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The impact of new preventive measures and treatment of surgical site infections after coronary artery bypass graft surgery

O impacto de mudanças nas medidas de prevenção e no tratamento de infecções incisionais em cirurgia de revascularização do miocárdio

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Abstract

Objective: **To assess the impact of new preventive measures of surgical site infections after coronary artery bypass graft (CABG) surgery.**

Method: **A retrospective study of 468 patients who underwent CABG surgery with cardiopulmonary bypass was performed. These patients were distributed into two groups: Group A (n=224) and Group B (n=244), respectively before and after a new protocol. The two groups were compared by statistical analysis to determine differences in risk factors, the incidence of sternotomy surgical site infections (superficial and deep), recurrent infections and hospital readmission.**

Results: **There was a greater use of internal thoracic artery grafts (p=0.003) and a shorter time of mechanical ventilation (p=0.001) in Group B. Surgical site infections occurred in 44 patients of Group A (19.6%); 33 superficial (14.7%) and 11 deep (4.9%) while in Group B only 13 patients had this complication (5.3%); 10 superficial (4.1%) and 3 deep (1.2%) surgical site infections. Significant improvements were seen in the total number of surgical site infections (p<0.001), of superficial infections (p<0.001) and of deep infections (p=0.037). There were 36.3% and 7.7% of recurrent infections in Groups A and B, respectively (p=0.102). Hospital readmissions due to surgical site infections were 21 in Group A and 3 in Group B (p<0.001).**

Conclusion: **The new preventive measures and treatment for surgical site infections after CABG surgery in this series of patients significantly reduced the incidence of sternotomy surgical site infections and hospital readmissions related to this complication.**

Descriptors: **Infection. Surgical wound infection. Infection control. Cardiac surgical procedures. Myocardial revascularization.**

Resumo

Objetivo: **Avaliar o impacto de novas medidas de prevenção e tratamento para infecções incisionais em cirurgia de revascularização do miocárdio (RM).**

Método: **Estudo retrospectivo incluindo 468 pacientes**

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submetidos a RM com circulação extracorpórea, distribuídos em Grupo A (n=224) e Grupo B (n=244), de pacientes operados antes e após a adoção do novo protocolo, respectivamente. Análise comparativa entre os grupos procurou detectar a incidência de infecções superficiais e profundas na incisão para esternotomia, de recorrências e reinternações.

Resultados: **Quanto aos fatores de risco relacionados a hábitos e doenças dos pacientes, aspectos cirúrgicos e hospitalares, ocorreram diferenças entre os grupos quanto a maior utilização da artéria mamária (p=0,003) e menor tempo de intubação orotraqueal (p=0,001) no Grupo B. Infecções incisionais - no Grupo A foram 44 (19,6%) casos, sendo 33 (14,7%) superficiais e 11 (4,9%) profundas; no Grupo B foram 13 (5,3%) casos com 10 (4,1%) superficiais e três (1,2%) profundas, sendo significativa a diferença quanto ao número total de infecções incisionais (p<0,001), superficiais (p<0,001) e profundas (p=0,037). As recorrências foram de 36,3% e 7,7%, respectivamente para os Grupos A e B (p=0,102). Ocorreram 21 reinternações relacionadas à infecção incisional no Grupo A e 3, no Grupo B (p<0,001).**

Conclusão: **Para este grupo de pacientes, as mudanças adotadas resultaram em redução nas infecções incisionais e também diminuíram as reinternações relacionadas a este aspecto.**

Descritores: **Infecção. Infecção da ferida operatória. Controle de infecções. Procedimentos cirúrgicos cardíacos. Revascularização miocárdica.**

INTRODUCTION

Even when surgical treatment for heart diseases is successful, costs and distress will always be higher, not only for the patient but also for the medical team, if incision site infections are not prevented.

According to the proposed Centers for Disease Control and Prevention (CDC) classification [1], infection of surgical wounds of sternotomies should be considered as superficial if only the skin and subcutaneous tissue is involved; deep, when the infection reaches the sternum but does not involve it and as organ or space infections when sternal osteomyelitis or mediastinitis occur. This classification also establishes when the infection should be considered as a wound infection and enables a better comparison among scientific works [2].

