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ORIGINAL ARTICLE

SURGICAL SITE INFECTION IN PATIENTS SUBMITTED TO NEUROLOGICAL AND ORTHOPEDIC SURGERIES ABSTRACT

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ABSTRACT

Objective: to analyze the incidence of surgical site infections (SSI) in patients submitted to neurological and orthopedic surgeries and their determinants in a public hospital. **Method:** retrospective cohort study, conducted between patients submitted to neurological and orthopedic surgeries, from January 2015 to December 2020. **Results**: of the 3,029 surgical procedures performed, 1,327 (43.8%) were neurosurgical; and 1,702 (56.2%) were orthopedic. The incidence of SSI was 6.7% (89) in neurosurgeries and 3.3% (56) in orthopedic surgery. The overall rate and death rates were 4.8% and 12.4%, respectively. In the univariate analysis, the risk factors associated with SSI in neurosurgeries involved surgical time (>231 minutes), an American Society of Anesthesiologists score greater than two and emergency surgeries; the risk factors for orthopedic procedures were emergency surgeries, preoperative hospitalization time (> four days), and surgical procedures (>149 minutes). In the multivariate analysis, emergency surgeries and longer surgical time remained as risk factors for SSI for both specialties; the SSI risk factors for orthopedic and neurological surgeries were preoperative hospitalization time and ASA classification, respectively. **Conclusion:** the incidence rate of SSI and mortality, as well as the risk factors identified in this study, should be considered in order to develop strategies aimed at preventing and controlling these infections.

Keywords: Surgical wound infection. Epidemiologic surveillance services. infection control. Nursing.

INTRODUCTION

Surgical site infections (SSI) are the most frequent health care-related infections (HCRI) in underdeveloped and developing countries and can affect up to one third of patients undergoing surgery(1). In Europe and the United States (USA), these have generally been highlighted as the second most frequent site of HCRI(2,3). In Brazil, SSI have occupied the third position and involve around 14% to 16% of patients admitted to hospital institutions(1). For this reason, this event becomes a serious public health problem, with serious economic, social and human implications(1,3).

The occurrence of SSI in neurosurgery and orthopedic surgery are serious problems due to the negative impact on morbidity and their causing an increase of 2 to 11 times in the risk of mortality(4). In addition, these infections are associated with the extension of hospitalization and antibiotic use for up to two weeks, on average; also, they can double the readmission rates because of the need for surgical retreatment and other complications(2,5,6).

Although financial burden data involving orthopedic and neurological surgery are scarce, it is estimated that, for other sites, SSI is the most expensive of all HCRI. Their annual cost ranges from US$ 3.3 billion to US$ 10 billion,

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and hospital expenses per patient may increase in around US$ 20,000[4.6-8]. In the specific field of neurological surgery, patients with SSI demand treatment that has a significantly higher expense, approximately 300% more than that of patients without SSI[9].

Specifically, regarding orthopedic surgeries, international data point to an incidence that may vary between 1.8% and 4.6%[6,10]; for neurosurgery this may vary between 1.5% and 15.3% [11-12]. In Brazil, according to the National Agency for Sanitary Surveillance (*Agência Nacional de Vigilância Sanitária* -ANVISA), in the period 2018 to 2021, the notifications of SSI in neurological and orthopedic surgeries increased from 2.7% to 3.9% and 1.6% to 3.0%, respectively[13]. These figures are probably underestimated due to the challenges of monitoring post-discharge patients and the reduction in the number of procedures due to the pandemic period.

Among the factors that predispose people to orthopedic and neurological SSI, the most important are those related to the patient, such as advanced age, pre-existing diseases (hypertension, diabetes *mellitus***,** obesity (body mass index > 35 kg/m^2), chronic use of medications (corticosteroids, immunosuppressants, anticoagulants). Its clinical condition is expressed by a classification higher than 2 according *to the American Society of Anesthesiologists* (ASA)[11,14-19]. Also, regarding procedure-related factors, these include prolonged surgical procedure time (above the cut-off point set by the Centers for disease Control and Prevention (CDC), preoperative hospitalization time, and postoperative hospitalization time, among others[4,15-17,20].

Although the risk factors are recognized for SSI in patients submitted to neurological and orthopedic surgeries, it is necessary to monitor them constantly in order to instrumentalize infection control services for targeted and assertive actions. This is especially due to the impact they have caused on both costs and mortality. Since these procedures are predominantly classified as clean, they represent an important indicator of patient quality and safety[1,2].

It was against this background that this study aimed to analyze the incidence of surgical site infections in patients submitted to neurological and orthopedic surgeries and their determinants in a public hospital.

METHOD

This was a retrospective epidemiological cohort study conducted among patients submitted to neurological and orthopedic surgeries from January 2015 to December 2020 in a public hospital in Belo Horizonte, Minas Gerais State, Brazil. It was initiated after approval by the Research Ethics Committee, under the number of the opinion 5.354.153, CAAE 26070919.9.0000.5149.

