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Original Article

Factors associated with hospital outcome in patients with Surgical Site Infection

Fatores associados ao desfecho hospitalar em pacientes com Infecção de Sítio Cirúrgico
Factores asociados con el resultado hospitalario en pacientes con infección del sitio quirúrgico

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ABSTRACT

Background and Objectives: surgical Site Infections (SSIs) represent a major challenge in the hospital setting and are among the most frequent complications of surgical procedures. This study aimed to investigate the factors associated with hospital outcomes in patients with SSIs at a public teaching hospital in Northeast Brazil. **Methods:** this was a cross-sectional analytical study. The study population comprised medical records of patients aged 18 years or older who developed SSIs between 2017 and 2023. Data were collected through reviews of both paper and electronic medical records. Descriptive and inferential data analyses were performed. **Results:** a total of 108 cases of surgical site infection were identified during the study period. The presence of oncological disease was associated with the outcome ($p = 0.050$), as were the surgical wound contamination potential ($p < 0.001$), the manifestation of signs and symptoms of infection during postoperative hospitalization ($p = 0.011$), the need for surgical reintervention ($p = 0.009$), sepsis ($p < 0.001$), and admission to the intensive care unit ($p < 0.001$). Preoperative length of hospital stay, total length of hospital stay, leukocyte counts, and the number of antibiotics used for treatment were also associated with the outcome. **Conclusion:** the results identified factors associated with hospital outcomes in patients with SSIs, highlighting the importance of understanding patient profiles in order to provide targeted care aimed at preventing complications.

Keywords: *Surgical Wound Infection. Hospital Care. Quality of Health Care.*

RESUMO

Justificativa e Objetivos: as Infecções do Sítio Cirúrgico (ISC) representam um importante desafio no âmbito hospitalar e estão entre as complicações mais frequentes de procedimentos cirúrgicos. Este estudo teve como objetivo investigar os fatores associados ao desfecho hospitalar em pacientes com ISC em um hospital público de ensino no Nordeste do Brasil. **Métodos:** trata-se de um estudo transversal analítico. A população compreendeu os prontuários dos pacientes, com idade igual ou superior a 18 anos, que desenvolveram ISC no período de 2017 a 2023. A coleta de dados foi realizada por meio de consultas aos prontuários físico e eletrônico. Foi realizada análise descritiva e inferencial dos dados. **Resultados:** foram identificados 108 casos de infecção de sítio cirúrgico no período descrito. A presença de doença oncológica apresentou associação com o desfecho ($p = 0,050$), assim como o potencial de contaminação da cirurgia ($p = <0,001$), a manifestação de sinais/sintomas de infecção durante a internação após a cirurgia ($p = 0,011$), a necessidade de reabordagem cirúrgica ($p = 0,009$), a sepse ($p = <0,001$) e a internação em unidade de terapia intensiva ($p = <0,001$). O tempo de internação pré-operatória, o tempo total de internação, os valores de leucócitos e o número de antibióticos utilizados para tratamento também estiveram associados ao desfecho. **Conclusão:** os resultados evidenciaram os fatores associados ao desfecho hospitalar em pacientes com ISC, sinalizando a importância de conhecer o perfil dos pacientes para traçar uma assistência direcionada à prevenção de complicações.

Descritores: *Infecção da Ferida Cirúrgica. Assistência Hospitalar. Qualidade da Assistência à Saúde.*

RESUMEN

Justificación y Objetivos: las infecciones del sitio quirúrgico (ISQ) representan un desafío significativo en el ámbito hospitalario y se encuentran entre las complicaciones más frecuentes de los procedimientos quirúrgicos. Este estudio tuvo como objetivo evaluar los factores asociados con los resultados hospitalarios en pacientes con ISQ en un hospital público escuela del Nordeste de Brasil. **Métodos:** este es un estudio transversal analítico. La investigación abarcó historias clínicas de pacientes mayores de 18 años que desarrollaron ISQ entre 2017 y 2023. La recolección de datos se realizó mediante consultas a historias clínicas físicas y electrónicas. Se realizó un análisis descriptivo e inferencial de los datos. **Resultados:** se identificaron 108 casos de infección del sitio quirúrgico durante el período descrito. La presencia de enfermedad oncológica se asoció con el resultado ($p = 0,050$), al igual que el potencial de contaminación quirúrgica ($p = <0,001$), la manifestación de signos/síntomas de infección durante la hospitalización después de la cirugía ($p = 0,011$), la necesidad de reintervención quirúrgica ($p = 0,009$), sepsis ($p = <0,001$) e ingreso a la unidad de cuidados intensivos ($p = <0,001$). La duración de la estancia preoperatoria, la duración total de la estancia, los recuentos de leucocitos y el número de antibióticos utilizados para el tratamiento también se asociaron con el resultado. **Conclusión:** los resultados destacaron los factores asociados con los resultados hospitalarios en pacientes con ISQ, lo que indica la importancia de conocer el perfil del paciente para diseñar la atención dirigida a prevenir complicaciones.