The incidence of superficial surgical site infections (SSSI) in sternotomies should be similar to any clean surgical procedure, that is, approximately 2% [3]. However, the infection rate reaches three times this value among heart disease patients, since these patients face a higher number of risk factors than the population in general. In respect to deep surgical site infections (DSSI), the incidence is from 0.5% to 5% [4,5]. But the incidence of mediastinitis, following median sternotomies, ranges from 0.4% to 2%, independent of the type of surgery and this is accompanied by a high mortality rate [6].

Some factors related to specific populations, associated diseases and social and economic levels elevate these incidences, as does, inappropriate care during the peri-operative period. Borer et al. [7], who identified this problem, suggested more strictly controlled prevention measures as the solution.

Thus, the aim of the current study was to assess the effects of a protocol of prophylactic conduct based on published recommendations [8,9] and specifically the control of postoperative infection, on surgical site infections and morbimortality rates.

METHOD

A total of 474 records of patients successively submitted to on-pump myocardial revascularization (MR) without associated procedures and whose surgeries were performed by the same surgical team at the Hospital Irmãos Penteado in Campinas, São Paulo, within the period from January 1, 2001 to December 31, 2004, were assessed.

Six patients were excluded as the patients died during the postoperative period of deaths not related to infection. Thus, 468 patients' records were included in the study, divided into two groups according to whether prophylactic measures were used with the patients or not. Group A consisted of 224 patients' records and Group B consisted of 244 who had undergone surgery, before and after the adoption of measures to control infection, respectively.

The parameters considered for comparative analysis were: age, gender, length of preoperative hospitalization, time in intensive care unit (ICU), times of surgery, cardiopulmonary bypass (CPB) and orotracheal intubation (OTI), the number of internal thoracic artery grafts (mammary arteries) and the urgent/elective nature of the surgery. Associate risk factors included smoking, alcohol use, diabetes mellitus (DM), obesity (body mass index – BMI > 30), chronic obstructive pulmonary disease (COPD), peripheral arterial disease (PAD), chronic renal insufficiency (CRI) and congestive heart failure (CHF).

Table 1 - Changes to preventive measures for control of surgical site infections

1) In-hospital Periods

	BEFORE	AFTER
Pre-operative period		
- bath with chlorhexidine gluconate degermant	Only one following hair removal Daily for 3 days if patient is colonized with Staphylococcus	Three baths within the last 24 hours before the surgery (1 bath following hair removal) Daily for three days if patient is colonized or if is in hospital for more than 7 days
- nasal mupirocin (used twice a day for 5 days)	Only in patients who are colonized with Staphylococcus colonies	If patient is colonized as before or if in hospital for more than 7 days
Inter-operative period		
- Gastric tube	Access via the nose (nasogastric tube)	Access via the mouth (orogastric tube)
- Thermometer lead	Access to nasopharynx via the nose	Access to retropharynx via the mouth
- Skin antisepsis	Polyvinylpyrrolidone iodine (PVPI) degermant followed by alcohol-containing products	Chlorhexidine gluconate degermant followed by alcohol-containing products
- Glove changing	If punctured or in contact with more contaminated areas (e.g., MMII)	The same procedure is continued plus two compulsory changes (before cannulation and after closing)
- Glycemic control in diabetic patients	Glycemic measurements accompanied by routine exams. 10U IV Insulin Bolus, if glucose level is > 250 g/dL.	Continuous insulin infusion, 3U/h and glucose capillary (GC) measurements at every 40 minutes. 10U IV Insulin Bolus, if GC >180g/dL
- Obesity	Without subcutaneous drainage	Suction drainage (portovac – 4.8mm) between sternal and subcutaneous tissue, if it is = 5 cm thick
- Final dressing	Washing with physiological solution (PS) and closure with sterile gauze	Combined use of neomycin and bacitracin-containing ointments for 24h
Postoperative (PO) Period		
-Dressing until 2nd PO day	Dressings twice daily with (PS) and closure with sterile gauze	Unchanged
-Dressings after 2nd PO day	Cleaning by bathing and dressing using PS and sterile gauze. No closure	Combined use of collagenase and chloramphenicol-containing ointments
- Incision site assessments	Daily with secretion collection for culturing if there is infection	Daily and collection of any secretion existing after 48hs
- Surgical site infection intended antibiotic therapy	Oral/ intravenous uses, in case of surgical site infection and, if possible, based on antibiogram	Early oral use of cephadroxil 2g/day, in case of>5mm area with hyperemia or in case of thick secretion in the following 48h. Changed according to antibiogram
- Surgical approach for surgical site infection	Indicated after unsuccessful use of antibiotic therapy or in cases of collections, great dehiscence or deep infections	Early indication for devitalized tissue debridement and to re-suture surgical wounds
- Glycemic control in diabetic patients:		
- immediate PO	GC measurement every 4 hours or more, if required SC R Insulin if GC > 250 IV R Insulin if GC > 400	GC measurement every 2 hours or more, if required. SC R Insulin, if GC > 180 IV R Insulin, if GC > 300
- PO 1	GC measurement every 6 hours or more, if required. SC R Insulin, if GC > 250	GC measurement every 4 hours or more, if required. SC R Insulin, if GC > 180 and if insulin is used, repeat GC after 2h.
- after PO 2	GC measurement every 6 hours or more, if required. SC R Insulin, if GC>250 Returned use of O.H. or NPH Insulin	GC measurements at 6, 10, 16 and 22 hours SC R Insulin, if GC > 180 and if insulin is used, repeat GC after 2h. Returned use of O.H. or NPH Insulin

