

Surgical site infection in adult patients after heart procedures: an integrative review

Infecção de sítio cirúrgico em pacientes adultos após procedimento cardíaco: revisão integrativa

How to cite this article:

Fiorin BH, Costa B, Rezende LDA, Aranha AL, Barbieri BM, Sipolatti WGR, et al. Surgical site infection in adult patients after heart procedures: an integrative review. Rev Rene. 2022;23:e80876. DOI: <https://doi.org/10.15253/2175-6783.20222380876>

-  Bruno Henrique Fiorin¹
-  Beatriz Costa¹
-  Lucas Dalvi Armond Rezende¹
-  Alcy Leal Aranha¹
-  Bruna Moraes Barbieri²
-  Walckiria Garcia Romero Sipolatti¹
-  Rita Simone Lopes Moreira³

¹Universidade Federal do Espírito Santo.
Vitória, ES, Brazil.

²Hospital Universitário Antônio Cassiano de Moraes.
Vitória, ES, Brazil.

³Universidade Federal de São Paulo.
São Paulo, SP, Brazil

Corresponding author:

Bruno Henrique Fiorin
Av. Marechal Campos, 1468 – Maruípe -
Departamento de Enfermagem,
CEP: 29043-900. Vitória, ES, Brazil.
E-mail: brunohenf@hotmail.com

Conflict of interest: the authors have declared that there is no conflict of interest.

EDITOR IN CHIEF: Ana Fatima Carvalho Fernandes
ASSOCIATE EDITOR: Francisca Diana da Silva Negreiros

ABSTRACT

Objective: to identify the risk factors for surgical site infection in patients after heart procedure. **Methods:** integrative literature review by searching the Medical Literature Analyses and Retrieval System online, Latin American and Caribbean Literature on Health Sciences, Scientific Electronic Library Online, Nursing Database. The search for the articles occurred during the month of February 2022. **Results:** 24 articles were eligible for the review. In all studies, the population was mostly male, aged between 51 and 70 years, who underwent elective myocardial revascularization surgery. The main comorbidities presented were diabetes mellitus, hypertension, and obesity. The infection rates ranged from 2.4% to 38.9%, and the main pathogen identified was *Staphylococcus aureus*. **Conclusion:** the main comorbidities present in patients who manifested surgical site infection were diabetes, hypertension, obesity, and smoking. The risk factors were gender, age, and prolonged preoperative hospitalization. Antibiotic prophylaxis, trichotomy, nasal decolonization, and adequate skin antisepsis were the most adopted prophylactic measures. **Contributions to practice:** knowing the profile of patients who developed infection may favor planning risk control actions.

Descriptors: Thoracic Surgery; Surgical Wound; Surgical Wound Infection; Nursing Care; Cross Infection.

RESUMO

Objetivo: identificar os fatores de risco para infecção do sítio cirúrgico em pacientes após procedimento cardíaco. **Métodos:** revisão integrativa de literatura por meio de busca na *Medical Literature Analyses and Retrieval System online*, Literatura Latino-Americana e do Caribe em Ciências da Saúde, *Scientific Electronic Library Online*, Base de Dados de Enfermagem. A busca dos artigos ocorreu durante o mês de fevereiro de 2022. **Resultados:** 24 artigos foram elegíveis para a revisão. Em todos os estudos a população era majoritariamente composta pelo sexo masculino com idades entre 51 e 70 anos, os quais foram submetidos à Cirurgia de Revascularização do Miocárdio de forma eletiva. As principais comorbidades apresentadas foram diabetes mellitus, hipertensão e obesidade. As taxas de infecção variaram entre 2,4% e 38,9%, sendo identificado como o principal patógeno, o *Staphylococcus aureus*. **Conclusão:** as principais comorbidades presentes nos pacientes que manifestaram infecção do sítio cirúrgico foram diabetes, hipertensão, obesidade e tabagismo. Os fatores de risco foram sexo, idade e internação pré-operatória prolongada. Antibioticoprofilaxia, tricotomia, descolonização nasal e antisepsia adequada da pele foram as medidas profiláticas mais adotadas. **Contribuições para a prática:** conhecer o perfil dos pacientes que desenvolveram infecção poderá favorecer o planejamento de ações para controle de riscos.

Descritores: Cirurgia Torácica; Ferida Cirúrgica; Infecção da Ferida Cirúrgica; Cuidados de Enfermagem; Infecção Hospitalar.

Introduction

Surgical site infection (SSI) in heart surgery is an important predictor of negative postoperative outcomes and is considered the leading cause of death unrelated to the underlying disease after the procedure⁽¹⁾. Despite the technological advances of pharmacological therapies, heart surgery is essential to increase the chances of survival and to maintain the patient's quality of life⁽²⁻³⁾. This infection is characterized by an infectious process that appears within the first 30 days after the surgical procedure, or up to 90 days in the case of prostheses and implants⁽⁴⁾. Such adverse event is classified according to the level of tissue involvement, as follows: superficial incisional, when it affects only skin and subcutaneous tissue; deep incisional, when it affects deep soft tissues such as fascia and muscles; and organ/cavity, when it involves organs or cavities, called mediastinitis, endocarditis, pericarditis, or myocarditis in heart surgery^(1,3-4).

In Brazil, it is understood that surgical site infections rank third in health care-related infections, representing about 14 to 16% of the conditions presented by hospitalized patients⁽⁵⁻⁶⁾. SSI is associated with increased mortality, in addition to prolonging the length of hospital stay⁽⁷⁻⁸⁾. It has an average mortality rate of 3%, highlighting the fact that 75% of deaths of patients with surgical site infection are directly linked to the infectious process as the primary cause of death⁽⁹⁻¹⁰⁾.