Palabras Clave: *Infección de la Herida Quirúrgica. Atención Hospitalaria. Calidad de la Atención de Salud.*

INTRODUCTION

Surgical Site Infections (SSI), associated with the surgical procedure, are classified based on the location and depth of infection involvement: superficial incisional SSI, deep incisional SSI, and organ/cavity SSI. These infections can occur up to 90 days after surgery if implants were placed, or within 30 days in procedures without implants.[1,2]

SSIs represent a significant challenge in the hospital environment, being among the most frequent complications of surgical procedures. SSIs are estimated to occur in 3% to 20% of surgical procedures performed, significantly impacting patient morbidity and mortality in addition to prolonging hospital stays and raising healthcare costs.[1]

According to the World Health Organization (WHO), SSIs are responsible for up to one-third of healthcare-associated infections in developing countries, highlighting the importance of using effective and targeted control strategies.[3]

Although data are limited in Brazil, SSIs occupy the third position among Health Care-Associated Infections (HAIs), with a prevalence of about 14% to 16% of hospitalized patients. The consequences include prolonged hospital stays, increased need for hospital readmissions and additional surgeries, as well as high costs, which can reach $1.6 billion annually.[2]

SSI occurrence is associated with several individual factors, including preexisting clinical conditions, individual aspects, and factors related to the surgical procedure and to the hospital environment itself. Sociodemographic characteristics such as gender, age, and comorbidities have been widely analyzed due to their potential impact on clinical outcome. Similarly, clinical aspects such as oncological disease, length of hospital stay, and signs of infection have been shown to be important predictors of adverse outcomes, including mortality.[4]

The potential for contamination from the surgery, the need for reoperation, and the occurrence of sepsis during hospitalization are crucial factors that directly influence hospital outcomes.[5] Previous studies indicate that deep or organ/cavity infections are more severe, inadequate or delayed management of these conditions can result in serious complications, such as the need for intensive care.[6] Despite progress in infection control practices and technological advances, the mortality rate associated with SSI remains high in several regions, especially in teaching hospitals with high complexity.[1]

Although the literature emphasizes the importance of investigating multiple factors associated with SSIs, gaps still persist in understanding how sociodemographic, clinical, and infection-related variables impact hospital outcomes, particularly in regional contexts and in overburdened health systems. Thus, it is essential to conduct studies that explore these associations in different scenarios and populations.[7]

This study investigated the factors associated with hospital outcome, defined as discharge or death, in patients with SSI treated at a public teaching hospital in the Northeast of Brazil. This study aims not only to contribute to the understanding of the main determinants of SAIs, but also to support the implementation of more effective control and prevention measures through the comprehensive analysis of these data, with a potential impact on reducing mortality and improving the quality of hospital care.

METHODS

This is a cross-sectional analytical study, conducted in a tertiary level public teaching hospital, located in the Northeast of Brazil, which serves several surgical specialties, such as: head and neck, digestive system, general surgery, pediatrics, plastic, mastology, neurosurgery, ophthalmology, vascular, coloproctology, gynecology, obstetrics, and urology. The Strengthening the Reporting of Observational Studies in Epidemiology (STROBE).

The study population comprised all the medical records of patients aged 18 years or older, who developed SSI after procedures performed in the general surgical center of the aforementioned hospital, from 2017 to 2023, totaling 108 cases, among 21,032 surgeries performed in this interval. The time frame was chosen based on the update of the diagnostic criteria for SSIs, which occurred in 2017, changing the observation period for deep and organ/cavity infections in implant surgeries.[1,2] The medical records of patients who underwent the surgical procedure in the general operating room of the institution and who developed infection and had a completed hospitalization outcome (death, discharge) were included. Duplicate records of infection involving the same surgical site were excluded

Data collection was conducted from September 2023 to April 2024 by the principal investigator and three undergraduate students. First, SSI cases were identified using the records of the Health Care-Associated Infection Control Service (SCIRAS) of the hospital. Next, the collection was conducted by consulting the physical medical records in the Medical Archive and Statistics Service (SAME – *Serviço de Arquivo Médico e Estatística*) and the electronic medical records via the SOUL MV system – Electronic Patient Record (PEP – *Prontuário Eletrônico do Paciente*) for the records from 2017 to 2020, and via the Management Application for University Hospitals (AGHU) for the years 2021 to 2023. The use of both electronic medical record systems was necessary due to the migration of the institutional system.

