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Original Article

Associations between surgical wound infectious and clinical profile in patients undergoing cardiac surgery

Andryele Santana Miranda[1*], Giovanna Bianca Figueira Rocha[1*], Omar Pereira de Almeida Neto[1*], Leonardo Daniel Reis Santos[1*], Maria Beatriz Guimarães Ferreira[1*], Patricia Magnabosco[1*], Iolanda Alves Braga[2*], Valeria Nasser Figueiredo[1*]

[1]Department of Medicine, Federal University of Uberlandia, Brazil; [2]Clinical Hospital of Uberlandia, State of Minas Gerais, Brazil. [*]Equal contributors.

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Abstract: Background: Infections are surgical severe adverse events that pose risks to patient safety in health services, in addition to increasing costs and morbidity and mortality. Aim: This study aims to describe the infectious profile of patients undergoing cardiac surgery and associate comorbidities and lifestyle habits with surgical wound infection. Design: Observational and retrospective study. Methods: The study included 453 patients undergoing cardiac surgery in a public teaching hospital from January 2014 to January 2019. Data were collected from the clinical records through an instrument composed of variables clinical characteristics, comorbidities, life habits, infection rates, infectious agents, clinical management and surgical wound features. Simple frequency, measures of central tendency and variability, Chi-Square test and logistic regression were used for data analysis. Results: There was a predominance of hypertensive patients (367; 81%), smokers (107; 23.6%), alcoholics (76; 16.8%). Surgical wound infection affected 86 (19%) patients. Besides, most patients were under antibiotic therapy (310; 68.4%). Klebsiella pneumoniae; Staphylococcus epidermides and Staphylococcus aureus were the most frequent pathogens. Diabetes Mellitus, nephropathy and age were statistically significant ($P<0.05$) for higher risk of surgical wound infection. Conclusion: Chronic diseases and lifestyle habits were related to postoperative infection. More research is needed, focusing on risk factors for the development of surgical wound infection.

Keywords: Surgical wound infection, cardiac surgical procedures, health profile, patient safety

Introduction

Although advances in scientific studies, both in treatment and prevention, cardiovascular diseases (CVDs) are considered the leading causes of death worldwide [1]. This is also observed in Brazil through academic studies, which reveal statistical data of 20% of the Brazilian population's mortality due to heart problems, characterizing a relevant theme in the health of Brazilians, and the need for methods that contribute to the reduction of this statistic [1, 2].

CVDs can be treated in two ways, depending on whether their etiology: using medications and surgeries. However, it is essential to emphasize that this treatment method may evolve with some complications, mainly Infections related to Health Care (IRAS) [3].

Infection at the surgical site is the presence and development of pathological agents at the operation site. The condition increases the patient's hospital stay in the hospital environment by 60%, in addition to the treatment costs, and exposes the individual to the risk of death, mainly due to sepsis [4].

Even with preventive recommendations from the National Health Surveillance Agency (ANVISA), several factors contribute to the increase in the rate of hospital infection, such as poor preparation of the preoperative period, environment, lack of personal protective equipment of the team, and sterilization of materials [5]. Previous researches show that mediastinitis, pneumonia, and sepsis are highlighted as the most frequent and severe infectious complications of the postoperative cardiac period [6-8].

Based on studies that identify risk factors related to the occurrence of infections, hospitals and complex care clinics may have subsidies for the adoption of prevention, monitoring, and infectious treatment strategies, allowing more excellent safety for the surgical patient [9].

Although many studies have indicated high rates of postoperative infections in cardiac surgery, we have not found associations between surgical wound infection and the profile of patients undergoing cardiac surgery, their comorbidities, and lifestyle habits. Also, by relating the clinical and sociodemographic conditions of individuals undergoing cardiac surgeries that evolved with hospital infections, specifically from the surgical site, care planning can be improved, considering the patient's clinical history and diseases.

This study aims to describe the infectious profile of patients undergoing cardiac surgery and associate comorbidities and lifestyle habits with surgical wound infection.

Methods

Study design

Observational and retrospective study with a quantitative approach from documentary analysis.

Study site and participants

The study was undertaken in a large public teaching hospital in Uberlandia, Minas Gerais State-Brazil, composed of 520 beds and assists an estimated population of 1.2 million habitants. Data collection occurred from March-July 2020.