The study institution is classified as a large hospital, with a capacity of approximately 600 beds, of which 526 are occupied. It is a reference institution in urgency, emergency, and trauma in the state of Minas Gerais. Regarding surgical capacity, it has nine surgical rooms and performs about 650 surgeries per month according to the National Healthcare Safety Network (NHSN) criterion[4]. The surgeries performed are predominantly orthopedic and neurosurgical, followed by general and plastic surgery.

Data were collected from the monitoring system of the Hospital infection Control Service (*Serviço de Controle de Infecção Hospitalar*-SCIH) of the study institution, registered in the specific database (Automated Hospital infection Control System -*Sistema Automatizado de Controle de Infecção Hospitalar* - SACIH®), which enables data analysis and monitoring of all hospitalized patients in relation to different infection sites. It is directly interlinked with the blood cultures results performed in the service laboratory, thus contributing to case analyses and their relations with a causal agent when the identification of microorganisms occurs. To notify surgical site infections, the criteria of NHSN and Centers for disease Control and Prevention standardized by the institution were adopted[4]. The included surgical procedures also followed the definition of NHSN and understood those that occurred in the surgical block, where the surgeon performed at least an incision in the skin or mucous membrane[4].

Regarding neurological surgeries, the following procedures were considered for analysis: Craniotomy, spinal refusion, laminectomy, carotid endarterectomy and ventricular derivation. In orthopedic surgeries, open fracture reduction, hip prosthesis, and tenorrhaphy were considered.

The categorization of SSI was due to the absence or presence of infection, defined on the basis of the NHSN criteria: A) superficial incisional SSI develops within 30 days of surgery, involving only the skin and subcutaneous tissues of the incision; b) deep SSI occurs within 30 to 90 days after the procedure and involves deep soft tissues (muscle, bone or others); c) organ/cavity SSI occurs within 30 to 90 days and includes any organ/cavity opened or manipulated during surgery[(4)]. To cover this surveillance period, tracking surgical site infection was performed at the study through the active search of cases during hospitalization and after hospital discharge, including analysis of medical records and telephone follow-up of patients.

The independent variables were as follows: age; gender (female and male); clinical condition of the patient in the preoperative period according to the score proposed by ASA, patient classification as I to V (I - healthy patient; II - patient with mild systemic disease; III - patient with severe systemic diseases, but not incapacitating; IV – patient with disabling systemic disease at risk of death; and V – a patient with no life expectancy for 24 hours with or without surgery)[(21)];surgeries classified by the surgeon according to the potential for contamination of the operative wound (clean surgery: performed in sterile tissues; potentially contaminated surgery: in tissues with small microbial flora; contaminated surgery: in tissues with abundant bacterial flora; and infected surgery: in tissues or organs in the presence of infectious process)[4)]; emergency (no and yes); preoperative hospitalization time; and surgery duration. The variables “age”, “preoperative hospitalization time”, and “surgery duration time” were collected as continuous variables, which were later dichotomized.

The data were analyzed using the Statistical Package for the Social Sciences for Windows (SPSS), version 28.0. To describe and characterize the patients, descriptive analysis was performed with simple frequency distribution, central trend measurements (mean and median), and variability measurements such as standard deviation and quartiles.

An univariate analysis was conducted to verify the association between SSI and risk factors using the chi-square test. The binary logistic regression model was used, with a significance level of 20%, to define the variables to be included in the model as per the *Forward: Log Likelihood Ratio* (LLR), which indicates the contribution of a variable towards better model adjustment. The model quality was determined by the Hosmer & Lemeshow test. The SSI occurrence proportion variance was given by the Nagelkerke R^2 model. Independent variable multicollinearity was evaluated by tolerance analysis and the variance inflation factor (VIF).

RESULTS

A total of 3,029 patients underwent at least one surgical procedure during the study period. Of these, 1,702 (56.2%) underwent orthopedic surgeries, while 1,327 (43.8%) of them underwent neurosurgeries. Regarding sex and age, 677 (51.0%) and 1,034 (60.8%) of them were women, and the mean age was 54 years ±15 (16-94) and 50 years ±19.9 (18-104) for neurological and orthopedic surgeries, respectively.

A hundred and forty-five SSI were notified in the period 2015-2020. Its global incidence of 4.8%, while 3.3% (56 of them) were submitted to neurosurgical procedures; and 6.7% (89 of them) were orthopedic. Of these notifications, 80 (55.2%) of them were diagnosed in post-discharge surveillance and 65 (44.8%) of them were diagnosed during hospitalization.