2) Outpatients' Follow-up

	BEFORE	AFTER
Hospital discharge	Guidance for patient and relatives related to daily dressings and wound monitoring	The same instructions and the use of 0.3% triclosan liquid soap, cleaning with PS and the use of collagenase and a chloramphenicol-containing ointment
Return date for outpatient visit	7 to 10 days following hospital discharge or before if condition of surgical wound worsens. Secretion collection if signs of surgical site infection exist.	The same period, but, with a reduction of 3 to 5 days, if there are signs of infection at hospital discharge. Collection of any secretion to perform a culture
Antibiotic therapy	Oral or IV use (re-hospitalization) if there is wound infection and, if possible, based on culture and antibiogram results	Early use of 2g/d Cephadroxil, in case of hyperemia or if thick secretion exists. Use during 7 to 15 days based on culture and antibiogram results.
- Surgical approach for surgical site infection	The same routine as in the in-hospital period.	Early indication as described for the in-hospital period.

Only the infection to the wound of the median incision used in the sternotomy was considered as a surgical site infection. Identification and classification of the infectious process were based on the criteria recommended by the CDCs [1]. Analyses were made comparing the overall number of infections, SSSI, DSSI, recurrences, re-admittance to hospital and re-operations to each group's incision surgical site for infections.

The present work was approved by the Ethics Committee of the Hospital Irmãos Penteado.

Changes in preventive measures for surgical site infection control

Changes were introduced for preoperative care and for standard procedures during the intra-operative and postoperative periods. Also changes to postoperative monitoring during outpatient visits and in the indication of antibiotics and reoperations due to surgical site infections were established. The adopted changes are detailed in Table 1.

Statistical analysis

The groups were assessed according to the following statistical tests: Student t-test to compare continuous variables, chi-square or Fischer exact tests (when values were less than 5) to compare categorical variables. The level of significance was set at 5% (p-value<0.05). For all data that demonstrated statistical difference, the relative risk reduction (RRR), the absolute risk reduction (ARR), the number needed to treat (NNT) and the odds ratio (OR) were estimated.

RESULTS

Patient characteristics and surgical and in-hospital aspects

The groups were homogenous in terms of age, gender, the patients' habits and associated diseases (Table 2). There were no differences between the groups with regards to the preoperative hospital stay, duration of the surgery, ICU stay and the urgent nature of surgeries. There was a greater use of mammary artery grafts (p=0.003) and also shorter OTI times (p=0.002) with Group B (Table 3).