In the international scenario, in developed countries, it is estimated that the incidence of surgical site infection associated with heart surgery is lower than in Brazil, ranging from 0.15% to 5%⁽¹¹⁾. With higher occurrence in the elderly and patients with more than one comorbidity in the form of sternal osteomyelitis and mediastinal abscesses. Thus, reinforcing that this type of infection is directly linked to the risk of mortality in the short and long term⁽¹¹⁻¹²⁾.

The adequate management in the preoperative period and intense efforts to guarantee intraoperative stability may provide the patient with a better evolu-

tion. Severe complications, including death, may occur when this attention to the patient is not a priority in the assistance, especially in relation to those who present risk factors or trigger hemodynamic instability during the surgical procedure, which generally leads to a worse prognosis in the postoperative period^(9,13).

Such events are directly associated with the higher number of comorbidities, the clinical profile, the invasive nature of the procedure, and the adoption of prophylactic measures^(5,9,12). The most common diseases related to postoperative complications are systemic arterial hypertension and diabetes mellitus^(3,5,7). Thus, the infectious outcome is favored by several factors that go through assistance, economic, educational and health aspects⁽¹³⁾.

This research is justified by the epidemiological importance of SSI after heart procedures, as well as by the need to improve the care process of the multi-professional team, especially nursing. By understanding the risks for the development of surgical infection, it is possible to plan management and care tools to control these risk factors, which positively impacts the postoperative evolution. Considering the complexity of heart surgeries and the risk of infection, especially those performed through thoracotomy, planning and knowledge about the profile of these occurrences is necessary, which is not easily found in the literature in a consolidated manner, thus integrating the clinical profile, risk factors and prevention measures.

Therefore, this study aimed to identify the risk factors for surgical site infection in patients after heart procedure.

Methods

This is an integrative review carried out in the following steps: elaboration of the guiding question; establishment of inclusion and exclusion criteria; search for studies; evaluation of studies; categorization; interpretation of results and synthesis of the results evidenced⁽¹⁴⁾.

The search was performed in the following

databases: Medical Literature Analyses and Retrieval System Online (MEDLINE) via National Library of Medicine National Institutes of Health (PubMed), Latin American and Caribbean Literature on Health Sciences (LILACS), Scientific Electronic Library Online (SCIELO) and the Nursing Database (BDENF) in order to answer the following question: What is the profile of patients undergoing heart surgery and which factors are associated with surgical site infection? To formulate the review question, the PICoS strategy was used where P = Population (Patients undergoing surgery) I = Intervention (Heart surgery via sternotomy) Co = Development of surgical site infection after heart surgery), S = Observational studies. The construction of the guiding question was carried out considering the guidelines of the adopted reference⁽¹⁴⁾ to favor the survey of relevant studies in the review.

The survey of articles was performed by combining standardized keywords in the list of Subject Descriptors in Health Sciences (DeCS), and their equivalents in English in Medical Subject Headings (MESH): *cirurgia cardíaca, ferida operatória, infecção de ferida operatória, cuidados de enfermagem, infecção hospitalar* (heart surgery, surgical wound, surgical wound infection, nursing care, hospital infection). The keywords were established after careful reading related to the investigated theme. The combinations were performed in English and Portuguese, totaling eight search engines, namely: “*cirurgia torácica and ferida cirúrgica*”, “*cirurgia torácica and infecção de ferida cirúrgica*”, “*cirurgia torácica and cuidados de enfermagem*”, “*cirurgia torácica and infecção hospitalar*” (“*thoracic surgery and surgical wound*”, “*thoracic surgery and surgical wound infection*”, “*thoracic surgery and nursing care*”, “*thoracic surgery and hospital infection*”).

Inclusion criteria considered articles that addressed the profile of patients undergoing heart surgery via sternotomy, relating the groups that developed surgical site infection to those that did not, with a time frame of 2011 to 2021 and in English, Portuguese, and Spanish languages. The temporal cut-

-off was determined to search for a larger number of studies and for being a period in which there were advances in heart surgical procedures. Theses, dissertations, monographs, and review studies without meta-analysis were excluded.

The search and selection were done independently by two researchers, on the same day, time, and Windows program and Word Office 365 package. The search for articles occurred in February 2022. After the organization of the articles listed in the described search process, they were evaluated, and those that did not meet the inclusion criteria or were duplicates were excluded, followed by analysis of the title, abstract, and full text.

To analyze the title, at least one of the key words used in its description was sought; based on the abstract and full text, the elements that could corroborate the answer to the guiding question were focused on. When the researchers disagreed on the inclusion of an article, they met to discuss the inclusion or exclusion of the text based on the established criteria.

After completion of this selection step, the studies underwent a thorough analysis, highlighting the relevant information that was compiled to meet the objectives of this review and highlight the risk factors related to surgical site infection. For the analysis of the articles, a form was built to extract the most relevant data, including authors of the study, year of publication, place of the study, sample, type of study, type of surgical procedure, patient profile, risk factors for infection and prophylaxis measures.

Results

From the selection process, 24 eligible articles were obtained for analysis and data extraction as described in Figure 1.

The sample size ranged from 50 to 32,707 patients with a predominance of males and an age range of 51 to 70 years. The rate of patients who developed surgical site infection ranged from 1.4 to 38% as described in Table 1.

