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Epidemiology of surgical site infections in a large tertiary hospital in Southern Brazil

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ABSTRACT. To analyze the epidemiological profile of Surgical Site Infections (SSIs) in a large tertiary hospital in Southern Brazil. This is a cross-sectional, prospective, analytical, and quantitative epidemiological study conducted in the surgical center of a tertiary hospital affiliated with the Brazilian Unified Health System (*Sistema Único de Saúde*, SUS). A total of 283 patients undergoing elective surgical procedures between September and November 2022 were included. Data were collected on the day of surgery and subsequently through telephone follow-up. The surgical site infection rate was 22.30%. [ASA] II score, duration of surgical hand antisepsis, and preoperative bathing were identified as significant risk factors for the development of SSIs. The main factors associated with the development of SSIs in this teaching institution are related to improvements in preoperative care and the practices of the multidisciplinary surgical team.

Keywords: Surgical wound infection; analytical epidemiology; perioperative care.

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Introduction

Surgical site infections (SSIs) remain a major concern despite scientific advances. Among health care-associated infections (HCAIs), SSIs are the third most prevalent in Brazil, with epidemiological data indicating rates ranging from 14% to 16% among hospitalized patients, according to the Brazilian Health Regulatory Agency (*Agência Nacional de Vigilância Sanitária* [ANVISA], 2017; Brasil, 2017)

Evidence-based nursing practices and prophylactic measures to control surgical site infections (SSIs) are among the core competencies of perioperative nursing (Dos Santos et al., 2022). The multidisciplinary team plays a crucial role in reducing SSI rates, as emphasized by the World Health Organization (WHO) in its Global Patient Safety Challenge on Surgical Safety. This initiative identifies SSIs as one of 10 essential objectives for safe surgery (Basei et al., 2022). Risk factors are well recognized, and preventing them is directly associated with reducing one of the most significant adverse events in the surgical setting (Da Câmara et al., 2022).

SSIs are characterized as infections resulting from surgical procedures, with or without the insertion of implants, regardless of their complexity. They can be classified according to the depth of tissue involvement: i) superficial incisional SSI, affecting only the skin and subcutaneous tissue; ii) deep incisional SSI, involving fascia and/or muscle; and iii) organ/space SSI, which extends to internal organs or body cavities (Boaventura et al., 2020).

SSIs are a public health concern that pose serious risks to patient safety and increase the cost of providing high-quality care. The impact of SSIs is reflected in increased mortality, hospital expenses, human suffering, and a reduced quality of life for patients and their families (Perez, 2023).

In Brazil, SSI rates are comparable to those reported in several other countries. In response, the WHO has established global guidelines for preventing SSIs. These guidelines aim to standardize care through evidence-based practices and continuous improvement. The primary goal of such efforts is to provide safe, high-quality perioperative care (Organização Mundial da Saúde [OMS], 2018).

Postoperative wound monitoring is essential after hospital discharge because signs and symptoms suggestive of SSIs may appear up to 30 days later — or up to 1 year in cases involving implants (Almeida et al., 2023). Despite the existence of specific prevention protocols, SSIs continue to be a major challenge in hospital settings. SSIs are considered detrimental to health care institutions because they prolong hospital stays, increase costs, cause overcrowding, and raise the need for additional procedures and antimicrobial use. In the worst cases, SSIs lead to the death of surgical patients (Pires et al., 2021).

The magnitude of the consequences associated with SSIs justifies addressing this issue. SSIs affect not only patients, but also their families and the health care system. This is particularly evident in active postdischarge surveillance of surgical recovery and the influence of surgical and hospital experiences on the family environment. Furthermore, studies that aim to identify the epidemiological characteristics of SSIs are crucial for assessing their impact. Such investigations help monitor changes in disease patterns, shifts in the occurrence of etiologic agents, and the development of targeted strategies to reduce risk.

Accordingly, this study aims to analyze the epidemiology of SSIs in a large tertiary hospital in Southern Brazil.

Material and methods

This is a prospective, quantitative epidemiological study conducted in the surgical center affiliated with a tertiary-level hospital in Southern Brazil and the Brazilian Unified Health System (*Sistema Único de Saúde*, SUS). The hospital is a referral center for trauma, orthopedics, emergency and urgent care, organ procurement, and video-assisted surgery. The surgical center has seven operating rooms that function 24 h a day and perform an average of 650 surgical procedures per month.

