ORIGINAL ARTICLE

Rev Bras Cir Cardiovasc 2014;29(2):167-76

Impact of hospital infections on patients outcomes undergoing cardiac surgery at Santa Casa de Misericórdia de Marília

Impacto das infecções hospitalares na evolução de pacientes submetidos à cirurgia cardíaca na Santa Casa de Misericórdia de Marília

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DOI: 10.5935/1678-9741.20140037

RBCCV 44205-1537

Abstract

Objective: **this study aimed to determine the incidence of nosocomial infections, the risk factors and the impact of these infections on mortality among patients undergoing to cardiac surgery.**

Methods: **Retrospective cohort study of 2060 consecutive patients from 2006 to 2012 at the Santa Casa de Misericórdia de Marília.**

Results: **351 nosocomial infections were diagnosed (17%), 227 non-surgical infections and 124 surgical wound infections. Major infections were mediastinitis (2.0%), urinary tract infection (2.8%), pneumonia (2.3%), and bloodstream infection (1.7%). The in-hospital mortality was 6.4%. Independent variables associated with non-surgical infections were age ≥ 60 years (OR 1.59, 95% CI 1.09 to 2.31), ICU stay ≥ 2 days (OR 5, 49, 95% CI 2.98 to 10, 09), mechanical ventilation ≥ 2 days (OR11, 93, 95% CI 6.1 to 23.08), use of urinary catheter ≥ 3 days (OR 4.85 95% CI 2.95 -7.99). Non-surgical nosocomial infections were more frequent in patients with surgical wound infection (32.3% versus 7.2%, OR 6.1, 95% CI 4.03 to 9.24). Independent variables associated with mortality were age greater than 60 years (OR 2.0; 95% CI 1.4 to3.0), use of vasoactive drugs (OR 3.4, 95% CI 1.9 to 6, 0), insulin use (OR 1.8; 95% CI 1.2 to 2.8), surgical reintervention (OR 4.4; 95% CI 2.1 to 9.0) pneumonia (OR 4.3; 95% CI 2.1 to 8.9) and bloodstream infection (OR = 4.7, 95% CI 2.0 to 11.2).**

Conclusion: **Non-surgical hospital infections are common in patients undergoing cardiac surgery; they increase the chance of surgical wound infection and mortality.**

Descriptors: **Cross Infection. Risk Factors. Mortality. Thoracic Surgery. Surgical Wound Infection.**

Resumo

Objetivo: **O objetivo deste estudo foi determinar as taxas das infecções hospitalares, os fatores de risco associados e o impacto destas infecções na mortalidade dos pacientes submetidos à cirurgia cardíaca.**

Métodos: **coorte retrospectivo que incluiu 2060 pacientes consecutivos, no período de 2006 a 2012 na Santa Casa de Misericórdia de Marília.**

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Financial support: This study was supported by FAPESP, Regular Research Aid Support Line, Project No. 2010/196281

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Article received on June 20th, 2013
Article accepted on October 17th, 2013

Abbreviations, acronyms & symbols	
BMI	Body mass index
CABG	Coronary artery bypass grafting
COPD	Chronic obstructive pulmonary disease
CVC	Central venous catheter
DM	Diabetes mellitus
HI	Hospital infection
HICS	Hospital infection control service
ICU	Intensive care unit
MV	Mechanical ventilation
PBSI	Primary bloodstream infection
SSI	Surgical site infection
UC	Urinary catheter
UTI	Urinary tract infection
VAP	Ventilator-associated pneumonia