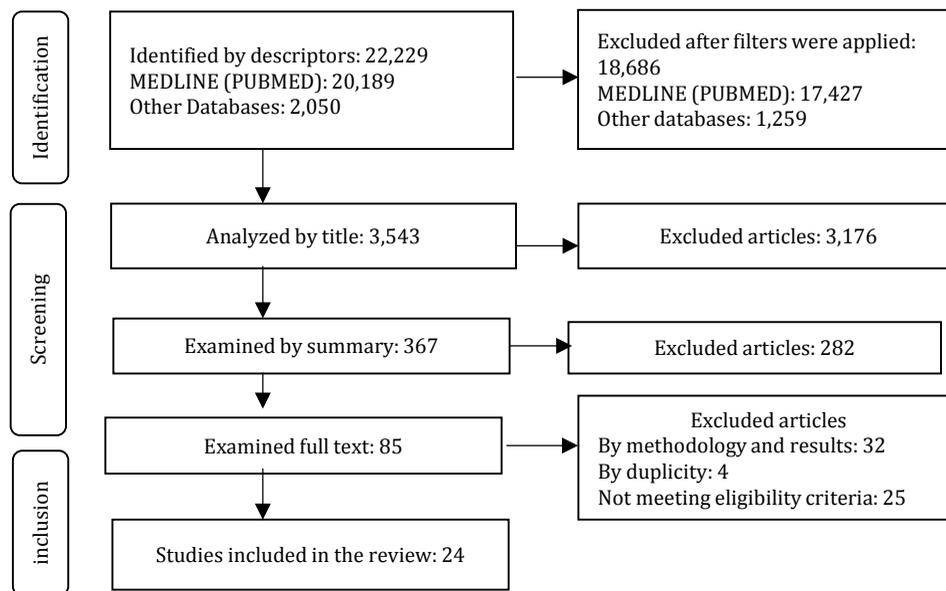


Figure 1 – Flowchart of study selection. Vitória, ES, Brazil, 2022

Table 1 – Description of studies included in the review that described surgical site infection in heart surgery: Vitória, ES, Brazil, 2022

Author/Year of publication	Sample	Type of procedure				SSI incidence (%) [§]
		CABG (%) [*]	Valve replacement (%) [†]	Others (%)	VCABG (%) [‡]	
Ferreira et al. 2020 ⁽⁸⁾	195	51.8	36.4	4.1	7.8	10.3
Andrade et al. 2019 ⁽¹⁵⁾	1,708	59.1	34.7	-	6.2	8.3
Kahl et al. 2019 ⁽⁵⁾	150	79.3	17.3	3.4	-	29.3
Barros et al. 2018 ⁽¹⁶⁾	50	68.4	26.3	5.3	-	38.0
Braz et al. 2018 ⁽¹³⁾	280	54.3	37.5	-	8.2	18.6
Nicolini et al. 2018 ⁽¹⁷⁾	2,606	100	-	-	-	4.9
Santo et al. 2018 ⁽¹⁸⁾	314	100	-	-	-	15.2
Cotogni et al. 2017 ⁽¹⁹⁾	741	34.1	33.5	13.5	18.9	8.1
Mahmood et al. 2017 ⁽²⁰⁾	10,979	48.7	28.6	12.7	10	4.3
Zittermann et al. 2016 ⁽²¹⁾	3,340	32.1	38.0	10.8	19.1	2.3
Ng et al. 2015 ⁽²²⁾	1,482	100	-	-	-	3.1
Omar et al. 2015 ⁽²³⁾	227	76.6	21.6	1.8	-	4.4
Gelijns et al. 2014 ⁽²⁴⁾	51,58	33	36	18	13	1.7
Kelava et al. 2014 ⁽²⁵⁾	32,707	29.2	35.3	16	19	1.4
Conterno et al. 2014 ⁽²⁶⁾	2,060	66.8	22.6	10.6	-	6.0
Andrade et al. 2013 ⁽²⁷⁾	460					7.8
Rahmanian et al. 2013 ⁽²⁸⁾	5,318	55.6	24.0	7.2	13.2	2.8
Chen et al. 2012 ⁽²⁹⁾	10,522	77.1	12.4	-	10.5	1.5
Hosseinrezaei et al. 2012 ⁽³⁰⁾	520					10.0
Koch et al. 2012 ⁽³¹⁾	28,250	73.5	26.5	-	-	4.7
Magalhães et al. 2012 ⁽³²⁾	896					10.7
Silva et al. 2012 ⁽³³⁾	384	48.7	35.6	12.9	2.8	9.4
Lola et al. 2011 ⁽³⁴⁾	172					5.8
Manniën et al. 2011 ⁽³⁵⁾	4,066	67.2	19.9	-	12.9	4.5

^{*}CABG: Coronary artery bypass graft surgery; [†]Valve surgery; [‡]VCABG: Coronary artery bypass graft surgery and concomitant valve replacement; [§]SSI: Surgical Site Infection Incidence; ^{||}Data not cited in the studies

Myocardial revascularization surgery was the procedure to which more than 50% of the analyzed patients were submitted (17 studies) in isolation or with another procedure in the same operative act, followed by Valve Surgery. Of the 24 articles selected, five^(13,27,30,32,34) did not specify the type of procedure performed. Of the 10 articles that cited mortality rate associated with surgical site infection, the range was from 2.4%⁽²⁹⁾ to 38.9%⁽³³⁾. The studies were conducted in several countries including Germany⁽²⁰⁻²¹⁾, Greece⁽³⁴⁾, Netherlands⁽³⁵⁾, Iran⁽³⁰⁾, Italy⁽¹⁹⁻²⁰⁾, Qatar⁽²³⁾, Singapore⁽²²⁾, United States of America^(24-25,29,31), multi-nationals⁽¹⁷⁾ and the others in Brazil^(5,8,13,15-16,18,27-26,32-33).