The study population consisted of patients who underwent cardiac surgery in the hospital from January 2014 to January 2019; according to data provided by the hospital's statistics department, 647 cardiac surgeries were performed in this period. The inclusion criteria were: 1) Being over 18 years old; 2) Medical criteria to be undergoing surgery procedure; 3) Cardiovascular indications to be undergoing specific cardiac surgery (coronary revascularization, valvuloplasty, angioplasty); 4) Patients with ischemic heart disease, especially those with myocardial infarction; 5) Patients with failed angioplasty with persistent ischemia refractory to hemodynamic instability; 6) Cases of ischemia refractory to drug therapy and cardiogenic shock; 7) Patients with unstable precordial pain, in silent ischemia with multivessel follow-up; 8) Patients with persistent ischemia even with drug therapy; 9) Patients who have not been successful with other types of surgery.

The exclusion criteria were: 1) Diagnosis of infection before the surgical procedure; 2) Hypertrophic or restrictive cardiomyopathy; 3) Heart failure NYHA IV; 4) Use of inotropic drugs and intra-aortic balloon; 5) Cardiac cachexia; 6) Presence of severe arrhythmias; 7) Patients with aortic insufficiency, aortic dissection and or severe peripheral arterial disease; 8) Medical reports insufficient to provide clinical data to researches.

Study protocol

Data were collected from the medical records, by the researchers, in the Medical Archive Service of the hospital. The hospital's statistics department was asked to survey cardiac surgical procedures from January 2014 to January 2019. Thus, the researchers performed the full reading of all clinical records so that the data collection instrument was completed. For data collection, the researchers prepared a tool, which was submitted to apparent validation of face and content by five experts, consisted of the following items: gender; age; length of stay; time after surgery; clinical characteristics (weight; height and vital signs); comorbidities; smoking and alcohol consumption; infection in different sites and pathogen; clinical management and characteristics of the surgical wound.

Data analysis

The data were stored in the Microsoft Office Excel program® 2016 by double typing and validation, and then imported into the Statistical Package for the Social Sciences® (SPSS) software, version 23, for statistical analysis. Categorical variables were presented as absolute and relative frequencies; and quantitative variables were presented as measures of descriptive centrality (mean) and dispersion (standard deviation [SD]), along with minimum and maximum values. The bivariate analysis

Table 1. Clinical characteristics of patients undergoing cardiac surgery in a Brazilian public hospital, 2014-2019 (n=453)

VARIABLE	MINIMUN	MAXIMUM	MEAN ± SD
Weight	35	127	73.38±14.0
Height	133	201	166.1±8.4
Axillary temperature	33	39	36.08±2.9
Respiratory Rate	10	77	19.37±5.1
Sat O_2%	51	100	95.18±3.6
Cardiac Rate	16	149	76.98±16.8
Systolic Blood Pressure	62	212	129.7±22.8
Diastolic Blood Pressure	38	120	76.19±14.3

Sat O_2%: Peripheral oxygen saturation; SD: standard deviation.

Table 2. Comorbidities and lifestyle habits of patients undergoing cardiac surgery in a Brazilian public hospital, 2014-2019

VARIABLES	n	%
Hypertension	367	81.0
Dyslipidemia	203	44.8
Heart attack	182	40.2
Diabetes Mellitus	157	34.7
Ex-smoking	156	34.4
Heart failure	151	33.3
Obesity	110	24.3
Valvopathy	63	13.9
Nephropathy	51	11.3
Lung diseases	49	10.8
Ex-ethylic	39	8.6
Brain stroke	33	7.3
Peripheral vascular disease	18	4.0
Smoking	107	23.6
Alcoholism	76	16.8

between lifestyle habits and comorbidities and infection of the surgical wound was performed using the Chi-Square test, considering all variables as dichotomous. Simultaneous Analysis of Influence predictors (Male Gender; Age; Diabetes Mellitus; Obesity; Peripherical vascular diseases; Nephropathy; Heart failure; Ethylic) for occurrence of surgical wound infection, binary logistic regression model was considered. These predictors were appointed according to previous researches [5, 8]. The results were considered significant at α=0.05 (5%).

Ethical considerations

The data collection occurred after approval by the Ethics Committee in Research, number 61307816.5.0000.5152, protocol number 1715990, according to National Health Council Resolution 466/2012 of the Brazilian Ministry of Health.