As for topography procedures, in relation to orthopedic surgery, open fracture reduction was predominant, corresponding to 1,466 (86.1%), in addition to 174 (10.2%) hip prostheses and 62 (3.6%) tenorrhaphy procedures. Regarding neurological procedures, 981 (73.9%) craniotomies, 253 (19.0%) spine refusions, 36 (2.7%) laminectomies, 32 (2.4%) carotid endarterectomies, and 25 (1.9%) ventricular leads were performed.

According to the diagnostic criteria for infection established by the NHSN, according to the specific SSI site, 12 superficial incisional infections, 79 deep infections, and 54 organ/cavity infections were reported (Table 1).

Table 1. Distribution of surgical site infections (n = 145) in neurosurgery and Orthopedics, according to the specific site - Belo Horizonte, Minas Gerais, Brazil, 2015-2020.

Topography	Neurosurgery n = 89	Orthopedic surgery n = 56	N = 145	n (%)
Superficial incisional infection	10	2	12	8.3
Deep incisional infection	30	49	79	54.5
Organ/cavity infection	49	5	54	37.2
Total	89	56		145

Regarding the SSI case outcomes, the vast majority of patients were discharged from hospital, amounting to 89% (n = 129) of them, while 11% (n = 16) of them died, i.e., the mortality rate was 12.4%. Also, in relation to deaths, most of them (n = 13; 81.3%) were due to organ/cavity infection after craniotomy (n = 10), hip prosthesis (n = 2), and ventricular shunt (n = 1); three deaths (18.3%) were due to deep incisional infections resulting from open fracture reduction surgery, craniotomy, or spinal refusion.

Mean duration of neurological and orthopedic surgeries was 230.9 minutes ±80.2 (120-530) and 149 minutes ±44.8 (120-470), respectively. Regarding preoperative hospital stay, the mean was 9.7 days ±13.8 (0-105) for neurosurgeries and 3.8 days ±7.9 (0-109) for orthopedic procedures.

In the univariate analysis related to neurological surgeries, the variables "surgical time", "ASA classification," and "emergency surgery" presented a significant association ($p < 0.20$) with SSI, except gender, age, preoperative hospitalization time, and potential for surgical wound contamination (Table 2).

Table 2. Distribution of independent variables and their relation to the occurrence of surgical site infection in neurological surgeries (n = 89) - Belo Horizonte, Minas Gerais, Brazil, 2015-2020.

Variables	Surgical site infection in neurological surgeries						
	No (n = 1,238)		Yes (n = 89)		OR*	CI† 95%	Value *p*
	N	%	N	%			
Sex							0.380
Female	636	93.9	41	6.1			
Male	602	92.6	48	7.4	1.2	0.8-1.9	
Age							0.347
≤ 54 years	590	92.6	47	7.4	1.2	0.8-1.9	
> 54 years	648	93.9	42	6.1			
Preoperative hospitalization time (n = 1,314)							0.814
≤ 10 days	832	93.2	61	6.8	1.0	0.7-1.7	
> 10 days	394	93.6	27	6.4			
Surgical time (n = 1,304)							0.036
≤ 231 minutes	567	95.0	30	5.0			
> 231 minutes	651	92.1	56	7.9	1.6	1.0-2.6	
ASA Classification‡							0.004
I/II	723	95.0	38	5.0			
III/IV	515	91.0	51	9.0	1.8	1.2-2.9	
Potential for surgical wound contamination							
Clean	1,093	93.3	79	6.7	1.0	0.5-2.0	0.892
Potentially contaminated; contaminated, and infected	145	93.5	10	6.5			
Emergency surgery							0.005
No	1,219	93.6	84	6.4			
Yes	19	79.2	5	20.8	3.8	1.4-10.5	

* *Odds Ratio*; † Confidence Interval; ‡ American Society of Anesthesiologists; § Reference category

Regarding the univariate analysis of orthopedic surgeries, the following variables presented a significant association ($p < 0.20$) with the development of SSI: Age, preoperative and surgical hospitalization time, ASA classification, potential for contamination of the surgical wound, and emergency surgery, except for sex (Table 3).

Table 3. Distribution of the independent variables and their relation to the occurrence of surgical site infection in orthopedic surgeries (n = 56) - Belo Horizonte, Minas Gerais, Brazil, 2015-2020.

Variables	Surgical site infection in orthopedic surgeries						
	No (n = 1,642)		Yes (n = 56)		OR*	CI† 95%	Value *p*
	N	%	N	%			
Sex							0.574
Female	1,002	96.9	32	3.1			
Male	644	96.4	24	3.6	1.2	0.7-2.0	
Age							0.018
≤ 50 years	853	97.7	20	2.3			
> 50 years	793	95.7	36	4.3	1.9	1.1-3.4	
Preoperative hospitalization time (n = 1,689)							< 0.001
≤ 4 days	1,259	97.8	28	2.2			
> 4 days	378	94.0	24	6.0	2.8	1.6-5.0	
Surgical time (n = 1,695)							< 0.001
≤ 149 minutes	1,085	97.8	24	2.2			
> 149 minutes	554	94.5	32	5.5	2.6	1.5-4.5	
ASA Classification‡							0.003
I/II	1,346	97.3	37	2.7			
III/IV	300	94.0	19	6.0	2.3	1.3-4.0	
Potential for surgical wound contamination							
Clean	1,347	97.0	42	3.0			0.194
Potentially contaminated; contaminated and infected	299	95.5	14	4.5	1.5	0.8-2.8	
Emergency surgery							< 0.001
Yes	5	62.5	3	37.5			
No	1,602	97.1	48	2.9	0.05	0.01-0.02	

* *Odds Ratio*; † Confidence Interval; ‡ American Society of Anesthesiologists; § Reference category.