All selected studies described the profile of patients undergoing some type of heart surgery, which allows a significant listing of the main risk factors and/or comorbidities associated with surgical site infection in these studies. The most prevalent ones are diabetes^(5,15-35), systemic arterial hypertension^(5,13,15,16,18-19,22-23,25-34), obesity (body mass index >35)^(15,19-21,28-29,32,35), smoking^(19-21,25-26,31-32, 34), Chronic obstructive pulmonary disease^(19,20,24,27,30-31,33), Dyslipidemia^(5,13,15,26,30), American Society of Anesthesiologists classification >III^(15-18,20) and glycated hemoglobin >7.5%^(17,23). Being male and age >60 years was a risk condition in all studies.

Regarding prophylactic measures, eight articles approached antibiotic prophylaxis, mainly cephalosporins, beta-lactams and vancomycin^(13,15,19-21,24,26,29). The antibiotic infusion time ranged from 60 to 120 minutes before the first surgical incision. The other measures found were trichotomy^(5,15,24,33), nasal decolonization^(5,15,24), preoperative bath with degerming solution^(5,15,27) and skin antiseptics^(5,19,24,33).

Regarding the clinical manifestations of surgical site infection, seven articles listed the most prevalent signs and symptoms, which were pain^(18,28,32), hyperemia^(18,25), dehiscence^(5,25,29-30,33), presence of exudate^(5,25,28-32) and fever^(5,18,28,32).

Among the selected articles, 10 presented information about the microorganisms most found in infected wound cultures, these being: *Staphylococcus*

spp.^(18-19,21,24,26,29,32,34-35); *Pseudomonas spp.*^(21,26,29,34); *Enterococcus spp.*^(21,24,29,34); *Klebsiella spp.*^(5,26,32); *Serratia spp.*^(5,21); *Acinetobacter spp.*⁽³⁴⁾, and *Proteus spp.*⁽²⁶⁾. In addition, nine of the selected studies also mention the correlation between the incidence of surgical site infection and other Health Care Related Infections, such as: Urinary Tract Infection^(8,21,24-27,34); Bloodstream Infection^(24,26-29); and Pneumonia^(8,24-28,34).

The studies also showed variation between the length of stay, ranging from six to 18 days for patients without surgical site infection and 14 to 33 days for patients with surgical site infection. The difference between the lengths of stay ranged from four to 25 days. In addition, prolonged preoperative length of stay was cited as a risk factor for the development of other Healthcare-Related Infections.

Discussion

The main symptoms mentioned by the articles eligible for this study were fever, dehiscence, hyperemia, presence of purulent exudate and pain. However, in some cases clinical signs and symptoms alone are not sufficient to close the diagnosis of surgical site infection^(4,6-9). In heart surgery, signs and symptoms appear up to 30 days after the procedure or 90 days in case of valve prosthesis implantation. Incisional surgical site infection may be classified into superficial or deep infection and manifest in the primary and/or secondary site in surgeries with more than one insertion^(1,6,10).

It is estimated that about 60% of surgical site infection cases could be avoided by adopting good practices and packages of prevention measures, known as bundles^(6,9). The main practices, considered preventive, cited throughout the survey were trichotomy, nasal decolonization, preoperative shower, use of antibiotic prophylaxis and skin antiseptics.

Regarding the surgical procedure, there are preventive measures that can be taken in the preoperative period. According to the Centers for Disease Control and Prevention guideline for prevention of

surgical site infection, a full body bath the night before the surgical procedure, regardless of the type of soap used (antimicrobial or not), is strongly recommended⁽⁹⁾. The National Health Surveillance Agency has not published recommendations or contraindications regarding preoperative bathing, leaving it up to each institution to define, or not to define, the adoption of this procedure as routine^(4,6).

Trichotomy is not considered an effective measure for infection control, but when performed, it is preferable to use specific equipment for this purpose with disposable blades and not razor or scalpel blades, performing it as close as possible to the beginning of the surgical procedure⁽⁹⁻¹⁰⁾. To be considered adequate, trichotomy must be performed with a trimmer or scissors up to two hours before the beginning of the surgery, and outside the surgical center. If trichotomy is performed outside the healthcare facility, regardless of the time or method used, it will be considered inadequate⁽⁶⁾.

Also, regarding preoperative care, nasal decolonization is performed by topical use of antibiotics in the nasal cavity, aiming to decrease contamination by organisms that inhabit the upper airways, especially *S. aureus*⁽³⁶⁾. Being a carrier of *S. aureus* increases the risk for developing surgical site infection, so nasal decolonization may be associated with a significantly reduced risk of general surgical site infection⁽³⁶⁻³⁷⁾.

Regarding patients submitted to surgery, between 18 and 30% are carriers of *S. aureus* and are three times more likely to develop surgical site infection or bacteremia⁽¹⁰⁾. It is recommended that nasal decolonization with topical mupirocin be universally applied in all patients⁽⁹⁻¹⁰⁾.

Regarding the use of antibiotics, it is recommended that prophylaxis in heart surgery be done with the use of parenterally administered cephalosporins up to 60 minutes before the first surgical incision and continued for up to 48 hours after the end of surgery. If the duration of the procedure exceeds 4h, a new dose should be given⁽⁹⁻¹⁰⁾. The antibiotic prophylaxis is con-

sidered adequate when performed up to 60 minutes before the incision and lasting less than 24h after the surgical procedure⁽⁶⁾. The choice of drug may vary according to the type of surgery, the patient's history, and the protocols of each institution^(1,4).