The qualitative parameters analyzed included sociodemographic and clinical data (year, gender, diabetes, hypertension, and oncological disease) and factors related to surgery, infection, and complications during hospitalization (potential for contamination of surgery, signs/symptoms of infection during hospitalization after surgery, readmission for treatment, classification of infection, reapproach, sepsis, and need for care in the Intensive Care Unit (ICU). The quantitative variables studied were age, preoperative hospitalization time, total hospitalization time, day of diagnosis/confirmation of infection, C-reactive protein (CRP) values, leukocyte count, and the number of different medications used for treatment.

Statistical analysis was performed using the GraphPadPrism software, version 2.3.28. The descriptive analysis included the calculation of absolute and relative frequencies, standard deviation and mean. For inferential analysis, Pearson's chi-square, Fisher's exact, Mann-Whitney's U, and T-test for independent samples were used for numerical and qualitative variables. The Shapiro-Wilk test was applied to verify data normality. A 95% confidence interval was adopted, and $p < 0.05$.

Therefore, for the dichotomous variables that showed a significant association, the Odds Ratio (OR) was verified, as well as the confidence interval, and the following interpretations were considered: OR > 1 – positive association indicating an increase in chance; OR = 1 – chance equality; OR < 1 – chance reduction.

This research was conducted in accordance with the ethical standards required by Resolutions 466/2012, 510/2016, and 580/2018, of the Ministry of Health, and was approved by the Research Ethics Committee (CEP), under opinion number 6.217.657 and registration CAAE 71184123.4.0000.5013 on August 3, 2023.

RESULTS

A total of 108 cases of surgical site infection were identified, from 2017 to 2023. The predominant outcome was hospital discharge (65.8%), whereas 34.2% died. There was a trend toward an association between oncological disease and death (p = 0.050), with a higher proportion of deaths among cancer patients compared to non-cancer patients (Table 1).

Table 1. Association of sociodemographic and clinical characteristics with hospital outcome among cases of surgical site infection. Northeast, Brazil, 2024.

Parameter	Hospital admission outcome		
	Discharge N (%)	Death N (%)	p-value
Sex			
Female	37 (34.3)	22 (20.4)	0.467
Male	34 (31.5)	15 (13.9)	
Diabetes			
Yes	19 (17.6)	10 (9.3)	0.976*
No	52 (48.1)	27 (25.0)	
Hypertension			
Yes	32 (29.6)	20 (18.5)	0.375
No	39 (36.1)	17 (15.7)	
Oncologic disease			
Yes	30 (27.8)	23 (21.3)	0.050*
No	41 (38.0)	14 (13.0)	

Abbreviation: *Pearson's chi-square test. +Fisher's exact test.

The potential for surgical contamination was associated with the outcome ($p < 0.001$), with the highest mortality rate in infected/contaminated surgeries (19.4%), followed by potentially contaminated surgeries (10.2%) and clean surgeries (4.6%). The presence of infectious signs and symptoms in the postoperative period was also associated with higher death (p = 0.011) (Table 2).

Readmission showed a significant association (p = 0.009), with lower mortality among readmitted patients (9.3%) compared to non-readmitted patients (25.0%). Deaths were more frequent in deep and organ/cavity infections than in superficial ones. There was also higher mortality among patients who underwent reoperation (28.7%), with sepsis (25.0%; $p < 0.001$) and ICU need (26.9%; $p < 0.001$) (Table 2).

Table 2. Factors related to surgery, infection, and complications during hospitalization associated with hospital outcome among cases of surgical site infection. Northeast, Brazil, 2024.