The Consent Form was not collected because the study is retrospective and was based on secondary data, present in the medical records. Also, the hospital under investigation is a reference for 86 municipalities; patients may not reside in the city of the hospital under study or have died, which would make it impossible to collect the Term.

Results

The study included 453 patients; 194 were excluded after analyzed inclusion and exclusion criteria.

Most of the study participants were male (n= 313; 69.1%) with a mean age of 59.9±12.2 years, minimum of 19 years old, and a maximum of 97 years old. The mean time after surgery was 2.79±1.4 years, minimum of one, and a maximum of five years, while the length of hospital stay was approximately 36.47±28.7 days, a minimum of two and a maximum of 190 days. The clinical profile of the patients evaluated in the medical records is shown in **Table 1**.

There was a predominance of hypertensive patients (367; 81%), dyslipidemia (203; 44.8%), and with a history of acute myocardial infarction (182; 40.2%). As for lifestyle habits, were detected that 107 (23.6%) individuals were smokers, 156 (34.4%) ex-smokers, 76 (16.8%) alcoholics and 39 (8.6%) ex-alcoholics (**Table 2**).

The incidence of infection from a different site, clinical management, and characteristics of the surgical wound is presented in **Table 3**. Among the different infection sites in patients submitted to cardiac surgery, the infection was predominant in the surgical wound (86; 19%), and most patients were under antibiotic therapy (310; 68.4%). It was observed that there was secretion in the surgical wound in 92 patients (20.3%), swab collection performed in 92 (20.3%), evidencing acceptable conduct in the identification of the infectious agent.

Table 4 describes the infectious agent of the different sites of infection of patients in this study. The microorganism *Klebsiella pneumo-*

Table 3. Site infection, medical management and characteristics of the surgical wound in patients undergoing cardiac surgery in a Brazilian public hospital, 2014-2019

VARIABLE	n	%
Surgical Wound Infection	86	19.0
Respiratory System Infection	48	10.6
Genitourinary System Infection	30	6.6
Cardiovascular System Infection	30	6.6
Idiopathic Infection	20	4.4
Infection Tegumentary System	17	3.8
Osteoarticular System Infection	8	1.8
Infection Digestive System	4	0.9
Using antibiotics	310	68.4
Antibiogram	101	22.3
SWAB Collection	92	20.3
Secretion	92	20.3
Blushing	70	15.5
Pain	62	13.7
Heating	59	13
Edema	59	13
Dehiscence	50	11

Table 4. Infectious agent of the different sites of infection of patients undergoing cardiac surgery in a Brazilian public hospital, 2014-2019 (n=453)

VARIABLES	n	%
Klebsiella pneumoniae	30	6.6
Staphylococcus epidermidis	22	4.9
Serratia marcescens	14	3.1
Enterobacter cloacae	11	2.4
Escherichia coli	10	2.2
Acinetobacter Bahmani	8	1.8
Pseudomonas aeruginosas	8	1.8
Enterococcus faecalis	5	1.1
Proteus mirabilis	3	0.7
Klebsiella oxytocic	2	0.4
Candida albicans	2	0.4
Staphylococcus lugdinesis	2	0.4
Stenotrophonas cst	2	0.4
Corynebacterium meningosepticum	1	0.2
Pseudomonas fluorescenses	1	0.2
Coco Gram +	1	0.2
Streptococcus agalactia	1	0.2
Proteus hauser	1	0.2

niae appears in 6.6% cases (n=30); followed by the Staphylococcus epidermides (22; 4.9%) and Staphylococcus aureus (17; 3.8%).

Bivariate analysis (chi square test) has shown associations between the occurrence of surgical wound infection and Diabetes Mellitus (0.49) when compared to non-diabetic individuals (0.31; P<0.01); Nephropathic patients had a higher mean infection (0.20) compared to those who did not have nephropathy (0.09; P<0.01); Alcoholic patients had a lower mean infection (0.10) than those who were not alcoholics (0.18; P<0.05) (**Table 5**).

Furthermore, when adjusting for possible confounding, the logistic regression analysis model showed that age, diabetes mellitus, and nephropathy presented a higher risk for the development of surgical wound infection, with differences statistically significant (**Table 6**).