The final logistic regression model presented in Table 4 includes these variables: "Surgical time", "emergency surgery" and "ASA classification" for neurosurgeries; and "emergency surgery", "surgical time" and "preoperative hospitalization time" for orthopedic procedures. Even though "ASA classification", "age" and "contamination potential" were selected in the bivariate analysis ($p < 0.20$) of this last specialty to be part of the multivariate analysis, they did not remain in the final model. They did not reach a significance level of 5%.

Table 4 - Final logistic regression model of independent variables in relation to surgical site infection in neurological (n = 56) or orthopedic (n = 89) surgeries - Belo Horizonte, Minas Gerais, Brazil, 2015-2020.

Variables	OR*	IC† 95%	*p*-value
	Surgical site infection in neurological surgeries		
Emergency surgery			0.027
No			
Yes	3.2	1.1-8.9	
Surgical time (n = 1304)			0.049
≤ 231 minutes			
> 231 minutes	1.6	1.0-2.5	
ASA‡ Classification			0.012
I/II			
III/IV	1.8	1.1-2.8	
	Surgical site infection in orthopedic surgeries		
Emergency surgery			< 0.001
No			
Yes	39.9	8.1-196	
Surgical time (n = 1695)			0.001
≤ 149 minutes			
> 149 minutes	2.7	1.5-5.0	
Pre-surgical hospitalization time			< 0.001
≤ 4 days			
> 4 days	3.1	1.7-5.7	

* *Odds Ratio*; † confidence interval; ‡ American Society of Anesthesiologists.

For neurological surgeries, the model was statistically significant [X^2 (3) = 15.8; $p < 0.001$], explained 3.1% of the variance in the occurrence of SSI and correctly verified 93.4% of the cases, with quality determination by the Hosmer - Lemeshow test (0.232; $p > 0.05$). Regarding orthopedic surgeries, the model was also statistically significant [X^2 (3) = 36.9; $p < 0.001$], explained 9.7% of the variance in the occurrence of SSI and correctly verified 97.2% of the cases, with determination of quality by the Hosmer - Lemeshow test (0.126; $p > 0.05$). In both models, no multicollinearity was identified between the variables (tolerance > 0.1 and VIF < 10).

DISCUSSION

In this study, the SSI incidence and mortality rates were analyzed, as well as the risk factors in a sample of 3,029 patients who underwent orthopedic and neurological procedures at a public institution in the period 2015-2020. In these procedures, an incidence of SSI of 3.3% in orthopedic procedures and 6.7% in neurological procedures, as well as a mortality of 12.4% were found-. The main risk factors were emergency surgery and longer surgical time in both specialties; the main risk factors for orthopedic and neurological surgeries were preoperative hospitalization time and the ASA classification, respectively.

The incidence of orthopedic surgeries was lower than that observed in developed countries such as those in Europe, with a variation from 1.8% to 5.8%[10,22]. However, other studies developed in Spain involving SSI neurosurgeries presented divergent rates, ranging from 1.5% to 15.3%[11-12]. The rate was even higher than what was found in Brazilian data reported by ANVISA, in which an incidence of SSI ranging from 1.6% to 3.9% was pointed out[13].

Furthermore, considering that the study hospital performs post-discharge surveillance of all patients for 30 to 90 days after the date of the procedure, it is inferred that the high incidence may be related to this method. It is known that methods of patient follow-up after hospitalization are a crucial tool for improving the indication of the occurrence of SSI and its early identification[2].

As for the SSI topography, the deep incisional ones prevailed, with 54.5%, followed by 37.2% in organs/cavities. This is in agreement with a study conducted involving 91 SSI after craniotomy, in which 17.6% (n = 16) were deep incisional; 73.6% (n = 67) in organs/cavities; and only 8.8% (n = 8), superficial incisional[9]. In view of this, it is worth pointing out that SSI in topographies involving deeper planes usually require a surgical reapproach and prolonged use of systemic antibiotics, which ultimately make it possible to have serious complications and even death[9].