Parameter	Hospital admission outcome		
	Discharge N (%)	Death N (%)	p-value*
Potential for contamination of surgery			
Infected/contaminated	11 (10.2)	21 (19.4)	< 0.001
Clean	20 (18.5)	5 (4.6)	
Potentially contaminated	40 (37.0)	11 (10.2)	
Signs and symptoms of infection during hospitalization after surgery			
Yes	40 (37.0)	30 (27.8)	0.011
No	31 (28.7)	7 (6.5)	
Readmission for treatment			
Yes	38 (35.2)	10 (9.3)	0.009
No	33 (30.6)	27 (25.0)	
ISC Classification			
Shallow	21 (19.4)	5 (4.6)	0.179
Deep	24 (22.2)	15 (13.9)	
Organ/Cavity	26 (24.1)	17 (15.7)	
Reoperation			
Yes	48 (44.4)	31 (28.7)	0.072
No	23 (21.3)	6 (5.6)	
Sepsis			
Yes	21 (19.4)	27 (25.0)	< 0.001
No	50 (46.3)	10 (9.3)	
ICU care			
Yes	29 (26.9)	29 (26.9)	< 0.001
No	42 (38.9)	8 (7.4)	

Abbreviation: N = Number. SSI = Surgical Site Infection. ICU = Intensive Care Unit. *Pearson's chi-square test.

The presence of oncological disease was associated with a higher chance of death (OR = 2.25), but with borderline significance. The presence of infectious signs and symptoms in the postoperative period increased the chance of death by more than three times (OR = 3.32). Sepsis and the need for ICU were strongly associated

continue

with poor outcomes, significantly increasing the risk of death, especially in the presence of sepsis (more than six times). On the other hand, hospital readmission was associated with a lower chance of death (Table 3).

Table 3. Risk and odds factors related to hospitalization outcome among cases of surgical site infection. Northeast, Brazil, 2024.

Parameter	Hospital outcome (Death x Discharge) OR (95%CI)
Oncologic disease	2.25 (0.994 – 5.07)
Signs and symptoms of infection during hospitalization after surgery	3.32 (1.29 – 8.56)
Readmission	0.322 (0.136 – 0.762)
Sepsis	6.43 (2.65 – 15.6)
ICU care	5.25 (2.1 – 13.1)

Abbreviation: OR = Odds Ratio. CI = Confidence interval.

Patients who died had a higher mean age compared to those who were discharged (58.05 years). They also had a longer preoperative hospital stay (4.27 days; p = 0.022) and a longer total hospital stay (48.35 days; p = 0.041).

The time to diagnosis of infection and CRP levels were similar between the groups. However, patients who died had higher leukocyte counts (p = 0.024). Moreover, there was a higher number of medications used among those who died (4.95 types; p = 0.011) (Table 4).

Table 4. Association of quantitative variables with the outcome of hospital admission in patients with surgical site infection. Northeast, Brazil, 2024.

Parameter	Hospital admission outcome				p-value
	Discharge		Death		
	N	Mean (±SD)	N	Mean (±SD)	
Age	71	53.99 (±15.86)	37	58.05 (±15.56)	0.206*
Preoperative length of hospital stay	71	1.69 (±3.07)	37	4.27 (±6.05)	0.022*
Total length of hospital stay	71	39.49 (±32.35)	37	48.35 (28.47)	0.041+
Day of diagnosis/confirmation of infection	71	15.75 (17.69)	37	15.54 (15.23)	0.997*
CRP	59	180.41 (95.44)	33	185.71 (114.06)	0.813+
Leukocytes	62	11,006.45 (4,753.29)	33	13,856.2 (7,274.54)	0.024*
Quantity of antibiotics used for treatment	69	3.93 (2.75)	37	4.95 (2.2)	0.011*

Abbreviation: dp = Standard deviation. *U for Mann-Whitney. +T-test for independent samples.

DISCUSSION

HAIs are associated with infections acquired after health care, with the presence of SSIs as subclassifications. In addition to being a problem that increases costs in hospitals, SSIs are responsible for a portion of the mortality cases associated with hospital health care worldwide.[8]

In this study, the mortality rate of surgical patients who developed SSI was 34.2%; Of these, 20.4% were women. This data shows the high lethality rate when compared to other countries in economic development, in which the mortality rate is between 0.5% and 5%.[9]

The high mortality rate found in this study can be explained by the profile of patients undergoing surgery, given that the higher burden of comorbidities and care complexity increases the risk of SSI.[10] An investigation that proposed to analyze an international database on SSI highlighted that an increasing number of surgeries, even if elective, in patients of advanced age and with important comorbidities leads to higher rates of mortality related to SSI.[11]