Surgical site infections

Within Group A, there were 44 (19.6%) infections of surgical sternotomy wounds reported; 33 (14.7%) SSSI and 11 (4.9%) DSSI. Within Group B, there were 13 (5.3%) infections related to sternotomy reported; 10 (4.1%) SSSI and three (1.2%) DSSI. The details of patients who suffered infections in both groups are shown in Table 4.

When comparing all the events of infection, Group B had a lower incidence in terms of overall numbers of SSSI and DSSI. The comparative analysis between the groups to identify associated risk factors showed that, within Group B, the infection rates related to smokers, diabetics and obese patients was lower than the rates in Group A, when these factors were examined separately. The reduction in the infection rates occurred independently of the functional class of CHF (Table 5).

Table 2 - Characteristics of patients in each group

Characteristics of patients	Group A n = 224		Group B n = 244		p-value
Age*	61.7	(61. 42-81)	62.4	(63.39-84)	NS
Gender male	145	(64.7%)	167	(68.4%)	NS
Alcoholism	6	(2.7%)	15	(6.1%)	NS
Smokers	98	(43.7%)	95	(38.9%)	NS
Diabetes mellitus	74	(33.0%)	70	(28.7%)	NS
Obesity (BMI > 30)	30	(13.4%)	32	(13.1%)	NS
COPD	17	(7.6%)	15	(6.1%)	NS
PAD	12	(5.3%)	22	(9.0%)	NS
CRI	5	(2.2%)	7	(2.8%)	NS
CHF (classification NYHA)					
class I - II	199	(88.8%)	221	(90.5%)	p = NS
class III-IV	25	(11.2%)	23	(9.5%)	NS
Ejection fraction < 40%	19	(8.5%)	17	(6.9%)	NS

** Mean age expressed in years and in parentheses median, minimum-maximum*
BMI Body mass index; COPD: Chronic obstructive pulmonary disease; PAD: peripheral artery disease; CRI: chronic renal insufficiency; CHF: congestive heart failure; NYHA: "New York Heart Association".

Table 3 - Surgical and hospital aspects for both groups

Surgical and hospital aspects	Group A n = 224		Group B n = 244		p-value
Pre-operative hospitalization					
Greater than 48h	66	(29.5%)	64	(26.2%)	NS
Greater than 7dias	17	(7.6%)	22	(9%)	NS
Urgent surgeries	55	(24.5%)	51	(20.9%)	NS
Utilization of 1 mammary graft	166	(74.1%)	209	(85.6%)	p=0.003
Utilization of 2 mammary grafts	6	(2.7%)	13	(5.3%)	NS
CPB time (min)*	72	(23-155)	74	(30-208)	NS
Surgery time (min)*	230	(120-450)	227	(120-420)	NS
OTI time (h)*	3.9	(2-12)	3.3	(2-12)	p=0.002
ICU time (h)*	46.8	(16-240)	45.7	(24-96)	NS

** Values expressed as means (minimum-maximum)*
CPB: cardiopulmonary bypass; OTI: orotracheal intubation; ICU: intensive care unit

Table 4 - Characteristics of patients with infection in both groups

Characteristics of patients with infection	Group A n = 44		Group B n = 13		p-value
age*	62	(57.49-78)	62.2	(61. 42-76)	NS
Gender male	24	(54.5%)	8	(61.5%)	NS
Alcoholism	2	(4.5%)	1	(7.7%)	NS
Smokers	22	(50%)	6	(46.1%)	NS
Diabetes mellitus	30	(68.2%)	7	(53.8%)	NS
Obesity (BMI > 30)	16	(36.3%)	4	(30.7%)	NS
COPD	5	(11.3%)	3	(23.1%)	NS
PAD	4	(9.1%)	2	(15.4%)	NS
CRI	2	(4.5%)	2	(15.4%)	NS
CHF (classification NYHA)					
class I - II	33	(75%)	10	(76.9%)	NS
class III-IV	11	(25%)	3	(23.1%)	NS
Ejection fraction < 40%	6	(13.6%)	3	(23.1%)	NS
Diagnosed after hospital release	14	(31.8%)	3	(23.1%)	NS

** Mean age expressed in years and in parentheses median, minimum-maximum*
BMI Body mass index; COPD: Chronic obstructive pulmonary disease; PAD: peripheral artery disease; CRI: chronic renal insufficiency; CHF: congestive heart failure; NYHA: "New York Heart Association".