International agencies also recommend preoperative glycemic screening through the measurement of glycated hemoglobin because there is an association between levels below 6.5% and significant decreases in deep sternal wound infection, ischemic events, and other complications⁽¹⁰⁾. In Brazil, glycemic control in heart surgery is considered adequate when glycemia is maintained < 200mg/dL in the first 6 hours postoperatively⁽⁶⁾.

Low glycemic levels may also be harmful. Consumption of clear liquids in the period of 2 to 4 hours before general anesthesia has been shown to be beneficial, impacting the reduction of postoperative complications⁽³⁸⁾. Patients who received carbohydrate-rich liquid drinks in this period had lower infection rates and shorter time of dependence on vasoactive drugs⁽³⁹⁾.

Regarding behavioral factors, smoking stands out mainly because of its direct association with chronic obstructive pulmonary disease. In the preoperative period, it is possible to perform screening by means of validated tools for cigarette abuse. Smoking is associated with respiratory problems, delayed wound healing, increased risk of bleeding, metabolic complications, and increased propensity to infectious complications^(10,16). Smoking cessation in the four weeks preceding the surgical procedure is associated with better postoperative outcomes; however, this intervention is not possible in cases of urgent and emergency surgery⁽¹⁰⁾.

Another important factor to be considered is the length of hospital stay that precedes the surgical procedure. The risk of the patient developing infections related to assistance increases proportionally to the length of hospital stay, and the preoperative length of stay is an independent risk factor for postoperative

infections^(9,40). The length of preoperative hospital stay is considered adequate when it is less than 24 hours before the surgery⁽⁶⁾.

In the trans-operative period, skin antisepsis should be performed with alcohol-based antiseptic agent, unless there is some contraindication⁽¹⁾. Antisepsis of the operative field is considered adequate when performed with the use of degerming antiseptic followed using alcohol solution^(1,6).

Systemic arterial hypertension was the second most cited comorbidity in patients who developed surgical site infection. It is not uncommon for patients aged 51 to 70 years to have dyslipidemia in addition to hypertension. Dyslipidemia is the main cause of atheroma plaque formation in blood vessels, causing coronary artery disease⁽⁴¹⁻⁴²⁾. When the unblocking cannot be achieved through angioplasty with stent placement, the patient must undergo myocardial revascularization surgery⁽⁴¹⁾.

Evidences also shows the relationship between obesity (body mass index >35) and increased postoperative morbidity and mortality, with significant increase in costs during hospitalization⁽⁴³⁾. Obesity and overweight are directly related to the emergence of a series of other comorbidities and possible complications, especially in relation to the cardiovascular system, obesity being statistically associated with coronary diseases and, consequently, with heart surgeries^(18,42).

Besides surgical site infection, there are other non-surgical Healthcare-Related Infections that may be associated with the performance of heart surgery due to the profile of the patients, the prevalence of one or more comorbidities, among them, the correlation between these comorbidities and infectious outcomes, in addition to exposure to various factors that interfere with the incidence of non-surgical infections, such as admission to intensive care and the use of invasive devices like central venous catheter, indwelling urinary catheter, and mechanical ventilation⁽⁴¹⁾.

Regarding the main microorganisms isolated in surgical site infection cultures, *S. aureus* ranked first.

S. aureus is the gram-positive pathogen most associated with infections and can be transmitted directly or indirectly, either by the patient's own skin flora or through contamination during the procedure itself⁽⁴⁴⁾. Corroborating this information, an integrative review that analyzed 56 articles identified that most health care-related infections were caused by *Staphylococcus aureus* (39.2%), and the minority of cases were associated with gram-negative infection⁽⁴⁵⁾.

The presence of these microorganisms indicates that most surgical site infections are caused by endogenous microorganisms, present in the patient's microbiota and in the hands and equipment of health professionals or used during the surgical procedure. This indicates that the main cause of contamination may be related to inadequate hand hygiene performed by the surgical team, incorrect skin preparation, inadequate use of surgical drapes and non-compliance of the surgical technique with aspects of asepsis in the trans-operative period^(42-43,45).

Study limitations

As a limitation of the study, we mention the fact that some texts were not freely accessible and could not be accessed through institutional partnerships, which hindered the search. Another fact was the impossibility of reviewing the bibliographic references cited by the selected articles.

Contributions to practice

Knowing the profile of patients who developed infection favors the planning of risk control actions. Based on this synthesis of information, it is essential to adopt preventive measures through a multidisciplinary approach, involving care teams, infection control professionals and the patient safety center, seeking proposals that improve the quality of care and postoperative prognosis, and that, together, the multidisciplinary team and the nurse develop intervention plans for patients at risk of infection due to heart surgery.

Conclusion

The epidemiological profile of patients undergoing heart surgery is composed mostly of men aged between 51 and 70 years. The most prevalent comorbidities were diabetes mellitus, hypertension, and obesity. The most common surgical procedure was elective coronary artery bypass grafting. Given these results, it can be inferred that surgical site infection is linked to several factors, such as preoperative hospital stay, epidemiological profile, presence of comorbidities and appropriate management in the perioperative period. The occurrence of surgical site infection is linked to other complications, higher mortality rates, hospitalization costs, and length of hospital stay.