Resultados: **Foram diagnosticadas 351 infecções hospitalares (17%), sendo 227 infecções não cirúrgicas e 124 infecções cirúrgicas. As principais infecções foram: mediastinite (2,0%), infecção urinária (2,8%), pneumonia (2,3%), infecção da corrente sanguínea (1,7%). A mortalidade global intra-hospitalar foi de 6,4%. As variáveis independentes associadas às infecções não cirúrgicas foram: idade ≥ 60 anos (OR 1,59; IC95%1,09-2,31), internação em UTI ≥ 2 dias (OR5,49; IC95% 2,98-10,09), ventilação mecânica ≥ 2 dias (OR11,93; IC95% 6,1 - 23,08), uso de sonda vesical ≥3 dias (OR 4,85 IC95% 2,95 -7,99). Infecções hospitalares não cirúrgicas foram mais frequentes em pacientes com infecção cirúrgica (32,3% *versus* 7,2%; OR 6,1; IC95% 4,03- 9,24). As variáveis independentes associadas a mortalidade foram: idade ≥60 anos (OR= 2,0 ; IC 95% 1,4-3,0), uso de droga vasopressora (OR 3,4; IC95% 1,9-6,0), uso de insulina (OR=1,8; IC 95% 1,2-2,8), reintervenção cirúrgica (OR=4,4 IC95% 2,1-9,0) pneumonia (OR=4,3 IC95% 2,1-8,9) e infecção da corrente sanguíneas (OR=4,7; IC95% 2,0-11,2).**

Conclusão: **infecções hospitalares não cirúrgicas são frequentes pós cirurgia cardíaca, e aumentam a chance de infecção cirúrgica e a mortalidade.**

Descritores: **Infecção Hospitalar. Procedimentos Cirúrgicos Cardíacos. Fatores de Risco. Mortalidade. Infecção da Ferida Operatória.**

INTRODUCTION

The hospital infections (HI) represent one of the most common complications in hospitalized patients undergoing surgical procedures. IH rates vary from 5% to 20% and are associated with increased morbidity, mortality, length of hospital stay and hospital costs[1,2].

Patients undergoing cardiac surgery are particularly susceptible to these infections, and surgical site infections (SSI) are the most studied due to the most serious consequences associated both to patients and hospital. These patients also have several risk factors for nonsurgical HI, such admission to ICU (intensive care unit), use over variable time of invasive devices such as central venous catheter (CVC), urinary catheter (UC) and mechanical ventilation (MV)[3,4].

Published data suggest that rates of HI postoperatively in these patients may vary from 3.5% to 21%, the most frequent being the ventilator-associated pneumonia (VAP), catheter-associated urinary tract infections (CAUTI), primary bloodstream infection (PBSI) or CVC infection[5,6].

The overall mortality of these patients developing HI can reach 25%[1-3]. However, there are few studies in Brazil that assessed the impact of non-surgical infections in outcomes of these patients. Thus, the aim of this study was to determine the rate of HI (surgical and nonsurgical) among patients undergoing cardiac surgery, the risk factors and the impact of these infections on patient outcomes.

METHODS

We performed a retrospective cohort study with nested case-control, using data from the Hospital Infections Control Service (HICS). The HICS performs active surveillance of HI, tracking daily all surgical patients, using a standardized form of data collection. The HICS participates in the diagnostic and therapeutic discussion of HI cases with the medical team. The diagnostic criteria of HI used were those recommended by the Center for Diseases Control and Prevention (CDC)[7].

All patients who underwent cardiac surgery during 2006-2012 had their data assessed since their admission until discharge or death. Despite not having been performed systematically surveillance after discharge of HI by the HICS, all patients were followed-up postoperatively during the outpatient care by the surgical team. The cases requiring hospital readmission, guidance on the use of antibiotics, dressings or with positive cultures were assessed by the HICS.

Therefore, we defined as cases the patients diagnosed with postoperative wound infection of the sternal region and compared with those without this diagnosis (control); in the same way, patients who survived (control) were compared to those who died (case) during hospital stay, in order to determine the variables associated with these outcomes. Risk factors for SSI on the site of removal of the graft were not assessed. The scores of the European System for Risk Assessment in Cardiac Surgery (EuroSCORE) were not calculated because not all variables were systematically recorded in the early years of the study.

This study was performed at the Santa Casa de Misericordia de Marilia, which is a philanthropic tertiary hospital with 200 beds and regional reference of SUS (Unified Health System) for cardiac surgery. It has a cardiac ICU and a general ICU with eight beds each.