Discussion

Regarding the epidemiological profile of patients undergoing cardiac surgery, Braz and collaborators [3] conducted a study in a large University Hospital, through the analysis of 280 medical records, which indicated an average age of patients aged 58 years, 65.8% male, 70.8% married and 52 cases of surgical site infection. It is known that female patients over 45 years and males over 55 have higher risks of developing heart diseases [3]. Other previous research showed the same data: age ranged from 32 to 83 years (mean of 63.59± 13.83), of which 63% were male and just 37% female [10].

Concerning weight, height, and obesity (as comorbidity), this study demonstrated important data (Mean ± SD), leading to conclude that nutritional habits need be improved in cardiac patients once these variables directly influence surgical outcomes. Studies have indicated post-surgical complications in obese patients such as high levels of infections [11].

Several studies have pointed comorbidities such as high blood pressure, nephropathy, chronic obstructive pulmonary diseases, obesity, and dyslipidemia associated with heart diseases and worse post-surgical prognoses [3]. Also, high blood pressure is one of the significant risk factors for the development of other CVDs, in addition to complications such as heart attack and stroke [12]. A recent study indicated hypertension evidenced in 81% of cardiac surgical patients, followed by other

Table 5. Association between comorbidities and lifestyle habits and surgical wound infection in patients undergoing cardiac surgery in a Brazilian public hospital, 2014-2019 (n=86)

VARIABLES	SURGICAL WOUND INFECTION		P*
	YES	NO	
Diabetes Mellitus	0.49	0.31	0.004
High blood pressure	0.83	0.81	0.68
Obesity	0.28	0.23	0.40
Peripherical vascular diseases	0.05	0.04	0.73
Dyslipidemia	0.48	0.44	0.55
Heart attack	0.42	0.40	0.72
Brain stroke	0.10	0.07	0.27
Lung diseases	0.09	0.11	0.60
Nephropathy	0.20	0.09	0.024
Heart failure	0.35	0.33	0.73
Valvopathy	0.15	0.14	0.72
Smoking	0.22	0.24	0.70
Ex-smoking	209.48	232.62	0.53
Ethylic	0.10	0.18	0.047
Ex-ethylic	294.36	306.77	0.75

*p-level of significance: P<0.05.

Table 6. Binary Logistic Regression Model between clinical variables and surgical wound infection in patients undergoing cardiac surgery in a Brazilian public hospital, 2014-2019 (n=86)

VARIABLES	β (CI)	P
Male Gender	1.084 (0.641-1.833)	0.763
Age	1.025 (1.003-1.047)	0.028*
Diabetes Mellitus	1.913 (1.156-3.166)	0.012*
Obesity	1.133 (0.637-2.017)	0.670
Peripherical vascular diseases	0.823 (0.252-2.684)	0.747
Nephropathy	2.168 (1.118-4.204)	0.022*
Heart failure	0.963 (0.571-1.624)	0.889
Ethylic	0.587 (0.273-1.262)	0.173

*p-level of significance: P<0.05; β (CI)-odds ratio adjusted (confidence interval).

previous diseases in 33%, diabetes mellitus in 30%, and dyslipidemia in 22% [10]. The same situation about comorbidities has been found in the present study.

The postoperative oxygen saturation had a high gap variation. The relationship between postoperative oxygen saturation and wound infections in adults undergoing cardiac surgery has not been determined in literature. Still, recent research designed a single-center prospective study to determine if the continuous monitoring of postoperative oxygen saturation could predict acute postoperative injury. The results showed thirty-five patients (28.9%) developed some acute cardiovascular injury [13]. It may have a relation with the healing process postoperative cardiac wounds and infections.

The results of this study corroborate with previously published research about postoperative complications of patients undergoing cardiac surgery, where complications were prevalent such as cardiac disorders, hospital infections, kidney, and pulmonary complications [14].

Some studies show some microorganisms more prevalent as causing postoperative infection, especially in cardiac surgeries, such as Klebsiella pneumoniae, Staphylococcus epidermidis, and Staphylococcus aureus [15, 16]. Another recent investigation showed the same perspective demonstrated in the present study; the rate of infection of the cardiac surgical site was 23.3%, with Klebsiella pneumoniae and S. epidermidis is the most frequently isolated microorganisms from the surgical wound [17].