Despite the mortality of surgical patients who developed SSI, a high lethality rate (12.4%) is observed in the study when compared to that of other developing countries, in which the mortality rate due to general surgeries varies between 0.5% and 5%[2]. Brazilian research that analyzed, respectively, 4,894 and 7,469 authorizations for hospital admissions (AIH) of the Unified Health System (*Sistema Único de Saúde* - SUS) for total primary knee arthroplasty and knee surgery review/total reconstruction between 2009 and 2018, points to a reduction in the mortality rate when the procedure is primary and an increase of 30.6% for review surgeries[23]. Therefore, it is valid to analyze other aspects that favor the increase in this rate.

The risk factors that contribute to the occurrence of SSI are multifactorial. They are classified as modifiable when related to the procedure, so they can be altered in the preoperative period in order to reduce the risk of these infections. The non-modifiable ones refer to the intrinsic characteristics of the patient[2,3].

Regarding non-modifiable factors , such as age and gender, there was no significant difference between patients who either developed or did not develop SSI for both specialties. Regarding the first finding, this corroborates data found in the literature[17,19]. However, regarding the variable “sex”, the result is divergent, since evidence points to male gender and other determinants (e.g. number of previous surgeries, smoking, diabetes *mellitus* and body mass index greater than 30) as being statistically associated with SSI in surgical procedures of neurology and Orthopedics[14-16,20].

Regarding modifiable factors, the potential for contamination of the operative wound was not associated with the occurrence of SSI in neurological and orthopedic surgeries.Similarly, in another study, among patients submitted to craniotomy, this variable was not statistically significant[11]. It should be emphasized that understanding and determining the degree of contamination of the surgical site is crucial to assist in the appropriate indication of the use of prophylactic antimicrobials in order to reduce the incidence of surgical infections classified as potentially contaminated and contaminated, as well as in clean surgeries, in which prophylaxis was not indicated[1-3,24].

Another risk factor commonly related to SSI is related to preoperative hospital stay due to greater patient exposure to the hospital environment; this favors the colonization of flora by multidrug-resistant germs, greater manipulation by health professionals, among other reasons[3]. This premise, in the present study, was also verified, because patients who remained hospitalized for more than four days to perform orthopedic surgeries presented a 3.1-time greater chance of developing SSI when compared to those with previous hospitalization below this period (95%CI 1.7-5.7; $p \leq 0.001$). Also, it is worth noting that the mean length of hospital stay before neurosurgeries was 9.7 days ±13.8 (0-105); however, this result was not statistically significant. Finally, it is important to highlight that despite the ANVISA recommendation that preoperative hospitalization should occur on the day of the procedure or on the previous day, patients from Brazilian public institutions experience excessive delay in performing surgeries even after hospitalization due to hospital overcrowding and lack of beds[1,25].

Concerning the ASA score, which includes the classification of the patient's clinical status to determine the risk of mortality during the surgical event, the data from this study indicated that patients who scored higher than two presented a 1.8-time greater chance (95%CI 1.1-2.8; $p = 0.012$) of developing SSI in neurosurgeries compared to those with ≤ 2 scores. This result is in agreement with two other studies: The first refers to a prospective cohort, while the second refers to a meta-analysis including 26 articles that indicated an ASA classification greater than or equal to 3 as a predictor factor for SSI in neurological procedures[11,15].

Another relevant finding concerns emergency surgery. In this study, neurological patients who underwent such procedures presented a 3.2-time greater chance (95%CI 1.1--8.9; $p = 0.027$)of developing SSI compared to those who underwent elective surgeries. In orthopedic surgeries, this risk was even higher, with an OR of 39.9, (95% IC 8.1-196.0; $p \leq 0.001$). These data corroborate a study carried out in the United States, which revealed an SSI incidence rate equal to 7.5% after 11,401 patients undergoing non-elective procedures for thoracic and lumbar fracture[27]. This fact should have occurred due to instability of the patient's clinical condition, as well as lack of time to adopt measures to prevent and control SSI, such as adequate skin preparation[3,9,22].

Similarly, it was found in this study that neurosurgeries with a mean duration greater than or equal to 231 minutes and orthopedic surgeries with a mean time greater than or equal to 149 minutes presented 1.6 (95% IC 1.0-2.5; $p = 0.049$) and 2.7 (95% IC 1.5-5.0) more chance of developing SSI, respectively, in relation to those that were performed in a shorter time. This corroborates the results of another retrospective analysis of 16,513 neurosurgeries over a seven-year period[5]. In view of this, it is worth emphasizing that surgical periods lasting longer than two hours potentially influence the occurrence of infections due to prolonged tissue exposure; this leads to microbial invasion, blood loss, and even a reduction in the systemic defenses of an individual[1,3].

It is also noteworthy that, although the occurrence of clinical and surgical complications was not investigated in this study, it is inferred that a longer surgical time may be a determining factor not only for the increase in the rates of SAI, but also for the risk of developing problems, as a need for surgical reapproach and the emergence of morbidities[5,26,28]. Thus, ensuring surgeries in the shortest possible time is paramount to prevent and reduce these infections and, consequently, possible complications.