A descriptive analysis of the data by calculating the mean and standard deviation for continuous variables and proportions of categorical variables was performed. The Pearson chi-square test was used to compare proportions, the Student t test was used to compare means. The *P* value of<0.05 was considered statistically significant. Possible risk factors statistically significant in univariate analysis were included in multiple logistic regression analysis by forward conditional technique to identify the variables associated with the occurrence of HI and death. The calibration of the model (goodness of fit) was estimated using the Hosmer Lemeshow test (HL) (high values of *P* means that the model is fit to the data). We used the SPSS (Statistical Package for Social Science) version 18.0 for Windows (*SPSS INC*., Chicago, IL) for data analysis. This study was approved by the Research Ethics Committee under number 094/10.

RESULTS

In the period from 2006 to 2012, 2060 surgeries were performed. Coronary artery bypass grafting (CABG) was performed in 1375 (66.8%) patients, valve surgery in 466 (22.6%) and other cardiac surgeries (which included aneurysm, congenital heart disease, aortic coarctation, Bentall De Bono) were performed in 219 (10.6%) patients. The grafts more used were internal thoracic artery and saphenous vein in 767 (37.2%) patients, in 304 (14.8%) patients were performed more than one procedure in the same surgery. Surgical revision for bleeding was performed in 60 (2.9%) patients.

In this population, males predominated (63%), the average age was 58 +14.5 years. Presence of risk factors and or cardiovascular disease were identified in 1475 (71.6%) patients, highlighting prior acute myocardial infarction (15.6%), hypertension (63.8%), dyslipidemia (32%), diabetes mellitus (23.5%), smoking (19.7%).

Antibiotic prophylaxis was performed in 96.7% (n=1983) of procedures, regardless performing saphenous vein grafting for obtaining the graft. First-generation cephalosporin was used in 98 % (1944) of cases. From 2010 an aminoglycoside was added to the prophylactic regimen of 23% (449) of patients who had > 4 days of preoperative hospital stay; in 2012, of 254 patients who underwent heart surgery in this year, 12.2% (n=31) received vancomycin associated with aminoglycoside in prophylactic regimen.

The average hospital stay was 13.36+12.4 days and in-hospital overall mortality was 6.4% (n=132). Table 1 shows the general characteristics of the patients and the preoperative and postoperative periods. 351 HI were diagnosed in 265 (12.9%) patients, corresponding to an incidence of 17% and 124 SSI (35.3%) and 227 (64.7%) infections in other topographies. Forty patients with SSI (32.3%) also had infection in other topography. The most frequent HI and their rates are described in Table 2.

Table 1. Characteristics of patients and procedures performed.

	No.	%
Nº. of Patients	2060	100
Age > =60 years	1082	52.4
BMI > = 30kg/m^2	423	20.5
Acute myocardial infarction	322	15.6
Hypertension	1314	63.8
Dyslipidemia	659	32.0
Diabetes mellitus	484	23.5
Smoking	406	19.7
Preoperative hospitalization in days ± SD	4.0 ± 4.0	
Mean surgical time in minutes± SD	206+ 80.8	
Time of cardiopulmonary bypass in minutes+ SD	81.6 ± 32.0	
Insulin use in the postoperative	693	33.6
Vasoactive drug use of postoperative	1229	59.6
Patients using CVC in the postoperative	1769	85.8
Average time in days of UC use ±SD	4.5 + 5.1	
Patients using UC in the postoperative	1799	87.3
Average time in days of CVD + SD	4.3 ±6.4	
Patients under MV in the postoperative	873	42.3
Average time in days under MV ± SD	2.0 + 4.4	
Average ICU days ± SD	4.0 ±7.4	
Average days of hospital stay± SD	13.3 ± 12.3	
Death	132	6.4

CVC: central venous catheter; MV: mechanical ventilation; UC: urinary catheter; ICU: intensive care unit, SD: standard deviation

Table 2. Main hospital infections.