A convenience sample was composed of 283 patients who underwent elective surgical procedures between September and November 2022. Inclusion criteria were age over 18 years; full orientation to person, time, and place; undergoing elective surgery; and having access to a personal or close contact's telephone (landline or mobile). Exclusion criteria included death following surgery; undergoing more than one surgical procedure and/or reoperation; having any preexisting systemic infection; and cases in which at least three attempts at telephone contact were unsuccessful.

Researchers developed a structured instrument to collect data, which consisted of two sections: the first section included in-person preoperative information, such as length of hospital stay, laboratory tests, comorbidities, and medications; the second section comprised postoperative information obtained via telephone, such as wound healing characteristics, pain, recovery, and signs and symptoms of SSI.

Sampling involved approaching patients who were the first to be admitted to the surgical center during the morning and afternoon shifts. The number of participants per day was determined based on the patient flow during two time intervals: 7:00–9:00 a.m. and 1:00–3:00 p.m. First, the researcher approached each patient and explained the objective of the study and the data collection process. After obtaining consent and a signed informed consent form, the researcher conducted an interview to gather health history and socioeconomic data. Clinical data were supplemented with information from the patients' medical records. After 30 days following the surgical procedure, the patient was contacted by telephone to collect information regarding postoperative recovery and the development of an SSI.

The theoretical framework adopted for SSIs was based on guidelines from the Centers for Disease Control and Prevention (2024) and ANVISA. The primary outcome was the development of an SSI. An SSI was diagnosed when at least one sign or symptom was present. Prevention protocols for SSIs include strategies for the preoperative, intraoperative, and postoperative periods.

The independent variables included sociodemographic characteristics, such as sex, ethnicity, and region of origin; and whether the patient had been hospitalized at another facility prior to being admitted for surgery. We also considered clinical and surgical characteristics, including comorbidities, laboratory tests, surgical classification and complexity, type of anesthesia, medication use, and history of previous infections. The dependent variable was the development of an SSI. Data were entered, standardized, and analyzed using IBM SPSS Statistics for Windows, version 2.0 (IBM Corp., Armonk, N.Y., USA).

To analyze signs and symptoms, proportion equality tests were applied to compare the frequency of individual signs and to determine which were most common, providing a 95% CI (with a significance level of 0.05) for these frequencies. Additionally, the total number of signs and symptoms per patient was calculated, as well as the frequency distribution for each count. An infection outcome was defined as the presence of at least one sign of infection.

The Mann-Whitney test was applied to numerical variables (e.g., age) and ordinal categorical variables (including length of hospital stay, American Society of Anesthesiologists [ASA] classification, and surgical complexity) in order to identify potential risk factors for infection. These tests were used to compare differences between patients who developed infections and those who did not. For nominal categorical variables (such as handwashing duration by health professionals), chi-square and Fisher's exact tests were used to assess the association between predictor variables and the infection outcome. Variables with a statistically significant association ($p < 0.05$) were then included in a logistic regression model, and results were reported as odds ratios (ORs).

This study was approved by the Research Ethics Committee of the institution where data collection was conducted, in accordance with Resolution No. 466/2012 of the Brazilian National Health Council. It was registered under CAAE 03477018.2.0000.5231 and received approval under Opinion No. 5.069.973, issued on October 28, 2021.

Results and discussion

The sample of 283 patients consisted of 54.8% male and 45.2% female participants, with ages ranging from 18 to 91 years. The mean age was 49.84 years, with a standard deviation of 17.69 years. The median age was 52 years, and the interquartile range was 28 years (Q1 = 36, Q3 = 64), indicating that the age distribution was symmetrical around the mean. Most surgeries were classified as potentially contaminated (50.18%), followed by clean surgeries (47.7%). Regarding surgical complexity, 49.47% of the procedures were classified as Grade I, and 38.87% as Grade II. Additionally, Table 1 presents the distribution of data related to the characteristics of the procedures and the detailed percentages of surgical site infection occurrence across each category.

Table 1. Data distribution and patient characteristics, n = 283.