The strong point of this study was the representative sample. However, there are limitations that should be considered, including: The research was carried out in only one public institution, which restricted extrapolation or comparison of the results and may interfere with its external validity; the fact that it is a retrospective study, which did not allow important variables such as whether or not to use prophylactic antibiotics; finally, the fact that there was a change in the professional team responsible for the release of data, which enabled changes in the collection patterns over time. It was found that there was a predominance of the realization of some specific procedures, hindering data homogeneity.

CONCLUSION

This study found a global incidence of 4.8%, showing that neurological and orthopedic surgeries require greater attention, especially considering a 12.4 %-death rate due to this complication. In the multivariate analysis, surgeries with longer duration and emergency surgeries presented a higher risk of developing SSI for both specialties; this was also found in orthopedic and neurological surgeries, preoperative hospitalization time and the ASA classification, respectively. To conclude, public policies should be reviewed and implemented to especially reduce the surgical time and duration of this hospitalization. This may lead to better qualify the safety of these patients. Furthermore, it is essential to recognize the risks of developing SSI so that prevention and control measures can be adopted in order to reduce its occurrence.

INFECÇÃO DO SÍTIO CIRÚRGICO EM PACIENTES SUBMETIDOS A CIRURGIAS NEUROLÓGICAS E ORTOPÉDICAS

RESUMO

Objetivo: analisar a incidência das infecções de sítio cirúrgico (ISC) em pacientes submetidos a cirurgias neurológicas e ortopédicas e seus determinantes em um hospital público. **Método:** estudo de coorte retrospectivo, conduzido entre pacientes submetidos a cirurgias neurológicas e ortopédicas, de janeiro de 2015 a dezembro de 2020. **Resultados**: dos 3.029 procedimentos cirúrgicos realizados, 1.327 (43,8%) foram neurocirúrgicos; e 1.702 (56,2%), ortopédicos. A incidência da ISC foi 6,7% (89) em neurocirurgias e 3,3% (56) em ortopedias. A taxa global e de óbitosfoi 4,8% e 12,4%, respectivamente. Na análise univariada, os fatores de risco associados às ISC em neurocirurgiasenvolveram tempo cirúrgico (>231 minutos), pontuação da American Society of Anesthesiologistsmaior que doise cirurgias emergenciais; para os procedimentos ortopédicos: cirurgias emergenciais, tempo de internação pré-operatório (>quatro dias) e cirúrgico (>149 minutos). Na análise multivariada, permaneceram cirurgiasemergenciais e maior tempo cirúrgico como fatores de risco de ISC para ambas as especialidades;e, para as cirurgias ortopédicas e neurológicas, tempo de internação pré-operatório e classificação ASA, respectivamente.**Conclusão:** a taxa de incidência das ISC e de mortalidade bem como os fatores de risco identificados neste estudo devem ser considerados para elaborar estratégias destinadas a prevenir e controlar essas infecções.

Palavras-chave: Infecção da ferida cirúrgica. Serviços de vigilância epidemiológica. Controle de infecção. Enfermagem.

INFECCIÓN DEL SITIO QUIRÚRGICO EN PACIENTES SOMETIDOS A CIRUGÍA NEUROLÓGICA Y ORTOPÉDICA

RESUMEN

Objetivo: analizar la incidencia de las infecciones de sitio quirúrgico (ISC) en pacientes sometidos a cirugías neurológicas y ortopédicas y sus determinantes en un hospital público. **Método**: estudio de cohorte retrospectivo, realizado entre pacientes sometidos a cirugías neurológicas y ortopédicas, de enero de 2015 a diciembre de 2020. **Resultados**: de los 3.029 procedimientos quirúrgicos realizados, 1.327 (43,8%) fueron neuroquirúrgicos; y 1.702 (56,2%), ortopédicos. La incidencia de la ISC fue 6,7% (89) en neurocirugía y 3,3% (56) en ortopedias. La tasa global y de muertes fue 4,8% y 12,4%, respectivamente. En el análisis univariado, los factores de riesgo asociados a las ISC en neurocirugía involucraron tiempo quirúrgico (>231 minutos), puntuación de la *American Society of Anesthesiologists* (ASA) mayor que dos y cirugías de emergencia; para los procedimientos ortopédicos: cirugías de emergencia, tiempo de internación preoperatorio (> cuatro días) y quirúrgico (>149 minutos). En el análisis multivariado, permanecieron cirugías de emergencia y mayor tiempo quirúrgico como factores de riesgo de ISC para ambas especialidades; y, para las cirugías ortopédicas y neurológicas, tiempo de internación preoperatorio y clasificación ASA, respectivamente. **Conclusión**: la tasa de incidencia de las ISC y de mortalidad, así como los factores de riesgo identificados en este estudio, debenser consideradosa la hora de elaborar estrategias para prevenir y controlar estas infecciones.