	No of HI	incidence	% of total HI
Total of hospital infection	351	17	
Total of patients with hospital infection	265	12.9	
Surgical site infection	124	6	35. 3
Urinary tract infection	57	2.8	16.2
Pneumonia associated ventilation	52	2.5	14.7
Tracheobronchitis	39	1.9	11.1
Primary bloodstream infection	35	1.7	9.9
Vascular Catheter Infection	18	0.8	5.1

HI: hospital infection

The overall rate of SSI was 6.0% (n=124), varying with the type of surgery, 7.0% in CABG surgeries (n=96), 4.9% (n=23) in the valve surgeries and 2.3% (n=5) in the other surgeries. Complication occurred in 2.0% (n=41) patients. Infection at the saphenous occurred in 2.2% (19/ 856) of patients who had saphenous resection for obtaining graft.

The etiologic agent was identified in 69 (55.6%) cases with SSI and the gram negative bacteria were the most frequently isolated, highlighting the *Klebsiella pneumoniae* (26.0%), and *Pseudomonas aeruginosa* (13.0%). Twenty-eight percent (n=5) were of *Klebsiella pneumoniae* producing extended spectrum beta-lactamases (ESBL). *Klebsiella pneumoniae producing carbapenemase* (KPC) were not identified. Sensitivity to gentamicin, amikacin, cefepime, imipenem was 77.7%, 83.3%, 72.2% and 94.4% among isolates of *Klebsiella pneumoniae* and 77.7%, 88.8%, 100% and 100% among isolates of *Pseudomonas aeruginosa*.

Staphylococcus aureus was isolated in 21% (n=15) of cases, 33% (n=5) were resistant to oxacillin. The etiologic agents identified were not related to baseline patient characteristics or surgical procedure.

Tables 3, 4 and 5 describe the results of the univariate analysis for the occurrence of SSI in the sternum, non-surgical HI and evolution to death. Tables 6, 7 and 8 describe the results of logistic regression analysis for the occurrence of SSI, nonsurgical HI and death.

Table 3. Variables associated with the occurrence of nonsurgical hospital infection.

	With HI	%	Without HI	%	*P*
Nº. of Patients	180	8.7	1880	91.3	
Age <60 years	55	5.6	927	94.4	
=> 60 years	125	11.6	953	88.4	<0.0001
Preoperative hospitalization in days ± SD	5.3 +5.0	5.3 +5.0	3.8 ± 3.8	3.8 ± 3.8	0.001
Postoperative insulin					
Yes	75	10.8	618	89.2	
No	105	7.7	1262	92.3	
Postoperative vasoactive drug					
Yes	154	12.5	1075	87.5	0.01
No	26	3.1	804	96.9	
Use of urinary catheter ≥ 3days	144	27.1	388	72.9	<0.0001
<3 days	36	2.4	1492	97.6	
Use of vascular catheter ≥ 3days	132	20.1	526	79.9	<0.0001
<3 days	48	3.4	1354	93.7	
Respirator ≥ 2 days	170	13.0	1 139	87.0	<0.0001
< 2 days	10	1.3	741	98.7	
Mean ICU stay in days ± SD	15.8 ± 6.7	15.8 ± 6.7	2.9 ± 4.4	2.9 ± 4.4	<0.0001
Mean hospital stay in days + SD	33 ± 7.4	33 ± 7.4	11.5 ± 7.5	11.5 ± 7.5	<0.0001
Death	35	19.4	97	5.2	
Survival	145	83.0	1 708	92.5	<0.0001

HI: hospital infection, SD: standard deviation; ICU: intensive care unit

Table 4. Variables associated with the occurrence of surgical site infection (SSI).

