

## WOUND INFECTION IN CARDIAC SURGERY

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The incidence of wound infection in cardiac surgery is rare but still remains a potential cause of morbidity and mortality. Most of the studies carried out on postoperative wound infections after cardiac surgery reported only deep wound infections (bone and mediastinum) with varying incidence of 0.4%-5%<sup>1</sup> and a mortality of between 8%-80%.<sup>2,3</sup> The management of sternal wound infection has evolved over a period of time and several reports have detailed the management of this problem.<sup>4,12</sup>

The most important step in the management of wound infection is prevention,<sup>1</sup> and this is best done by identifying the risk factors, which varies from one study to another.<sup>1-8</sup> The present study was carried out in our institution to identify the incidence of wound infections following cardiac surgery, to identify the risk factors and evaluate the efficacy of present modes of management.

### Materials and Methods

Between April 1990 and December 1992, a prospective study of postoperative wound infections in 3200 consecutive patients who had cardiac surgery under cardiopulmonary bypass through median sternotomy incision at the Ottawa University Heart Institute was conducted. The procedures carried out are shown in Table 1. At a confidence interval of 95% with an anticipated population proportion of 5% and an absolute precision of 1%, the minimal sample size<sup>13</sup> in the present study was 1825 consecutive cardiac surgical cases. The diagnosis of wound infection was established as follows:

1. Positive culture (bacteria  $\geq 10^5$ )
2. Clinical evidence of cellulitis
3. Clinical evidence of wound infection in the presence of negative culture

### Potential Risk Factors

Sixteen possible risk factors were analyzed and included

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age, weight, sex, left internal mammary artery or right internal mammary artery used for grafting, redo operations, reopening of wound, duration of cardiopulmonary bypass, duration of mechanical ventilation, length of stay in intensive care unit, number of days in the hospital prior to surgery, amount of blood loss, blood transfusion, type of operation (emergency/elective), nature of operating room, time of day that the operation took place, and the presence of diabetes mellitus.

The risk factors for infection were assessed by univariate analysis. Discrete variables were assessed using chi-squared analysis or Fisher's exact test. Continuous variables were assessed using unpaired Student's *t*-test. The chosen level of significance was 5%.

### Results

#### Incidence of Infection

One hundred and thirty-six patients developed wound infection (4.25%). Sternal wound infection occurred in 90 patients (2.87%). Sternal wound infection was divided into superficial (skin and subcutaneous tissue), which occurred in 78 patients (2.5%) and deep wound infection (bone and mediastinum), which occurred in 12 patients (0.37%). Forty-six of the 2460 patients who had coronary artery bypass graft (CABG) developed leg wound infection (1.8%).

The results of the wound cultures are shown in Table 2. *Staphylococcus aureus* was cultured in 46 patients (33%) and *Staphylococcus epidermidis* in 44 patients (31%). Mixed growth was obtained on culture in 16 patients (11.7%).

#### Risk Factors

Univariate analysis was carried out for age, weight, left internal mammary artery, right internal mammary artery, redo operation, postoperative reopening and length of cardiopulmonary bypass (Table 3). The only significant factor found was the mean weight of the patient ( $P=0.000043$ ). Patient's sex, amount of postoperative blood loss, number of blood transfusions, presence of diabetes mellitus, room in which the operation was performed and time of day surgery took place, had no significant influence on the incidence of wound infection (Tables 3 and 4).

### Morbidity and Mortality

The average length of stay in our hospital following cardiac surgery is 8 days, whereas infected patients remained in hospital for a mean of 27 days. Five of the 136 patients who had cardiac surgery died from wound infection (3.5%). All the patients had coronary artery bypass grafts and the causative pathogen was *Staphylococcus aureus*. Four of the patients had deep sternal wound infection and one had a leg wound infection. All the patients developed multi-organ failure (Table 4). Other morbidity factors noted in the patients with sternal wound infection included pneumonia, respiratory failure, urinary tract infection and gastrointestinal bleeding.

### Management

During the period of the study, one or more of the following methods of treatment was used: antibiotics, warm compresses, irrigation with antiseptic solution or normal saline, packing, and debridement with or without primary closure. In the cases of deep wound infection, 6 of the 12 patients underwent debridement, 3 of them with primary closure.

### Discussion

Wound infection, especially mediastinitis following cardiac surgery, is rare but could be life-threatening.<sup>10,14</sup> Recent studies have shown a downward trend in the incidence of wound infection after cardiac surgery ranging from 0.1% to 8.5%.<sup>9,15,16</sup> In patients who develop mediastinitis, mortality could be as high as 14%.<sup>9</sup> In the present study, the overall infection rate was 4.25% while the mortality among this group was 3.5%.