Palabras clave: Infección de la herida quirúrgica; Servicios de vigilancia epidemiológica; Control de infección; Enfermería.

REFERENCES

1. Agência Nacional de Vigilância Sanitária (BR). Medidas de prevenção de infecção relacionada à assistência à saúde [Internet]. Brasília: ANVISA; 2017 [acesso em: 29 nov. 2022].Available from: https://www.gov.br/anvisa/pt-br/centraisdeconteudo/publicacoes/servicosdesaude/publicacoes/caderno-4-medidas-de-prevencao-de-infeccao-relacionada-a-assistencia-a-saude.pdf/view
2. World Health Organization. Protocol for surgical site infection surveillance with a focus on settings with limited resources[Internet]. Geneva: WHO; 2018 [acesso em: 29 nov. 2022].Available from: https://www.who.int/publications/i/item/protocol-for-surgical-site-infection-surveillance-with-a-focus-on-settings-with-limited-resources
3. Seidelman JL, Mantyh CR, Anderson DJ. Surgical site infection prevention: a review. JAMA. 2023;329(3):244-52. DOI: https://doi.org/10.1001/jama.2022.24075
4. Centers for Disease Control and Prevention, National Healthcare Safety Network. Patient safety component manual [Internet]. Atlanta: CDC's National Healthcare Safety Network; 2022 [cited 2022 Feb 08]. p. 9/1-9/41. Available from: https://www.cdc.gov/nhsn/pdfs/pscmanual/pcsmanual_current.pdf
5. Patel S, Thompson D, Innocent S, Narbad V, Selway R, Barkas K. Risk factors for surgical site infections in neurosurgery. Ann R Coll Surg Engl. 2019;101(3):220-5. DOI: https://doi.org/10.1308/rcsann.2019.0001
6. Suranigi SM, Ramya SR, Sheela Devi C, Kanungo R, Najimudeen S. Risk factors, bacteriological profile and outcome of surgical site infections following orthopaedic surgery. Iran J Microbiol. 2021;13(2):171-7. DOI:https://doi.org/10.18502/ijm.v13i2.5976
7. Pennington Z, Sundar SJ, Lubelski D, Alvin MD, Benzel EC, Mroz TE. Cost and quality of life outcome analysis of postoperative infections after posterior lumbar decompression and fusion. J Clin Neurosci. 2019;68:105-110. DOI: https://doi.org/10.1016/j.jocn.2019.07.025
8. Edmiston Jr CE, Spencer M, Gunja NJ, Holy CE, Ruppenkamp JW, Leaper DJ. Longitudinal rates, risk factors, and costs of superficial and deep incisional surgical-site infection (SSI) after primary and revision total knee arthroplasty: A US retrospective claims database analysis. Infect Control Hosp Epidemiol. 2023 Feb 2:1-9. DOI: https://doi.org/10.1017/ice.2023.10
9. Jiménez-Martínez E, Cuervo G, Carratalà J, Hornero A, Ciercoles P, Gabarrós A, et al. Economic impact of a care bundle to prevent surgical site infection after craniotomy: a cost-analysis study. Antimicrob Resist Infect Control. 2021;10(1):146. DOI: https://doi.org/10.1186/s13756-021-01016-4
10. Wałaszek MZ, Słowik R, Domański A, Wałaszek MJ, Różańska A, Kołpa M. Five-Year Analysis of Surgical Site Infections in Three Orthopaedics and Trauma Wards under HAI-Net from the South of Poland in 2014-2018 Considering the Standardized Infection Ratio. Medicina (Kaunas). 2022;58(5):682. DOI: https://doi.org/10.3390/medicina58050682
11. Jiménez-Martínez E, Cuervo G, Hornero A, Ciercoles P, Gabarrós A, Cabellos C, et al. Risk factors for surgical site infection after craniotomy: a prospective cohort study. Antimicrob Resist Infect Control. 2019 May 2; 8:69. DOI: https://doi.org/10.1186/s13756-019-0525-3
12. Ying H, Luo ZW, Peng AF, Yang QK, Wu X, Chen XY, et al. Incidences and reasons of postoperative surgical site infection after lumbar spinal surgery: a large population study. Eur Spine J. 2022;31(2):482-8. DOI: https://doi.org/10.1007/s00586-021-06967-1
13. Agência Nacional de Vigilância Sanitária (BR). Boletim Segurança do Paciente e Qualidade em Serviços de Saúde nº 28: Avaliação Nacional dos indicadores de IRAS e Resistência Microbiana (RM), ano 2021 [Internet]. Brasília: ANVISA; 2022 [acesso em: 29 nov. 2022].Available from: https://app.powerbi.com/view?r=eyJrIjoiZDIwZjYyMzUtMmYxZS00MTRjLTk0NWMtZWE2ZDUzOGRjOTVjIiwidCI6ImI2N2FmMjNmLWMzZjMtNGQzNS04MGM3LWI3MDg1ZjVlZGQ4MSJ9
14. Deng H, Chan AK, Ammanuel S, Chan AY, Oh T, Skrehot HC, et al. Risk factors for deep surgical site infection following thoracolumbar spinal surgery. J Neurosurg Spine. 2019;32(2):292-301. DOI: https://doi.org/10.3171/2019.8.spine19479
15. Fang C, Zhu T, Zhang P, Xia L, Sun C. Risk factors of neurosurgical site infection after craniotomy: A systematic review and meta-analysis. Am J Infect Control. 2017;45(11):123-34. DOI: https://doi.org/10.1016/j.ajic.2017.06.009
16. Yao R, Zhou H, Choma TJ, Kwon BK, Street J. Surgical site infection in spine surgery: Who is at risk? Global Spine J. 2018;8(4Suppl):5S-30S. DOI:https://doi.org/10.1177/2192568218799056
17. AlGamdi SS, Alawi M, Bokhari R, Bajunaid K, Mukhtar A, Baeesa SS. Risk factors for surgical site infection following spinal surgery in Saudi Arabia: A retrospective case-control study. Medicine (Baltimore). 2021;100(17):255-67. DOI: https://doi.org/10.1097/md.0000000000025567
18. Bischoff P, Kramer TS, Schröder C, Behnke M, Schwab F, Geffers C, et al. Age as a risk factor for surgical site infections: German surveillance data on total hip replacement and total knee replacement procedures 2009 to 2018. Euro Surveill.2023;28(9):2200535.DOI: https://doi.org/10.2807/1560-7917.es.2023.28.9.2200535
19. Zhang X, Liu P, You J. Risk factors for surgical site infection following spinal surgery: A meta-analysis. Medicine (Baltimore). 2022;101(8):e28836. DOI:https://doi.org/10.1097/md.0000000000028836
20. Liang Z, Rong K, Gu W, et al. Surgical site infection following elective orthopaedic surgeries in geriatric patients: Incidence and associated risk factors. Int Wound J. 2019;16: 773-80. DOI: https://doi.org/10.1111/iwj.13096
21. American Society of Anesthesiologists. ASA Physical Status Classification System [Internett]. Washington D. C.: American Society of Anesthesiologists; 2020 [acesso em: 29 nov. 2022]. Available from: http://www.asahq.org/quality-and-practice-management/standards-guidelinesand-related-resources/asa-physical-status-classification-system
22. Pawłowska I, Ziółkowski G, Wójkowska-Mach J, Bielecki T. Can surgical site infections be controlled through microbiological surveillance? A three-year laboratory-based surveillance at an orthopaedic unit, retrospective observatory study. Int Orthop. 2019;43(9):2009-16. DOI: https://doi.org/10.1007/s00264-019-04298-x.
23. Oliveira DB, Barcelos VA, Guimarães RPM, Oliveira KAS, Ramos Filho RL, Appelt AL,et al. Análise da taxa de mortalidade em cirurgias de artroplastia total de joelho primária e de revisão no sistema único de saúde, de 2009 a 2018. BJHR. 2021;4(5):22498-505. DOI: https://doi.org/10.34119/bjhrv4n5-343
24. Costa AC, Santa-Cruz F, Ferraz AAB. What's new in infection on surgical site and antibioticoprophylaxis in surgery?