When describing the profile of patients who developed surgical site infection after surgical treatment, it can be inferred that most cases could be prevented by simple actions, including preoperative shower, antibiotic prophylaxis, glycemic control, smoking management, reduced hospital stay, nasal decolonization and other safe surgery strategies. The infection control service, health surveillance, and multi-professional commitment are critical to the success of these protective measures. The more these data are disseminated and known, the greater the chances of reducing surgical site infection.

Acknowledgments

To the National Council for Scientific and Technological Development for granting a scientific initiation scholarship to Lucas Dalvi Armond Rezende, and to the Coordination for the Improvement of Higher Education Personnel in partnership with the Federal Council of Nursing, for the support of master's student Alcy Leal Aranha.

Authors' contribution

Conception and design, data analysis and interpretation: Fiorin BH, Costa B, Rezende LDA, Barbieri BM.

Writing of the manuscript or relevant critical review of the intellectual content: Fiorin BH, Costa B, Rezende LDA, Aranha AL, Barbieri BM, Sipolatti WGR, Moreira RSL.

Final approval of the version to be published: Fiorin BH, Costa B, Rezende LDA, Aranha AL, Barbieri BM, Sipolatti WGR, Moreira RSL.

Agreement to be responsible for all aspects of the manuscript related to the accuracy or completeness of any part of the manuscript to be properly investigated and resolved: Fiorin BH, Costa B, Rezende LDA.

References

1. Ling ML, Apisarnthanarak A, Abbas A, Morikane K, Lee KY, Warriar A, et al. APSIC guidelines for the prevention of surgical site infections. *Antimicrob Resist Infect Control*. 2019;8:174. doi: <https://dx.doi.org/10.1186/s13756-019-0638-8>
2. Ansari S, Hassan M, Barry HD, Bhatti TA, Hussain SZM, Jabeen S, et al. Risk factors associated with surgical site infections: a retrospective report from a developing country. *Cureus*. 2019;11(6):e4801. doi: <http://dx.doi.org/10.7759/cureus.4801>
3. Santos AJ, Rodrigues DE, Andrade VLC, Martins GM, Rodrigues TE. Infecção de sítio cirúrgico em cirurgias cardíacas realizadas em um hospital filantrópico acreditado. *Braz J Health Rev*. 2021;4(3):9635-46. doi: <https://dx.doi.org/10.34119/bjhrv4n3-003>
4. Agência Nacional de Vigilância Sanitária (ANVISA). Nota técnica nº 02/2021 GVIMS/GGTES/ANVISA-critérios diagnósticos de IRAS [Internet]. 2021 [cited May 12, 2022]. Available from: <https://www.gov.br/anvisa/pt-br/centraisdeconteudo/publicacoes/servicosdesaude/notas-tecnicas/nt-022021-revisada-criterios-diagnosticos-de-iras-050521.pdf/view>
5. Kahl ERPY, Brião RC, Costa LM, Silveira LR, Moraes MAP. Ambulatory setting of patients with surgical site infections after a cardiac intervention. *Rev Gaúcha Enferm*. 2019;40:e20180200. doi: <https://doi.org/10.1590/1983-1447.2019.20180200>
6. Agência Nacional de Vigilância Sanitária (ANVISA). Critérios diagnósticos de infecção relacionada à assistência à saúde. série: segurança do paciente