	Surgical site infection				
	Yes		No		*P*
	No.	%	No.	%	
Nº. patients	124	6	1936	94	
Age < 60 years	46	4.7	936	95.3	
> = 60 years	78	7.2	1000	92.8	0.01
Body mass index ≥ 30kg/m²	38	9.0	385	91.0	
< 30 Kg/m²	71	5.3	1274	94.7	0.008
Preoperative hospitalization					0.002
in days± SD	5.4±4.9		3.9±4.0		
Mean surgical time in minutes ±SD	231±81.0		204±80.5		< 0.0001
Average time of cardiopulmonary bypass in minutes ± SD	91±35.0		81± 31.7		0.005
Surgical reintervention					
Yes	18	30.0	42	70.0	
No	106	5.3	1894	94.7	<0.0001
Postoperative insulin use					
Yes	60	8.7	633	91.3	
No	64	4.7	1303	95.3	0.001
Postoperative vasoactive drug use					
Yes	102	8.3	1127	91.7	
No	22	2.7	808	97.3	<0.0001
Urinary tract infection					
Yes	8	14.0	49	86.0	
No	116	5.8	1887	94.2	0.01
Ventilation associated pneumonia					
Yes	10	19.2	42	80.8	
No	114	5.7	1894	94.3	0.001
Vascular catheter infection					
Yes	7	38.9	11	61.1	
No	117	5.7	1925	94.3	<0.0001
Bloodstream infection					
Yes	102	8.6	25	7 1.4	
No	114	5.6	1911	94.4	<0.0001
Mean of ICU stay in days ± SD	12.6 +17.1		3.5 +5.9		< 0.0001
Mean of hospital stay in days ± SD	32.5 +29.1		12.1 + 9.1		< 0.0001
Death	45	17	87	4.8	
Survival	220	83.0	1 707	92.5	< 0.0001

ICU: intensive care unit; SD standard desviation

Table 5. Variables associated with evolution in the univariate analysis.

	Death		Survival		
	N	%	N	%	*P*
Age <60 years	34	3.5	948	96.5	
= >60	98	9.1	980	90.0	<0.0001
Body mass index> = 30Kg/m^2	35	8.5	378	91.5	
< 30Kg/m^2	75	5.6	1270	94.4	0.03
Mean of preoperative hospital stay in days± SD	5.7 ± 9		3.9+3.9		0.001
Mean time of cardiopulmonary bypass in minutes ± SD	105 ± 59.4		80 ± 28.5		<0.0001
Surgical reintervention					
Yes	10	43.5	13	56.5	
No	122	6	1915	94.0	<0.0001
Postoperative use of insulin					
Yes	63	9.1	630	90.9	
No	69	5.0	1298	95.0	<0.0001
Postoperative use of vasoactive drug					
Yes	111	9.0	1118	91.0	
No	21	2.5	809	97.5	<0.0001
Mediastinitis					
Yes	10	24.4	31	75.6	
No	122	6.0	1897	94.0	<0.0001
Pneumonia					
Yes	13	25. 0	39	75.0	
No	119	5.9	1889	94.1	<0.0001
Tracheobronchitis					
Yes	6	15.4	33	84.6	
No	126	6.2	1895	93.8	0.03
Primary Bloodstream infection					
Yes	11	31.4	24	68.6	
No	121	6.0	1904	94.0	<0.0001
Secondary sepsis					
Yes	12	37.5	20	62.5	
No	120	5.9	1908	94.1	0.001

Table 6. Variables associated with the occurrence of non-surgical infection in logistic regression analysis.

	B Coefficient	Odds Ratio	95% CI
Age > = 60 years	0.46	1.59	1.09-.31
ICU stay > 2days	1.70	5.49	2.98-10.09
Use of urinary catheter ≥ 3days	1.58	4.85	2.95-7.99
Mechanical ventilation ≥ 2days	2.47	11.93	6.1-23.08
Constant	-3.346		

CI: 95% confidence interval; Hosmer & Lemeshow test P = 0.23, 91.2% correct prediction

Table 7. Variables associated with the occurrence of surgical site infection in logistic regression analysis.

	B Coefficient	Odds Ratio	95% CI
Postoperative use of vasoactive drugs	0.91	2.9	1.5 - 4.1
Postoperative use of insulin	0.55	1.7	1.2 - 2.6
Primary bloodstream infection	1.28	3.6	1.6-8.3
Vascular catheter infection	1.9	6.8	2.3-19.8
Pneumonia	0.99	2.7	1.2-5.9
Surgical reintervention	1.92	6.8	3.6 - 12.7
Constant	-3.840		

CI: 95% confidence interval; Hosmer & Lemeshow test P=1; 94.1% correct prediction

Table 8. Variables associated with evolution in the logistic regression analysis.