Other authors who analyzed the incidence of SSI in patients undergoing surgery observed that the lethality rate reached 12.4%, due to organ/cavity infections[12]. This data corroborates this study, in which surgeries with the highest potential for contamination and deeper surgical site infections had the most death outcome, with emphasis on infections involving organs and cavities. Thus, surgical manipulation in areas with a higher concentration of pathogens shows a higher risk of developing infections when compared to other regions.[13]

The relationship between potential contamination and SSI is widely known and used as a risk stratification tool for unfavorable outcomes, in view of the greater microbial innocuousness and the greater complexity of asepsis control in these cases. From this perspective, the importance of correctly classifying the potential for contamination is evident, so that measures proportional to the degree of surgical complexity can be adopted to reduce the incidence of SSI and its impacts on mortality and health costs.[14]

Another factor analyzed in the study was related to the presence of oncological disease in the patients studied. According to the literature, cancer patients have an aggravating underlying condition that can directly influence their rehabilitation and health conditions. Nutritional factors and stage of the disease, associated with metabolic stress as a result of surgery, can be considered aggravating factors.[15] Moreover, the oncological disease analyzed showed a trend of association with the outcome death (p = 0.050), among which 21.3% of the cancer patients with SSI died.

In addition to presenting an accumulation of factors that increase the risk for SSI, oncological surgeries tend to be more extensive and with extensive tissue manipulation, and often require complex resections and reconstructions. Moreover, previous exposure to antineoplastic drugs compromises the immune response and, consequently, the healing process.[16]

As a result, studies have addressed the importance of reintroducing oral nutrition early in cancer patients in the postoperative period, as well as maintaining the patient's health status to later perform the surgical procedure.[15]

According to the variable present in the study, which is intended to analyze the length of hospital stay of patients who developed SSI in the preoperative period, it was observed that patients with a death outcome were hospitalized on mean 4.27 days before surgery, whereas patients who were discharged were hospitalized in a shorter time, corresponding to a mean of 1.69 days before ($p = 0.022$). Nevertheless, according to the Diagnostic Criteria for Healthcare-Associated Infection established by the Ministry of Health, a shorter pre- and postoperative hospitalization time means less exposure to the hospital environment and, consequently, less risk of developing infections.[1,15]

Regarding the need for ICU care, the results showed that SSI patients who needed ICU care were statistically associated with a higher risk of death (p-value < 0.001). According to the WHO, patients who develop SSI tend to stay longer, about four to seven days, increasing the risk of worsening the clinical condition, requiring intensive care and presenting a higher risk of death.[3]

Furthermore, regarding reoperation, the study showed a higher mortality trend compared to patients who did not undergo reoperation. Moreover, regarding the patients who died with SSI, they had a significantly higher rate of sepsis during hospitalization ($p < 0.001$) and had a total length of stay exceeding 8.86 days compared to patients who were discharged. This may be related to complications and attempts to stabilize their health and improve clinical condition, requiring a longer hospital stay.[16]

The limitations of the study are that the research was conducted in a single public health institution, which restricts the comparison of results; Another point refers to the research in medical record data, as there is a lack of certain information that would be important for a better understanding of the disease and that was not filled in uniformly in the analyzed medical records.

This study investigated factors associated with hospital outcome in patients with surgical site infection in a public teaching hospital, showing high mortality, with a predominance of females. An association was observed between death and oncological disease, as well as with surgeries with greater potential for contamination, especially those infected. Infections occurred mainly in deep planes, and patients who died had a longer hospital stay, in addition to a higher frequency of reoperation, sepsis, and the need for ICU. These findings reinforce the severity of these infections and the importance of preventive measures and appropriate management to reduce complications and mortality.

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AUTHORS' CONTRIBUTIONS

Anderson da Silva Moreira and **Thaís Honório Lins Bernardo** contributed to the conception and design of the study, bibliographic research, writing of the abstract, introduction, methodology, discussion, interpretation and description of the results, elaboration of tables, conclusions, and critical review of the manuscript. **Mirelle dos Santos** and **Lucas Cavalcante Chalegre** contributed to bibliographic research, writing of the manuscript, analysis and interpretation of data, and critical review of the manuscript. **Yhasmin Santos Silva** and **Yasmin Eliziário Martins Melo** contributed to the interpretation of the data and critical review of the manuscript.

All authors approved the final version to be published and are responsible for all aspects of the work, including ensuring its accuracy and integrity.

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