In this study, 92 patients had secretion in the surgical wound, and all had this secretion collected and analyzed, indicating adequate care management. However, it is perceived that the most significant concern in diagnosing infections in the surgical wound is through the presence of secretion since the number of patients with operative wound infection (n=86; 19%) was higher than the number of inflammatory characteristics reported in medical records.

Although the World Health Organization (WHO) created and implanted safe surgery protocol at the national and international level, this study pointed out 243 cases of infections, affirming the need for incisive preventive actions in patients undergoing cardiac surgery.

Besides, nephropathic patients had a higher mean infection than those who did not have this comorbidity showed by bivariate analysis and through Binary Logistic Regression Model (P<0.05). In regression model, Nephropathy increase 2.16 probability of surgical wound infection. There is a hypothesis to explain these informations once drug immunosuppression in patients on kidney replacement therapy or even due to hypoalbuminemia [9]. A recent paper published showed that the receiver operating characteristic curve analysis of kidney oxygen saturation could predict the risk of acute kidney injury and other infections. Kidney oxygen saturation less than 65% (area under the curve-receiver operating characteristic, 0.679±0.054, 95% confidence interval, 0.573-0.785, P=0.002) and 20% decrease from baseline (area under the curve-receiver operating characteristic, 0.639±0.059, 95% confidence interval, 0.523-0.755, P=0.019) showed the better performance, respectively [13].

Regarding lifestyle habits, it was possible to notice that alcoholic patients had a lower mean infection than ex-alcoholics (P<0.05). However, studies show that alcohol consumption is a risk factor for developing cardiovascular diseases and greater susceptibility [3]. Hypothetically it is believed that ex-alcoholic patients in the present study may have developed nephropathies and immunosuppression, consequently statistically standing out the risk of infection of those patients who still use alcohol.

Furthermore, it was possible to analyze that the mean number of infections in diabetic patients was higher than those who did not have this comorbidity whether bivariate analysis (P<0.01) or binary logistic regression model (P<0.05). Our data pointed that diabetes can increase 1.91 chances of occur surgical wound infection. A study shows the negative impact of diabetes mellitus on physiological processes of cell recruitment for wound healing and consequently, the occurrence of postoperative infections [19, 20].

Finally, the age in regression model was statistically significant (P<0.05) increasing in 1.02 chances of surgical wound infection happen. As times years by, physiological changes occur, alteration and decrease in the response of the immune system, reasons to explain greater number of elderly hospitalizations. The most important feature of immunosenescence is the accumulation in the “immune space” of memory and effector cells as a result of stimulation caused by repeated clinical and subclinical infections and by continuous exposure to antigens (inhaling allergens, food, etc.). This state of chronic inflammation that characterizes senescence has a significant impact on survival and frailty. In addition, immunosenescence is characterized by a specific “remodeling” of the immune system, induced by oxidative stress, predisposing surgical wound infections, for instance [21, 22-25].

The quality of care, comorbidities, primary diseases of the individual, age, and lifestyle habits are contributing factors for the development of hospital infections, which are related to health care processes and may also result from invasive procedures, such as mechanical ventilation, surgeries, and the use of catheters, in addition to other factors such as the use of immunosuppressants and prolonged periods of hospitalization [21].

Conclusion

The present study achieved all objectives showing clinical and epidemiological profile of patients undergoing cardiac surgery, as well the incidence of infection wounds of 19%. Besides, were stablished significative associations between diabetes mellitus, nephropathy and ethylic habits with operatory wounds infection. Diabetes, age, nephropathy and gender (male) had important outcomes when undergone to binary logistic regression model leading to complex clinical inferences.

This kind of research can help epidemiological diagnosis of patients undergoing cardiac surgery so that healthcare professionals and managers can predict possible complications and management of similar clinical cases. In other words, they contribute to the safe and effective clinical care.

Although some limitations are present (incomplete clinical records and documentary-based study, for instance) the study has the potential to support future research with a similar theme, where we can explore deeper collection and analysis methods, with more predictive power and clinical inference.

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Disclosure of conflict of interest

None.

Address correspondence to: Dr. Omar Pereira de Almeida Neto, Cardiovascular Science, Health Attention, Federal University of Uberlandia, Pará Avenue, Minas Gerais State 38400-902, Brazil. Tel: +55 34 3218-2000; E-mail: omar.almeida@ufu.br

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