	B Coefficient	Odds Ratio	95% CI
Age≥60 years	0.72	2.0	1.4-3.0
Postoperative use of vasoactive drugs	1.11	3.4	1.9-6.0
Postoperative use of insulin	0.54	1.8	1.2-2.8
Pneumonia	1.4	4.3	2.1-8.9
Primary infection of the bloodstream	1.55	4.7	2.0-11.2
Surgical reintervention	1.52	4.4	2.1-9.0
Constant	-4.34		

CI: 95% confidence interval; Hosmer & Lemeshow test P=1; correct prediction 93,5%

DISCUSSION

Patients undergoing cardiac surgery are more likely to develop HI because several risk factors for coronary heart disease are also considered at risk for the development of HI, including advanced age, diabetes mellitus, obesity and smoking. In addition, these patients remained in the ICU for a variable time, where they are subjected to multiple invasive procedures[1-6,8,9].

This study assessed the occurrence of HI, including 2060 patients from a single center undergoing cardiac surgery, and noted an overall rate of 17.0% of HI, while 64.7% of these infections were HI unrelated to the surgical site, highlighting UTI (2.8%), VAP (2.5%), Primary Blodstream Infection (PBSI) (1.7%) and infection of the site of insertion of the CVC (0.8%).

The overall in-hospital mortality observed was 6.4%, being higher in patients ≥ 60 years, who required reoperation for bleeding, which used vasoactive drugs postoperatively, and had VAP or PBSI.

HI rates reported in patients undergoing cardiac surgery are variable. In the study by Bouza et al.[5], involving 42 hospitals in 13 European countries, the prevalence of HI was 26.8%. Other studies including one center reported overall rates of HI 3.5% to 21%[3, 8,9]. These variations are probably related to differences in the population studied, the characteristics of the hospital and the care process, as well as the type of epidemiological surveillance adopted and the degree of compliance to control measures advocated.

In general, it is recommended surveillance of SSI after discharge, since they may appear within 30 days after surgery, with reported median time from surgery until diagnosis of sternal SSI of 15 days[10,11]. In study by Berg et al.[11], in Norway, where the average hospital stay was 6 days, most of the SSI on the sternal wound was diagnosed after discharge. In our study, however, as the average length of stay was very high (13.3+12.3 days) and the surgical team performed systematically assessment of patients postoperatively; therefore we believe that losses in cases with sternal SSI, if it occurred, were small and limited to superficial infections. Regarding the non-surgical infection, the surveillance only during hospital stay has been considered appropriate.

In this study, the non-surgical HI were more frequent among older patients and those who stayed longer in the ICU, as it is known as the hospital sector with the highest rates of HI, as reported by other authors[1,12]. Likewise, the use and length of stay of UC, MV and CVC were associated with the occurrence of nonsurgical HI, in logistic regression analysis. These are the factors most frequently reported in several studies[3,4,6,8,9]. Invasive devices break down the natural barrier of defense and can be a gateway to microorganisms during its insertion or manipulation. It is estimated that 50% to 70% of these infections could be prevented if strategies considered effective were implemented and systematically incorporated into the daily care of these patients, for example, the early removal of invasive devices[2].

In the medical literature, it has been described mediastinitis occurrence from 0.4% to 5% of the patients. In our study, the observed overall rate of SSI was 6.4% and the rate of mediastinitis was 2.0%, similar to values reported by Brazilian authors, who reported rates of mediastinitis from 1.3% to 5.6%[13-15].

The rate of infection at the site of the graft removal (2.2%) is among those described by other authors[10,11], however, this study did not assess the factors associated with its occurrence.

In this study, the risk factors associated with the occurrence of SSI of sternal wound, in the logistic regression analysis were: surgical reintervention, use of vasoactive drugs and insulin postoperatively, VAP diagnosis and PBSI.

Surgical reintervention is considered an important risk factor for SSI, probably due to greater surgical manipulation and delayed sternal closure. In the present study, this event has increased by six times the chance of SSI and four times the chance of dying as described by other authors[15-18].

