-lactams, whereas Staphylococcus aureus remained sensitive to vancomycin and clindamycin.

Relationship between pathogens, surgical procedures, and patient characteristics

- Digestive Surgery: Mostly *E. coli* and other Enterobacteriaceae (endogenous contamination).
- Neurosurgery and Orthopedics: Predominantly *Staphylococcus aureus* (skin flora).

- ICU: *Pseudomonas aeruginosa* linked to prolonged hospitalization.
- Older patients (≥60 years): Higher risk of gram-negative infections.
- Extended hospital stay (>14 days): Associated with multidrug-resistant organisms.

Table 1: Distribution of isolated pathogens by bacterial family

Family	Pathogen	Frequency	Percentage
Gram-negative bacilli	*Escherichia coli*	7	38%
	Pseudomonas aeruginosa	3	16%
	Pseudomonas spp.	2	10%
	Citrobacter koseri	1	6%
	Citrobacter freundii	1	6%
	Klebsiella pneumoniae	1	6%
	Proteus mirabilis	1	6%
	Providencia sp.	1	6%
Subtotal		18	100%
Gram-positive cocci	*Staphylococcus aureus*	7	88%
	Streptococcus spp.	1	12%
Subtotal		8	100%
Grand Total		26	100%

Table 2: Distribution of isolated pathogens according to antimicrobial resistance

Antibiotique	Staphylocoque aureus N=7		Escherichia Coli N=7		Pseudomonas aeruginosa/SPP N=4		Citrobacter freundii/ koseri N=2		Proteus mirabilis N=1	Klebsiella pneumonia N=1
Pename										
Pénicilline G	100									
Amoxicilline + Acide clavulanique			50	50	0	100			100	
Ticacilline + Acide clavulanique	100		60	40		100	50	50	100	100
Pipéracilline+Tazobactam			100			100	100			100
Monobactam										
Aztreonam			100		100	100	100		100	100
Cephalosporin										
Ceftazidine			75	25		100	100			
Céfixime			20	80		100	100		100	
Cefotaxime	100		100							100
Ceftriaxone			40	60			100			100
Carbapenem										
Imipénème	10		100		100		100		100	100
Méropénème			100		50	50	100		100	100
Ertapeneme									100	
Aminoside										
Gentamycine	70	30	100			100	100		100	
Amikacine	50	50	100				100			100
Tobramycine	50	50	100		70	30				
Quinolone										
Plefloxine		100								
Lévofloxacine	50	50	60	40		100	0,5	0,5	100	100
Ciprofloxacine		100	60	40		100	50	50	100	
Norfloxacine	60	40							100	
Glycopepetide										
Vancomycine	100									
Tetracyline										
Tetracyline	100								100	
Phosphonic acids										
Fosfomycine			50	50			100			
Nitrofurane										
Nitrofurantoine	100									
Doxycycline	100									
Macrolide										
Erythromycine	70	30					100			
Lincosamide										
Clindamycine	100									
Sulfamide										
Sulfamethoxazole - Triméthoprime	100									

Discussion

Characteristics of the study population

The trauma and orthopedics department accounted for the largest proportion of hospitalizations (38%), primarily due to bone fractures that required invasive procedures. Hospital stays were frequently prolonged, with more than half of the patients hospitalized for over two weeks and some exceeding one month. Extended hospitalization increases exposure to hospital-acquired pathogens, thereby elevating the risk of healthcare-associated infections (HAIs) and indicating the presence of complications, such as surgical site infection. The overall mortality rate was 6%, rising to 11% among patients with SSI. However, two-thirds of the patients were discharged in improved condition, often requiring outpatient follow-up. This lack of post-discharge surveillance represents a major limitation, as SSIs developing after discharge likely went undetected, leading to underestimation of prevalence.[16,17]

Prevalence and distribution of SSIs

The SSI prevalence of 1.7% observed in this study is lower than the rates reported in other African studies, which range from 6.8% to 26%.[1,6] For example, one study reported 7.81%, while Niamey's national hospital recorded 2.47% in 2018.[1] These discrepancies may stem from information bias due to incomplete medical records and surveillance bias from the absence of active post-discharge monitoring in our setting. Previous research confirms that many SSIs are diagnosed after discharge, escaping passive surveillance.[16,17] Trauma-orthopedics accounted for the highest SSI burden (10 cases), which is clinically significant given the functional and economic consequences of SSIs in orthopedic surgery, often requiring reoperations or causing permanent disability.[16,18]

Isolated pathogens and microbiological profile

Cultures from 23 SSI cases yielded 26 isolates, predominantly *Staphylococcus aureus* and *Escherichia coli* (each 27%). This pattern mirrors findings from regional studies, such as one in Togo reporting *S. aureus* in 50% of cases and *E. coli* in 23.3%, and another in Burkina Faso where *E. coli* predominated (30%) followed by *S. aureus* (16.5%).[19,20] The predominance of Gram-negative enterobacteria in digestive surgery cases points to endogenous contamination, while Gram-positive cocci in neurosurgery and orthopedics reflect skin flora involvement. These findings suggest possible lapses in aseptic practices, such as inadequate hand hygiene or the sterilization of reusable instruments.

Antimicrobial resistance: a critical concern

The detection of ESBL-producing enterobacteria and methicillin-resistant *Staphylococcus aureus* (MRSA) underscores a serious antimicrobial resistance (AMR) challenge. These findings align with global trends linking AMR to irrational antibiotic use and insufficient infection control measures.[16] Resistance to beta-lactams and fluoroquinolones among gram-negative isolates, combined with MRSA presence, threatens treatment efficacy and patient safety.

Conclusion

This study demonstrates the substantial burden of surgical site infections at the General Referral Hospital of Niamey, with *Staphylococcus aureus* and *Escherichia coli* identified as the predominant causative pathogens. These findings highlight the urgent need to strengthen infection prevention and control measures in healthcare settings. Hospitals should prioritize staff training in aseptic techniques and rational use of antibiotics, enhance infrastructure for sterilization and hygiene, and implement active surveillance systems to monitor surgical site infections both during hospitalization and after discharge. Additionally, conducting longitudinal follow-up studies of patients after discharge would provide more comprehensive data on SSI trends and the effectiveness of interventions, thereby supporting evidence-based strategies to reduce morbidity, mortality, and healthcare costs

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