Table 5 - Rates of infections in both groups and characteristics of the infected patients

Classifications of infections	Group A Number patients	Group A % patients	Group B Number patients	Group B % patients	p-value
incision infections (total)	44	19.6	13	5.3	p <0.001
deep infections	11	4.9	3	1.2	p = 0.039
superficial infections	33	14.7	10	4.1	p <0.001
Characteristics of patients with infection	**Number patients**	**% patients***	**Number patients**	**% patients***	
Gender male	24	16.5	8	4.7	p = 0.001
Alcoholism	2	33.3	1	6.6	p = NS
Smokers	22	22.4	6	6.3	p = 0.003
Diabetes mellitus	30	40.5	7	10	p < 0.001
Obesity (BMI > 30)	16	53.3	4	12.5	p = 0.002
COPD	5	29.4	3	20	p = NS
PAD	4	33.3	2	9.1	p = NS
CRI	2	40	2	28.6	p = NS
CHF (classification NYHA)					
class I - II	33	16.6	10	4.5	p < 0.001
class III-IV	11	44	3	13	p = 0.041
Ejection fraction < 40%	6	31.6	3	17.6	p = NS

** Percentage related to the total number of patients in each characteristic*
BMI Body mass index; COPD: Chronic obstructive pulmonary disease; PAD: peripheral artery disease; CRI: chronic renal insufficiency; CHF: congestive heart failure; NYHA: "New York Heart Association"

Among the 44 patients who suffered infections in Group A, two of them developed organ and space infections, one had sternal osteomyelitis and the other, who eventually died due to septic shock, suffered from mediastinitis. Within this group 16 recurrent infections occurred with the necessity of 28 new surgical procedures and 21 rehospitalizations, all of which were related to infection of the sternotomy surgical wound. The average follow-up period for this group was 11.6 months.

Among the patients of Group B, no surgical site infections evolved to organ or space infections. In this group one recurrent infection occurred, nine surgical procedures were required and three patients were re-hospitalized, all of which were related to surgical wound infections. The average follow up was 10.8 months.

There was a significant difference in the number of recurrent infections between the groups (7.1% and 0.4%; p-value < 0.001), but not among patients with infections within each group (36.3% and 7.7%; p-value = 0.102). In respect to the need of new surgical interventions, there was also a significant difference between the groups (12.5% and 3.7%; p-value < 0.001), but not among infected patients (63.6% and 69.2%; p-value = 0.136). There was a difference in terms of overall number of rehospitalizations related to surgical wound infections; 21 (9.3%) in Group A (5 due to late diagnoses and 16 due to recurrences) and three (1.2%) in Group B (2 late diagnoses and one recurrence), giving a p-value < 0.001.

The values related to risk reduction, NNT and OR, which gave statistical differences, are shown in Table 6.

Table 6 - Values related to risk reduction, number necessary to treat and ODDs Ratio for the aspects with statistical difference between groups

Aspects with statistical difference between groups	RRR 95% CI	ARR IC 95%	NNT IC 95%	OR IC 95%
Total incision infections	0.73 (0.51-0.85)	14.3% (8.4-20.2)	7 (5-12)	0.23 (0.12-0.44)
Superficial infections	0.72 (0.45-0.86)	10.6% (5.3-15.9)	9 (6-19)	0.25 (0.12-0.51)
Deep infections	0.76 (0.13-0.93)	3.7% (0.6-6.8)	27 (15-167)	0.24 (0.07-0.88)
Smokers	0.72 (0.34-0.88)	16.1% (6.5-25.7)	6 (4-15)	0.22 (0.09-0.58)
Diabetes mellitus	0.75 (0.47-0.88)	30.5% (17.3-43.7)	3 (2-6)	0.16 (0.07-0.40)
Obesity (BMI >30)	0.77 (0.38-0.91)	40.8% (19.6-62)	2 (2-5)	0.13 (0.04-0.44)
CHF (classification NYHA)				
class I - II	0.73 (0.46-0.86)	12.1% (6.3-17.9)	8 (6-16)	0.25 (0.12-0.51)
class II - IV	0.71 (0.07-0.91)	31% (7.2-54.8)	3 (2-14)	0.24 (0.07-0.88)
Rehospitalizations for infection	0.87 (0.58-0.96)	8.2% (4.1-12.3)	12 (8-24)	0.12 (0.04-0.41)