- e qualidade em serviços de saúde [Internet]. 2017 [cited May 12, 2022]. Available from: https://bvsms.saude.gov.br/bvs/publicacoes/criterios_diagnosticos_infecoes_assistencia_saude.pdf
7. O'Brien WJ, Gupta K, Itani KMF. Association of post-operative infection with risk of long-term infection and mortality. *JAMA Surg.* 2020;155(1):61-8. doi: <http://doi.org/10.1001/jamasurg.2019.4539>
 8. Ferreira GB, Donadello JCS, Mulinari LA. Healthcare-Associated Infections in a Cardiac Surgery Service in Brazil. *Braz J Cardiovasc Surg.* 2020;35(5):614-8. doi: <https://dx.doi.org/10.21470/1678-9741-2019-0284>
 9. Centers for Disease Control and Prevention (CDC). National Healthcare Safety Network (NHSN) Patient Safety Component Manual [Internet]. 2019 [cited May 23, 2022]. Available from: https://www.cdc.gov/nhsn/pdfs/pscmanual/pscmanual_current.pdf
 10. Engelman DT, Ben Ali W, Williams JB, Perrault LP, Reddy VS, Arora RC, et al. Guidelines for perioperative care in cardiac surgery: enhanced recovery after surgery society recommendations. *JAMA Surg.* 2019;154(8):755-66. doi: <https://dx.doi.org/10.1001/jamasurg.2019.1153>
 11. Kaspersen AE, Nielsen SJ, Orrason AW, Petursdottir A, Sigurdsson MI, Jeppsson A, et al. Short- and long-term mortality after deep sternal wound infection following cardiac surgery: experiences from SWEDEHEART. *Eur J Cardiothorac Surg.* 2021;60(2):233-41. doi: <http://dx.doi.org/10.1093/ejcts/ezab080>
 12. Fernandez FG, Shahian DM, Kormos R, Jacobs JP, D'Agostino RS, Mayer Jr JE, et al. The Society of Thoracic Surgeons National Database 2019 Annual Report. *Ann Thorac Surg.* 2019;108(6):1625-32. doi: <https://dx.doi.org/10.1016/j.athoracsur.2019.09.034>
 13. Braz NJ, Evangelista SS, Evangelista SS, Garbaccio JL, Oliveira AC. Surgical site infection in patients submitted to cardiac surgeries: an epidemiological profile analysis. *Rev Enf Cent-Oeste Min.* 2018;8:1793. doi: <https://dx.doi.org/10.19175/recom.v8i0.1793>
 14. Mendes KDS, Silveira RCCP, Galvão CM. Use of the bibliographic reference manager in the selection of primary studies in integrative reviews. *Texto Con-*
texto Enferm. 2019;28:e20170204. doi: <https://doi.org/10.1590/1980-265X-TCE-2017-0204>
 15. Andrade LS, Siliprandi EMO, Karsburg LL, Berlesi FP, Carvalho OLDF, Rosa DSD, et al. Surgical Site Infection Prevention Bundle in Cardiac Surgery. *Arq Bras Cardiol.* 2019;112(6):769-74. doi: <http://dx.doi.org/10.5935/abc.20190070>
 16. Barros CSMA, Cordeiro ALAO, Castro LSA, Conceição MM, Oliveira MMC. Risk factors for surgical site infection in cardiac surgical procedures. *Rev Baiana Enferm.* 2018;32:e26045. doi: <https://dx.doi.org/10.18471/rbe.v32.26045>
 17. Nicolini F, Santarpino G, Gatti G, Reichart D, Onorati F, Faggian G, et al. Utility of glycated hemoglobin screening in patients undergoing elective coronary artery surgery: prospective, cohort study from the E-CABG registry. *Int J Surg.* 2018;53:354-9. doi: <http://dx.doi.org/10.1016/j.ijsu.2018.04.021>
 18. Santo LS, Moscariello C, Zebele C. Implications of obesity in cardiac surgery: pattern of referral, physiopathology, complications, prognosis. *J Thorac Dis.* 2018;10(7):4532-9. doi: <https://dx.doi.org/10.21037/jtd.2018.06.104>
 19. Cotogni P, Barbero C, Passera R, Fossati L, Olivero G, Rinaldi M. Violation of prophylactic vancomycin administration timing is a potential risk factor for rate of surgical site infections in cardiac surgery patients: a prospective cohort study. *BMC Cardiovasc Disord.* 2017;17(1):73. doi: <https://dx.doi.org/10.1186/s12872-017-0506-5>
 20. Mahmood E, Knio ZO, Mahmood F, Amir R, Shahul S, Mahmood B, et al. Preoperative asymptomatic leukocytosis and postoperative outcome in cardiac surgery patients. *PLoS One.* 2017;12(9):e0182118. doi: <https://dx.doi.org/10.1371/journal.pone.0182118>
 21. Zittermann A, Kuhn J, Ernst JB, Becker T, Larisch J, Dreier J, et al. Circulating 25-Hydroxyvitamin D and 1,25-Dihydroxyvitamin D concentrations and postoperative infections in cardiac surgical patients: the CALCITOP-study. *PLoS One.* 2016;11(6):e0158532. doi: <https://dx.doi.org/10.1371/journal.pone.0158532>
 22. Ng RR, Myat OA, Liu W, Tan TE, Ti LK, Chew ST. Changing glucose control target and risk of surgical site infection in a Southeast Asian population. *J*