Diabetes mellitus on its own has no effect on postoperative wound infection but it becomes a significant factor in patients who have had bilateral internal mammary artery used for grafting.<sup>9</sup> Only one-third of our infected patients were diabetic, thus confirming the findings by Loop et al.<sup>9</sup>

The patients' weight was the only significant risk factor confirmed in our study, and this factor has also been identified by other reports.<sup>9,18</sup>

*Staphylococcus aureus* was the most common pathogen isolated in patients with infection after cardiac surgery, both in our study and in cases reported in the literature.<sup>1,9,16</sup> In an effort to reduce infection after cardiac surgery, several studies have attempted to identify specific risk factors that may predispose to postoperative wound infection,<sup>8,9,15,16</sup> and offer perioperative measures that may help to reduce these infections.<sup>17,19,20</sup> Significant risk factors that have been identified include longer preoperative stay,<sup>16</sup> longer period of ventilation,<sup>14,16</sup> longer intensive care unit stay,<sup>15</sup> longer bypass time and longer operation time,<sup>9,16</sup> combined coronary artery and valvular surgery,<sup>8</sup> bilateral internal mammary artery graft in diabetics,<sup>9</sup> obesity,<sup>9,18</sup> and perioperative blood transfusion.<sup>9</sup>

TABLE 1. Cardiac surgical procedures carried out in 3200 consecutive patients.

Procedure	No. of patients
CABG	2258
Valve replacement	434
Valve replacement + CABG	202
Cardiac transplantation	58
Others	248

CABG=coronary artery bypass graft; others=aortic surgery, cardiac tumor, left ventricular aneurysmectomy, arrhythmia surgery.

TABLE 2. Microorganisms isolated from 136 patients who had wound infection after cardiac surgery.

Bacteria	No. of patients	%
<i>Staphylococcus aureus</i>	46	33.3
<i>Staphylococcus epidermis</i>	44	31
Mixed	16	11.7
No growth	10	7.3
<i>Escherichia coli</i>	8	5.8
<i>Enterobacter spp.</i>	2	1.4
<i>Pseudomonas aeruginosa</i>	1	0.7
<i>Streptococcus beta B-hemolytic streptococcus</i>	1	0.7
<i>Proteus spp.</i>	1	0.7

17 patients (12.5%) had cellulitis and no cultures were obtained.

TABLE 3. Univariate analysis of risk factors for sternal wound infection in cardiac surgery.

Risk factors	Non-infected patients	Infected patients	P-value
Mean age (years)	58.62	59.3	ns
Mean weight (Kg)	73.39	79.99	0.000043
LIMA	39	53	ns
LIMA + RIMA	88	4	ns
REDO	76	16	ns
Re-opening	87	5	ns
Duration of CPB (minutes)	104.18	107.51	ns

LIMA=left internal mammary artery; RIMA=right internal mammary artery; CPB=cardiopulmonary bypass; ns=no significance.

TABLE 4. Univariate analysis of other risk factors for sternal wound infection in cardiac surgery.

Risk factors	Relationship to infection
Sex	ns
Duration of mechanical ventilation (days)	ns
Duration of ICU stay (days)	ns
Days in hospital prior to surgery	ns
Blood loss (ml)	ns
Blood transfusion (ml)	ns
Category of surgery (emergency/elective)	ns
Operating room	ns
Time of day operation took place	ns
Patients with diabetes mellitus	ns

In order to reduce bacterial contamination and wound infection after cardiac surgery, clean air operating room suites and impermeable patient clothing (drapes) were recommended in the study reported by Verkkala et al.<sup>20</sup> In patients who develop sternal wound infection postoperatively, several management modalities have been

employed.<sup>9,11,12,22,24</sup> These include the transposition of the greater omentum<sup>25</sup> and muscle flap reconstruction.<sup>22,23</sup> In cases complicated by mediastinitis, adjuvant treatment with immunoglobulins has been proposed and put to clinical trials.<sup>9,12,13,26,27</sup> In our study, there were 136 patients with postoperative wound infections of which 12 had deep sternal wound infection. The patients were managed with antibiotics, warm compresses, irrigation with antiseptic solution and wound debridement with or without primary sternal closure. All five patients who died in our series had infections caused by *Staphylococcus aureus*.

### Conclusion

Although postoperative wound infections after cardiac surgery is declining and the mortality is low, several risk factors have been identified which contribute to the infection rate. The administration of prophylactic antibiotics, weight reduction regimes, shortening of the operating time and the duration of cardiopulmonary bypass, identifying promptly treating high-risk groups, will help in further reducing the incidence of wound infection in cardiac surgery. Should wound infection develop after cardiac surgery, aggressive treatment is recommended.

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