Hemodynamic instability or postoperative shock have been identified as associated with the development of mediastinitis and nonsurgical HI[3,8]. The use of vasoactive drugs postoperatively was interpreted as a marker of hemodynamic instability, which increased the chance of SSI 2.9 times (OR 2.9 95% CI 1,5 to 4,1).

Despite DM being one of the risk factors most often associated with the SSI, in this study this was not observed. There was association between insulin use and the occurrence of postoperative SSI, however, insulin may have been necessary due to previously undiagnosed DM or by hyperglycemia secondary to surgical stress, usually seen in major surgery[19]. Thus, this finding should be interpreted with caution, because confounding variables not adequately controlled may explain this result.

It is known that infections at other sites increase the risk for SSI because they can represent the gateway to the microorganisms colonize the wound, or transmission by contact or blood[6]. In our study, patients with SSI had also more UTI, VAP, CVC infection, PBSI, when compared with those without SSI. Although it was not possible in all cases clearly establish what is the temporal relationship of these infections, they can be interpreted as adverse events arising from the coexistence of multiple risk factors present in this population.

In the study by Le Guillou et al.[6] 5% to 15% of SSI in cardiac surgery were assigned to CVC-related infections, both when the same agent was isolated in both topographies or not. PBSI has been described as one of the most frequent HI in this population of patients with major impact on the evolution, because some of the risk factors reported for this infection overlap factors associated with SSI, such as age, COPD, duration of mechanical ventilation[4,5,20].

As noted by other authors[9,16], the duration of hospitalization was higher among patients with SSI compared with those without SSI, as well as among patients with nonsurgical HI compared with those without infection. One cannot say if the prolonged staying was cause or consequence of SSI or other infections, but it can certainly be considered a marker of increased morbidity and increased costs associated with care, one of the main consequences of HI for the health system.

At Santa Casa de Marilia has been more frequent isolation of gram negative bacteria (*Klebsiella pneumoniae* and *Pseudomonas aeruginosa*), more than *Staphylococcus aureus*, in cultures of surgical specimens. One possible explanation may be advanced age, prolonged hospital stay during preoperative period, diabetes mellitus, which were prevalent in this population, and are considered risk factors for SSI for gram negative[21]. This prompted a review of the scheme of an antibiotic prophylaxis for patients with prolonged preoperative hospital stay. From 2010, aminoglycoside was associated to cefazolin in 23% of cases, in order to expand coverage for gram negative bacteria in patients with preoperative hospitalization > 4 days. There is little evidence to support the use of aminoglycoside as a prophylactic drug in cardiac surgery, in addition to exist a concern with adverse events related to the use of this group of antimicrobials. However, gentamicin associated with other antibiotics with anti-staphylococcal action has been adopted in some hospitals in England, due to high rates of *Clostridium difficile* infection and its association with the use of cephalosporins, which are now little used. The study by Insker[22] that assessed antibiotic prophylaxis use in 23 English cardiac centers found that 61% of these used gentamicin associated with flucloxacillin.

Vancomycin was not the standard antibiotic prophylaxis of the Santa Casa de Marília during the study period, since most of the *S. aureus* isolates from surgical patients were sensitive to oxacillin. However, in 2012 vancomycin already was part of the prophylactic scheme of 12.2% of patients with prolonged preoperative hospitalization, in order to also try to ensure better coverage for oxacillin-resistant *Staphylococcus aureus*. Due to the changes that may be occurring in bacteria isolated from the SSI and the sensitivity pattern, we believe it is imperative to continue monitoring the rates of SSI and the etiologic agents involved in order to assess the impact and appropriateness of prophylactic standard and the used for specific patient groups in this institution.

The global in-hospital mortality was 6.4% and statistically different between patients with and without SSI (17 % versus 4.8%, OR), VAP (25% versus 5.9%), tracheobronchitis (15.4% versus 6.2%), PBSI (31.4% versus 6.0%). In the literature, the mortality reported in patients undergoing cardiac surgery who develop HI varies from 4% for UTI[3] to 35% for VAP[4]. Mortality among patients with mediastinitis was 24.4% and 6.0% among patients without this complication. Mediastinitis increased by five times the chance of dying (OR 5.0 95% CI 2.4 10.50). These rates are similar to those described by national and international authors, who reported a mortality rate between 14% to 42%[13,14,17]. There was no statistically significant difference in mortality when the infection was superficial or deep.