RRR: reduction of relative risk; ARR: absolute risk reduction; NNT: number necessary to treat; OR: "odds ratio"; BMI: body mass index; CHF: congestive heart failure; NYHA: "New York Heart Association"

COMMENTS

Many works address the issue of postoperative wound infections in heart surgery. Most Brazilian studies focus on the risk factors of DSSI and its evolution to mediastinitis [10-12]. Although the mortality rate due to mediastinitis following heart surgeries is extremely high, ranging from 14% and 47%, the incidence of such infection varies from 0.4% to 2% [6]. The incidence of SSSI, however, is higher; from 1.6% to 6.4 % and there are few works that specifically focus on this issue probably due to its lower mortality rate [4]. It is known that there are differences in the risk factors among DSSI and SSSI. [13], however, general preventive measures can be effective in all cases. In fact, risk classifications for wound infections after sternotomies are based on factors that have an effect not only on the incidence of DSSI but also SSSI. [14].

The high surgical site infection rates, which occurred in our service in 2002, led to the implementation of prophylactic measures based on published data with the purpose of reducing this incidence. The results in the reduction of infection rate motivated retrospective analysis of this group of patients. The study was, thus, focused on patients who had been submitted to on-pump MR without other associated procedures, corresponding to the largest number of procedures in our service and also the majority of other heart surgery services.

Chlorhexidine was chosen as the first-line antiseptic agent, not only to be used in the preoperative period but also in the intraoperative period, due to its better residual effect in relation to other iodine-based antiseptic agents and also because it can be inactivated by the blood. [8,15]. The use of nasal mupirocin reduces the number of infections caused by *Staphylococcus aureus*. Additionally, gastric catheters and tele-thermometer leads should not be inserted in these orifices in the intra-operative period; only the oral cavity should be used for these purposes. [8,16].

It has been recommended that surgical teams should only change gloves when there is contact with large contaminated areas or when perforations occur. However, frequently in surgeries, such perforations are not detected. There is evidence that the longer the surgery takes the greater the probability of perforations is, with this rate reaching as high as 60% [17,18]. Thus, changing gloves more frequently during intra-operative periods, as set forth in the protocol, aims to reduce contamination by hands.

In respect to obese patients, who have thick subcutaneous tissue; the formation of collections between adipose tissue and the sternum is a serious problem as it poses a higher risk for infection. For such patients, the use of a permanent suction drain over 24 hours in the region that is liable to form accumulation of collections is recommended, a measure that was included in our protocol. Because of this measure, reductions in infection and dehiscence rates occur [19]. In our study, the RRR was 0.77 and the ARR was 40.8% among obese patients with the NNT equivalent to 2 and the OR 0.13.

Unquestionably, an extremely important change occurred in respect to patients suffering from DM. The tight glycemic control of such patients, in the pre- inter- and post-operative periods, independently reduced surgical site infection rates [20]. The RRR was 0.75 and ARR was 30.5% among diabetic patients in our study. In this group of patients, NNT was 3 and OR was 0.16.

Even though, in our service, daily assessment of surgical wounds was already routinely performed, the new protocol established a stricter sampling of wound secretions for culturing and an earlier start to antibiotic therapy. The empirically selected antibiotic agent was cephadroxil as it has a better range compared to cephalexin, with a better action against strains of *Staphylococcus* and *Streptococcus*, as well as exhibiting a good penetration into bone tissue [21]. Specific antibiotic therapy, on the other hand, is limited to subsequent stages, according to the results of cultures.