Variable	n	% without infection	% with infection	p-value
Sex				
Male	155	24.52%	75.48%	0.390[a] (v = 0.06)
Female	128	19.53%	80.47%	
Preoperative hospital stay				
Up to 1 day	101	64.52%	57.55%	
1 day	15	4.84%	11.32%	
1 to 3 days	11	6.45%	6.6%	
More than 3 days	41	24.19%	24.53%	
Surgical specialty				
Oral and maxillofacial surgery	19	26.32%	73.68%	0.567[b]
Head and neck surgery	10	20%	80%	
Digestive system surgery	26	19.23%	80.77%	
Ophthalmic surgery	18	22.22%	77.78%	
Plastic surgery	3	66.67%	33.33%	
Thoracic surgery	5	0%	100%	
Vascular surgery	13	7.69%	92.31%	
Gynecology and obstetrics	13	30.77%	69.23%	
Neurosurgery	13	15.38%	84.62%	
Orthopedics	91	19.78%	80.22%	
Otolaryngology	17	17.65%	82.35%	
General surgery	2	0%	100%	
Urology	53	32.08%	67.92%	
Wound classification				
Clean	135	20%	80%	0.449[b]
Potentially contaminated	142	25.35%	74.65%	
Contaminated	1	0%	100%	
Infected	5	0%	100%	
Anesthesia				
General	107	16.82%	83.18%	0.117[a] (v = 0.1)
Regional	176	25.57%	74.43%	
ASA classification				
ASA I	208	47.62%	80.91%	< 0.001***[d] (r = 0.32)
ASA II	69	44.44%	18.64%	
ASA III	6	7.94%	0.45%	
Surgical complexity				
Grade I	140	52.38%	48.64%	0.361[d] (r = -0.05)
Grade II	110	41.27%	38.18%	
Grade III	22	4.76%	8.64%	
Grade IV	11	1.59%	4.55%	

Diabetes				
No	136	38.24%	61.76%	0.748[a] (v = 0.03)
Yes	33	33.33%	66.67%	
Smoking				
No	140	38.57%	61.43%	0.580[a] (v = 0.05)
Yes	29	31.03%	68.97%	
Obesity (BMI > 30 kg m^{-2}):				
No	112	41.96%	58.04%	1.000[a] (v=0)
Yes	34	41.18%	58.82%	
Blood transfusion				
No	153	37.25%	62.75%	1.000[a] (v = 0.01)
Yes	15	40%	60%	
History of infection				
No	75	49.33%	50.67%	0.715[a] (v = 0.04)
Yes	23	56.52%	43.48%	
Antibiotic use				
No	79	53.16%	46.84%	0.542[a] (v = 0.05)
Yes	19	42.11%	57.89%	
Preoperative bath				
Yes	264	19.7%	80.3%	< 0.001***[b]
No	19	57.89%	42.11%	
Handwashing duration (health professionals)				
40 to 60 seconds	55	56.36%	43.64%	< 0.001***[a] (v = 0.4)
More than 60 seconds	228	14.04%	85.96%	

When analyzing the ASA classification using the Mann-Whitney test, a statistically significant difference was found between patients who developed infections and those who did not (Mann-Whitney W = 9325.5, $p < 0.001$). Patients who developed infections had a significantly higher ASA score compared to those who did not. Specifically, patients classified as ASA II showed a significantly increased risk of infection (OR: 2.26; 95% CI: 1.11 to 4.55; $p = 0.023$). Patients classified as ASA III demonstrated a trend toward increased risk, although it was not statistically significant (OR: 6.97; 95% CI: 0.96 to 142; $p = 0.093$).

A significant association was found between preoperative bathing and infection. Patients who performed a preoperative bath developed fewer infections compared to those who did not (Fisher's exact test, $p < 0.001$***). Additionally, a significant association was observed between handwashing duration among health professionals and SSI rates ($\chi^2(1) = 43.46$, $p < 0.001$***). Professionals who washed their hands for more than 60 seconds were associated with fewer infection cases compared to those who washed for 40 to 60 seconds.