The logistic regression analysis identified independent association between mortality and the following variables: age ≥ 60 years, use of vasoactive drug postoperatively, VAP, PBSI and surgical reintervention. However, SSI was not an independent variable associated with death in this series.

Kollef et al.[3] assessed the impact of SSI after cardiac surgery and also identified VAP and PBSI as independent risk factors for multiple organ dysfunction and mortality.

It has long been known that age is considered an independent risk factor for mortality, particularly when associated with the occurrence of infection[12]. Rahamanian et al.[23] in a study involving more than 6000 patients identified the following variables associated with death in patients undergoing cardiac surgery: age > 70 years (OR 1.4 95 CI 1.1 to 1.9), sepsis (OR 1.6 95% CI 1.0 to 2.6), reoperation (OR 1.5 95% CI 1.1 to 2.1) and hemodynamic instability (OR 2.2 95% CI 1.2 to 3.9), data very similar to our study.

Pneumonia and bloodstream infection are independent risk factors for hospital mortality in ICU patients, with attributed mortality ranging from 5% to 70%[2,20]. In the study performed in eight European countries[4], the mortality among patients undergoing cardiac surgery who developed pneumonia was 35%.

Our study has some limitations because it is an observational study, performed in a single hospital and the identification of HI after discharge have been performed in the ambulatory by the surgical teams, and only then assessed by HICS. Although the length of hospital stay was long, there is the possibility that the HICS has not been called to assess some patients, particularly those with superficial infections, not requiring hospital readmission; or cultures were not collected for their diagnosis and did not require antibiotic orientation. We believe that patients with deep infection or mediastinitis were all included. Another aspect to be mentioned is that, although the main objective was assess risk factors for nonsurgical HI and its impact on patient outcomes, overall mortality observed was not adjusted for the EuroSCORE values, because not all variables were recorded for its calculation in the initial years of study.

However, the results of this study confirm the risk factors and the negative impact of non surgical HI on outcomes of these patients and points to some possible improvement.

It is known that the incidence of HI among patients undergoing cardiac surgery depends on factors related to the hospital, the patient's characteristics, invasive procedures, the preventive measures that are implemented and the level of compliance of health professionals to these measures[24].

In this sense, it is necessary that strategies with proven effectiveness for the prevention of surgical site and nonsurgical HI be planned before be actually adopted. Special attention should be given to the factors liable to modification related to the care process, and to the multiple risk factors for the occurrence of HI present in this population. Such measures require major behavioral changes, which should be encouraged by in-service education, audit and continuous feedback, since the benefits of its application can only be achieved when the membership compliance reaches 100%, a scenario still far from being achieved in most hospitals[2,25].

CONCLUSIONS

Patients who underwent cardiac surgery had increased chance of developing infections in various topographies, particularly UTI, VAP, PBSI and CVC infection, besides the SSI. The use of postoperative vasoactive drugs and surgical reintervention were identified as risk factors for both sternal SSI or nonsurgical infections. The sternal SSI was associated with the occurrence of pneumonia, bloodstream infection and the use of insulin in the postoperative period. Gram-negative bacteria were the most frequently identified in these infections. The age, length of ICU stay, length of stay of UC, CVC and MV were predictors of the development of nonsurgical HI.

Independent variables associated with mortality were age, VAP, PBSI, surgical reintervention, use of insulin and vasoactive drugs postoperatively.

Authors' roles & responsibilities	
LOC	Idealizer of the project, coordination of data collection, analysis and interpretation of data, writing of the manuscript.
SMDT	Participated in the idealization of the project, data collection and writing of the manuscript.
RGK	Participated on data collection, interpretation of data and writing of the manuscript.
ESG	Participated in the data collection, drafting the manuscript.
RTB	Participated on idealization of the project and writing of the manuscript.
MGT	Participated on idealization of the project and writing of the manuscript.

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