- Thorac Cardiovasc Surg. 2015;149(1):323-8. doi: <http://dx.doi.org/10.1016/j.jtcvs.2014.08.076>
23. Omar AS, Salama A, Allam M, Elgohary Y, Mohammed S, Tuli AK, et al. Association of time in blood glucose range with outcomes following cardiac surgery. *BMC Anesthesiol.* 2015;15(1):14. doi: <http://dx.doi.org/10.1186/1471-2253-15-14>
 24. Gelijns AC, Moskowitz AJ, Acker MA, Argenziano M, Geller NL, Puskas JD, et al. Cardiothoracic Surgical Trials Network (CTSNet). Management practices and major infections after cardiac surgery. *J Am Coll Cardiol.* 2014;64(4):372-81. doi: <http://dx.doi.org/10.1016/j.jacc.2014.04.052>
 25. Kelava M, Robich M, Houghtaling PL, Sabik JF, Gordon S, Mihaljevic T, et al. Hospitalization before surgery increases risk for postoperative infections. *J Thorac Cardiovasc Surg.* 2014;148(4):1615-1621.e3. doi: <https://dx.doi.org/10.1016/j.jtcvs.2014.06.067>
 26. Conterno LO, Toni SM, Konkiewitz RG, Guedes ES, Barros RT, Tiveron MG. Impact of hospital infections on patients outcomes undergoing cardiac surgery at Santa Casa de Misericórdia de Marília. *Rev Bras Cir Cardiovasc.* 2014;29(2):167-76. doi: <http://doi.org/10.5935/1678-9741.20140037>
 27. Andrade EV, Barbosa MH, Mattia AL. Predictors of healthcare associated infections in heart surgery. *Rev Eletr Enferm.* 2013;15(4):965-72. doi: <http://dx.doi.org/10.5216/ree.v15i4.21280>
 28. Rahmanian PB, Kröner A, Langebartels G, Özel O, Wippermann J, Wahlers T. Impact of major non-cardiac complications on outcome following cardiac surgery procedures: logistic regression analysis in a very recent patient cohort. *Interact Cardiovasc Thorac Surg.* 2013;17(2):319-26. doi: <http://dx.doi.org/10.1093/icvts/ivt149>
 29. Chen LF, Arduino JM, Sheng S, Muhlbaier LH, Kanafani ZA, Harris AD, et al. Epidemiology and outcome of major postoperative infections following cardiac surgery: risk factors and impact of pathogen type. *Am J Infect Control.* 2012;40(10):963-8. doi: <http://dx.doi.org/10.1016/j.ajic.2012.01.012>
 30. Hosseinrezaei H, Rafiei H, Amiri M. Incidence and risk factors of sternal wound infection at site of incision after open-heart surgery. *J Wound Care.* 2012;21(8):408-11. doi: <https://dx.doi.org/10.12968/jowc.2012.21.8.40>
 31. Koch CG, Nowicki ER, Rajeswaran J, Gordon SM, Sabik JF, Blackstone EH. When the timing is right: Antibiotic timing and infection after cardiac surgery. *J Thorac Cardiovasc Surg.* 2012;144(4):931-937.e4. doi: <https://dx.doi.org/10.1016/j.jtcvs.2012.01.087>
 32. Magalhães MGPA, Alves LMO, Alcantara LFM, Bezerra SMMS. Post-operative mediastinitis in a heart hospital of Recife: contributions for nursing care. *Rev Esc Enferm USP.* 2012;46(4):865-71. doi: <https://dx.doi.org/10.1590/S0080-62342012000400012>
 33. Silva QC, Barbosa MH. Risk factors for surgical site infection in cardiac surgery. *Acta Paul Enferm.* 2012;25(spe2):89-95. doi: <https://dx.doi.org/10.1590/s0103-21002012000900014>
 34. Lola I, Levidiotou S, Petrou A, Arnaoutoglou H, Apostolakis E, Papadopoulos GS. Are there independent predisposing factors for postoperative infections following open heart surgery? *J Cardiothorac Surg.* 2011;6:151. doi: <https://dx.doi.org/10.1186/1749-8090-6-151>
 35. Manniën J, Wille JC, Kloek JJ, van Benthem BH. Surveillance and epidemiology of surgical site infections after cardiothoracic surgery in The Netherlands, 2002-2007. *J Thorac Cardiovasc Surg.* 2011;141(4):899-904. doi: <https://dx.doi.org/10.1016/j.jtcvs.2010.09.047>
 36. Navirian H, Navyashree G. Antimicrobial prophylaxis uses and incidence of surgical site infection in Jayanagar General Hospital, Bangalore, India. *J Family Med Prim Care.* 2022;11(3):1179-83. doi: https://doi.org/10.4103/jfmpc.jfmpc_1068_21
 37. Tang J, Hui J, Ma J, Mingquan C. Nasal decolonization of *Staphylococcus aureus* and the risk of surgical site infection after surgery: a meta-analysis. *Ann Clin Microbiol Antimicrob.* 2020;19(1):33. doi: <https://doi.org/10.1186/s12941-020-00376-w>
 38. Robich MP, Iribarne A, Leavitt BJ, Malenka DJ, Quinn RD, Olmstead EM, et al. Northern New England Cardiovascular Disease Study Group. Intensity of glycemic control affects long-term survival after coronary artery bypass graft surgery. *Ann Thorac Surg.* 2019;107(2):477-84. doi: <https://dx.doi.org/10.1016/j.athoracsur.2018.07.078>
 39. Bouza E, de Alarcón A, Fariñas MC, Gálvez J, Goenaga MÁ, Gutiérrez-Díez F, et al. Prevention, diag-

- nosis and management of post-surgical mediastinitis in adults Consensus Guidelines of the Spanish Society of Cardiovascular Infections (SEICAV), the Spanish Society of Thoracic and Cardiovascular Surgery (SECTCV) and the Biomedical Research Centre Network for Respiratory Diseases (CIBERES). *J Clin Med*. 2021;10(23):5566. doi: <http://dx.doi.org/10.3390/jcm10235566>
40. Sulzgruber P, Schnaubelt S, Koller L, Laufer G, Pilz A, Kazem N, et al. An extended duration of the preoperative hospitalization is associated with an increased risk of healthcare-associated infections after cardiac surgery. *Sci Rep*. 2020;10:8006. doi: <https://doi.org/10.1038/s41598-020-65019-8>
 41. Aneman A, Brechot N, Brodie D, Colreavy F, Fraser J, Gomersall C, et al. Advances in critical care management of patients undergoing cardiac surgery. *Intensive Care Med*. 2018;44(6):799-810. doi: <http://doi.org/10.1007/s00134-018-5182-0>
 42. Sousa ALL, Batista SR, Sousa AC, Pacheco JAS, Vitorino PVO, Pagotto V. Hypertension prevalence, treatment and control in older adults in a Brazilian capital city. *Arq Bras Cardiol*. 2019;112 (3):271-8. doi: <https://doi.org/10.5935/abc.20180274>
 43. Knuuti J, Wijns W, Saraste A, Capodanno D, Barbato E, Funck-Brentano C, et al. ESC Scientific Document Group. Guidelines for the diagnosis and management of chronic coronary syndromes. *Eur Heart J*. 2020;41(3):407-77. doi: <https://dx.doi.org/10.1093/eurheartj/ehz425>
 44. Brunet A, N'Guyen Y, Lefebvre A, Poncet A, Robbins A, Bajolet O, et al. Obesity and preoperative anaemia as independent risk factors for sternal wound infection after coronary artery bypass graft surgery with pedicled (non-skeletonized) internal mammary arteries: the role of thoracic wall ischemia? *Vasc Health Risk Manag*. 2020;16:553-9. doi: <http://dx.doi.org/10.2147/VHRM.S264415>
 45. Costa ACD, Santa-Cruz F, Ferraz AAB. What's new in infection on surgical site and antibiotic prophylaxis in surgery? *Arq Bras Cir Dig*. 2021;33(4):e1558. doi: <https://doi.org/10.1590/0102-672020200004e1558>



This is an Open Access article distributed under the terms of the Creative Commons