ABCD Arq Bras Cir Dig. 2020;33(4):e1558. DOI: https://doi.org/10.1590/0102-672020200004e1558

25. Albuquerque NMQ, Castelo Branco AL, Pimentel MRAR, Silva FVC, Assad LG, Santos MA. Process of hospitalization at surgical-clinic unit at a public university hospital.Rev. enferm. UERJ. 2020; 28:e48849.DOI: https://doi.org/10.12957/reuerj.2020.48849

26. Alcantara C, Dellaroza MSG, Ribeiro RP, Carvalho CJA. Femoral fracture in the elderly: surgery waiting time and hospitalization outcome. Cienc Cuid Saúde. 2021;20:e54726. DOI:https://doi.org/10.4025/ciencuidsaude.v20i0.54726

27. Yamamoto EA, Mazur-Hart DJ, Yoo J, Orina JN. Surgical site infection in thoracic and lumbar fractures: incidence and risk factors in 11,401 patients from a nationwide administrative database. Spine J. 2023;23(2):281-6. DOI: https://doi.org/10.1016/j.spinee.2022.10.007

28. Stefani L, Borges PKO, Gaspar MDR. Infecções de sítio cirúrgico: reabordagem cirúrgica e infecção em cirurgias limpas e potencialmente contaminada. Rev Enferm UFSM. 2022;12: e12.DOI: https://doi.org/10.5902/2179769267474.

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