Among patients who had surgical wound infections and who required future surgical interventions, patients from Group B were submitted to earlier treatment according to the new protocol guidelines. Francel & Kouchoukos [22], when assessing treatment alternatives for complications after sternotomies, concluded that the earlier the surgical procedure is performed the better the results produced, particularly when it involves a surgical wound infection. They also reported the sequence of treatment adopted for their patients. In our study, the methodology used does not allow us to reach conclusions about early treatment, but other authors compared the traditional treatment with a more aggressive approach which proved to provide more benefits [23].

Thus, it was impossible to identify the extent to which more intensive monitoring of preventive measures adopted in Group B really contributed to the reduction of infection rates [3].

The significant reduction in the surgical site infection rates reported in the present study can be attributed to changes which were established on January 1, 2003, because of the similarity between the studied groups in respect to the characteristics of patients and the operative and in-hospital aspects. It must also be stressed that the percentages of infections achieved after the adoption of the new protocol are consistent with incidences reported in the literature [4,5,7,13]. Similar values of RRR (0.73) and RRA (14.3%) calculated in this study, were also demonstrated in similar works on control of surgical site infections [7,24]. The NNT rate was 7, when assessing the overall incidence of surgical site infections and the value of OR was 0.23.

The comparison among infection rates for both groups and the association with habits and underlying diseases showed a significant reduction for smokers, diabetics and obese patients. There was a reduction of surgical site infections in all CHF functional classes. The fact that the reduction in other groups did not give a significant difference is probably due to the low number of patients studied.

Although this was not an objective of this study, the significant reduction in the rates of rehospitalizations for surgical site infections (9.3% to 1.2%; p-value < 0.001) results in lower costs to treat these patients [25].

The present work did not allow a more detailed analysis of some important aspects and it was not possible to identify which measures had the strongest impact on the reduction of infection rates. However, it can be concluded that, for this group of patients, the changes in preventive measures and how the patients were treated resulted in significant reductions in the incidences for superficial and deep surgical site infections and in a lower number of rehospitalizations in connection with infections. This has a direct effect on the costs of treatment, on reduced stress of the surgical team and, particularly, a better quality of life for these patients.

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BIBLIOGRAPHIC REFERENCES

1. Horan TC, Gaynes RP, Martone WJ, Jarvis WR, Emori TG. CDC definitions of nosocomial surgical site infections, 1992: a modification of CDC definitions of surgical wound infections. Infect Control Hosp Epidemiol. 1992;13(10):606-8.

2. Ehrenkranz NJ, Richter EI, Phillips PM, Shultz JM. An apparent excess of operative site infections: analyses of evaluate false-positive diagnoses. Infect Control Hosp Epidemiol. 1995;16(12):712-6.

3. National Nosocomial Infections Surveillance (NNIS) System. National Nosocomial Infections Surveillance (NNIS) System Report, data summary from January 1992 to June 2002, issued August 2002. Am J Infect Control. 2002;30(8):458-75.

4. Ridderstolpe L, Gill H, Granfeldt H, Åhlfeldt H, Rutberg H. Superficial and deep sternal wound complications: incidence, risk factors and mortality. Eur J Cardiothorac Surg. 2001;20(6):1168-75.

5. Roy MC. Surgical-site infections after coronary artery bypass surgery: discriminating site-specific risk factors to improve prevention efforts. Infect Control Hosp Epidemiol. 1998;19(4):229-33.

6. El Oakley RM, Wright JE. Postoperative mediastinitis: classification and management. Ann Thorac Surg. 1996;61(3):1030-6.

7. Borer A, Gilad J, Meydan N, Riesenberg K, Schlaeffer F, Alkan M et al. Impact of active monitoring of infection control practices on deep sternal infection after open-heart surgery. Ann Thorac Surg. 2001;72(2):515-20.