To support the statistical analysis, the signs and symptoms were grouped by the number of symptoms presented per patient (Table 2). The frequency of individual signs and symptoms was as follows: 77.74% of patients exhibited no signs or symptoms; 12.72% reported tenderness at the surgical site; 12.37% experienced pain at the surgical site; 11.66% had redness at the surgical site; 8.48% had swelling; 6.36% presented with yellow discharge; 4.95% had delayed healing at the suture site; 4.24% had warmth at the surgical site; 2.12% showed the presence of a mass or lump at the site; and 1.41% had a fever above 38°C. In other words, a patient could have developed only one of these symptoms, while another could have experienced all of them.

Table 2. Distribution of the number of symptoms per group, n = 283.

Number of Symptoms	n	%
None	220	77.74%
One symptom	18	6.36%
Two symptoms	18	6.36%
Three symptoms	7	2.47%
Four symptoms	8	2.83%
Five symptoms	4	1.41%
Six symptoms	4	1.41%
Seven symptoms	1	0.35%
Eight symptoms	3	1.06%

The overall rate of SSIs identified at the teaching institution was 22.30%.

Previous studies have identified several patient-related risk factors for the development of SSIs, including extremes of age, poor nutritional status, diabetes mellitus, smoking, obesity, altered immune response, prior infections, colonization by microorganisms, and length of preoperative hospital stay (Do Rêgo et al., 2023). However, in the present study, none of these factors demonstrated statistical significance. This lack of association may be attributed to the limited sample size, which was constrained by the research timeline.

The relevance of the ASA classification in this study was notable due to its correlation with infection rates, highlighting how certain risk factors align with chronic and/or acute comorbidities and lifestyle habits. ASA I includes healthy patients without chronic conditions or risk behaviors; ASA II includes patients with mild systemic diseases, which may or may not be related to the need for surgical intervention; ASA III includes individuals with severe systemic disease causing functional limitations but not incapacitation; ASA IV indicates the presence of severe systemic disease that is incapacitating; ASA V includes patients at imminent risk of death within 24 h without surgical intervention; ASA VI is assigned to brain-dead patients whose organs are being removed for donor purposes ([ASA], 2020; Horvath et al., 2021). In the current study, a higher incidence of SSIs was identified among patients with higher ASA scores, a finding consistent with previous research. Additionally, 80.91% of patients were classified as ASA I — a result attributable to the institutional patient profile.

Preoperative bathing showed a significant association with the development of SSIs in this study. Patients who performed preoperative bathing had lower infection rates compared to those who did not. Similar findings have been reported in integrative review studies conducted in São Paulo and Portugal, which demonstrated a direct association between proper skin preparation — particularly adequate preoperative bathing on the day of or the night before the procedure — and a reduced risk of SSI development (Ferreira et al., 2020; Araújo & Oliveira, 2023; Dos Santos et al., 2024).

Regarding hand hygiene duration among healthcare professionals, surgical teams that performed hand antisepsis for longer periods had lower SSI rates. A study conducted in Rio Grande do Sul identified key variables related to optimal handwashing duration and the reduction of microbial load among surgical staff. On average, the study concluded that the ideal time for surgical hand antisepsis ranges from 90 to 180 seconds. The combination of proper technique and adherence to the WHO recommended time significantly improves bacterial reduction compared to shorter durations, thereby lowering the risk of contamination at the surgical site (Peixoto et al., 2020).

This study reported an SSI rate of 22.30%, a significant figure that aligns with findings from other national studies conducted in institutions with similar profiles, which reported epidemiological SSI rates ranging from 18% to 20% (De Souza & Serrano, 2020; Gomes et al., 2019). Teaching hospitals have distinct characteristics that may inherently contribute to higher infection rates, as they combine standard multidisciplinary teams with the involvement of interns, residents, and undergraduate and graduate students who are still in the teaching–learning process.

Conclusion

In the teaching institution, the key factors associated with the development of SSIs were ASA classification, preoperative bathing, and the duration of handwashing by the surgical team. ANVISA also emphasizes these factors, which appear to be influenced by the specific patient profile served by the institution.

Among the limitations of the study, some widely recognized risk factors — including those highlighted by the CDC — did not show statistical significance in this analysis. These results highlight the importance of taking targeted actions to improve preoperative care and enhance the practices of the multidisciplinary surgical team.

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