8. Mangram AJ, Horan TC, Pearson ML, Silver LC, Jarvis WR, The Hospital Infection Control Practices Advisory Committee. Guideline for prevention of surgical site infection, 1999. Infect Control Hosp Epidemiol. 1999;20(4):247-78.

9. The Infectious Diseases QIOSC of the Oklahoma Foundation for Medical Quality, Inc. Surgical infection prevention project - literature review. September 30, 2002 Update[on line]. Disponível em URL: http://www.medqic.org/sip

10. Souza VC, Freire ANM, Tavares-Neto J. Mediastinite pós-esternotomia longitudinal para cirurgia cardíaca: 10 anos de análise. Rev Bras Cir Cardiovasc. 2002;17(3):266-70.

11. Guaragna JC, Facchi LM, Baião CG, da Cruz IBM, Bodanese LC, Albuquerque L et al. Preditores de mediastinite em cirurgia cardíaca. Rev Bras Cir Cardiovasc. 2004;19(2):165-70.

12. Abboud CS, Wey SB, Baltar VT. Risk factors for mediastinitis after cardiac surgery. Ann Thorac Surg. 2004;77(2):676-83.

13. Olsen MA, Lock-Buckley P, Hopkins D, Polish LB, Sundt TM, Fraser VJ. The risk factors for deep and superficial chest surgical-site infections after coronary artery bypass graft surgery are different. J Thorac Cardiovasc Surg. 2002;124(1):136-45.

14. Kohli M, Yuan L, Escobar M, David T, Gillis G, Comm B et al. A risk index for sternal surgical wound infection after cardiovascular surgery. Infect Control Hosp Epidemiol. 2003;24(1):17-25.

15. Kaiser AB, Kernodle DS, Barg NL, Petracek MR. Influence of preoperative showers on staphylococcal skin colonization: a comparative trial of antiseptic skin cleansers. Ann Thorac Surg. 1988;45(1):35-8.

16. Cimochowski GE, Harostock MD, Brown R, Bernardi M, Alonzo N, Coyle K. Intranasal mupirocin reduces sternal wound infection after open heart surgery in diabetics and nondiabetics. Ann Thorac Surg. 2001;71(5):1572-9.

17. Wong PS, Young VK, Youhana A, Wright JE. Surgical glove punctures during cardiac operations. Ann Thorac Surg. 1993;56(1):108-10.

18. Eklund AM, Ojajärvi J, Laitinen K, Valtonen M, Werkkala KA. Glove punctures and postoperative skin flora of hands in cardiac surgery. Ann Thorac Surg. 2002;74(1):149-53.

19. Allaire AD, Fisch J, McMahon MJ. Subcutaneous drain vs. suture in obese women undergoing cesarean delivery: a prospective, randomized trial. J Reprod Med. 2000;45(4):327-31.

20. Furnary AP, Zerr KJ, Grunkemeier GL, Starr A. Continuous intravenous insulin infusion reduces the incidence of deep sternal wound infection in diabetic patients after cardiac surgical procedures. Ann Thorac Surg. 1999;67(2):352-60.

21. Nungu KS, Olerud C, Rehnberg L, Larsson S, Nordell P, Allvin I et al. Prophylaxis with oral cefadroxil versus intravenous cefuroxime in trochanteric fracture surgery: a clinical multicentre study. Arch Orthop Trauma Surg. 1995;114(6):303-7.

22. Francel TJ, Kouchoukos NT. A rational approach to wound difficulties after sternotomy: the problem. Ann Thorac Surg. 2001;72(4):1411-8.

23. Merrill WH, Akhter SA, Wolf RK, Schneeberger EW, Flege Jr JB. Simplified treatment of postoperative mediastinitis. Ann Thorac Surg. 2004;78(2):608-12.

24. Lutarewych M, Morgan SP, Hall MM. Improving outcomes of coronary artery bypass graft infections with multiple interventions: putting science and data to the test. Infect Control Hosp Epidemiol. 2004;25(6):517-9.

25. Jenney AW, Harrington GA, Russo PL, Spelman DW. Cost of surgical site infections following coronary artery bypass surgery. ANZ J Surg. 2001;71(11):662-4.