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SHORT REPORT

Mortality rate, length of stay and extra cost of sternal surgical site infections following coronary artery bypass grafting in a private medical centre in Turkey

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Summary Florence Nightingale Hospital is a 300-bed, university-affiliated, private medical centre with a large open heart surgery programme in Istanbul, Turkey. In this study, the mortality rates, lengths of stay (LOS) and extra costs of patients with deep sternal surgical site infections (DSSSIs) and superficial sternal surgical site infections (SSSSIs) following coronary artery bypass grafting (CABG) were determined from January 1999 to December 2002. Group I included 52 patients with DSSSIs, Group II included 36 patients with SSSSIs and Group III included 88 controls. The controls were selected at random from patients operated within the same year, with the same sex and age within five years, but who had not developed infection. Mortality rates in Groups I, II and III were 19.2%, 0% and 4.5%, respectively; the mortality rate in Group I was significantly different from that in Groups II and III ($P<0.005$). LOS was 47, 33 and 12 days for Groups I, II and III, respectively, and LOS was statistically different for each group ($P<0.005$). The costs of extra LOS, antibiotics, and radiological, microbiologial and other laboratory examinations for Groups I and II were US$6850.93 and US$3740.58, respectively. Both DSSSI and SSSSI following CABG extended the LOS and increased the cost, and DSSSI was significantly associated with a high mortality rate. These results suggest the need for improved infection control measures to reduce

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SSSIs following CABG. As an important component of the extra cost is the extra LOS, it is essential to shorten this period. This may be particularly applicable in patients with SSSSIs.

Introduction

Prior studies have shown that surgical site infections in different groups of surgical patients are not only an important cause of morbidity and mortality, but are also associated with excess cost. Coronary artery bypass grafting (CABG) is a high-technology medical procedure, and surgical site infections are the most frequent postoperative nosocomial infections following CABG.

Studies performed at university and community hospitals to determine mortality, additional length of stay (LOS) and cost of sternal surgical site infections (SSSIs) following CABG do not generally distinguish deep sternal surgical site infections (DSSSIs) from superficial sternal surgical site infections (SSSSIs), and some focus on deep infection alone. The aim of this study was to evaluate mortality rates and LOS in both DSSSIs and SSSSIs following CABG, and to discuss the economic consequences of these infections for the patient and the hospital in a private medical centre in Turkey.

Methods

Nosocomial infection surveillance, selection of patients and controls

An active prospective and laboratory-based surveillance programme has been in place since January 1999 at Florence Nightingale Hospital, a private medical centre affiliated to Kadir Has University, Istanbul, Turkey. More than 2000 cardiovascular and vascular operations are performed each year at Florence Nightingale Hospital. All patients who developed nosocomial infection (NI) received 'NI follow-up forms' in addition to their routine hospital reports. There was no formal postdischarge surveillance, but patients who referred back to the hospital with an NI after discharge were included in the inpatient surveillance system.

All patients with SSSIs following CABG were selected from NI follow-up forms and included in the study. Using the hospital reports, the control patients were selected at random from the patients operated within the same year, with the same sex and age within five years, but who did not develop infection. Group I included 52 patients with DSSSIs, Group II included 36 patients with SSSSIs and Group III included 88 controls.

Definitions

Centers for Disease Control and Prevention definitions were used in the diagnosis of SSIs.[1] Infections related to the skin were considered to be SSSSIs, and infections of sternum, mediastinum or both were considered to be DSSSIs.

Determination of LOS and extra LOS

Postoperative LOS was recorded in whole days and was calculated from the day of operation. When a case was re-admitted for treatment of SSSI, the duration in days was added to the initial LOS. The total LOS was divided by the number of patients to find the average LOS for Groups I, II and III. Extra LOS for Groups I and II was calculated as follows:

$$\text{Extra LOS}_{\text{Group I}} = \text{Average LOS}_{\text{Group I}} - \text{Average LOS}_{\text{Group III}}$$

$$\text{Extra LOS}_{\text{Group II}} = \text{Average LOS}_{\text{Group II}} - \text{Average LOS}_{\text{Group III}}$$

Extra cost analysis

The types and doses of antibiotics, and the types and number of radiological, microbiological and other laboratory examinations were calculated from NI follow-up forms for Groups I and II, separately.

Costs of hospital stay/day, antibiotics, and radiological, microbiological and other laboratory examinations were provided by the Hospital's Finance Department and converted to US dollars at the time of the study. The exact cost of re-operation could not be provided by the Finance Department, but was taken as equal to the cost of an operation.

Extra cost per patient for Groups I and II was the sum of costs of extra LOS, antibiotics to treat SSIs, and radiological, microbiological and other

Table I Characteristics of Groups I, II and III

	Group I	Group II	Group III
N	52	36	88
Age (years)	62.86 (SD 8.50)	59.38 (SD 9.31)	61.68 (SD 9.05)
Male/female	32/20	22/14	54/34
Mortality	10 (19.2%)	-	4 (4.5%)
Length of stay (days)	46.59 (SD 25.28)	32.94 (SD 12.08)	11.66 (SD 4.84)
Extra length of stay (days)	35	21	-
Extra cost[a] (US$)	6850.93	3740.58	-

Group I, patients with deep sternal surgical site infections; Group II, patients with superficial sternal surgical site infections; Group III, controls without infection; SD, standard deviation.
[a] This includes the cost of extra length of stay, antibiotics, and radiological, microbiological and other laboratory examinations.

laboratory examinations to diagnose and follow-up patients with SSSIs. Re-operation costs were not included in the analysis.

Statistical analysis

One-way ANOVA test was used for the statistical analysis of LOS, and multiple comparisons were made by Tamhane test.[2,3] Chi-squared test was used for the statistical analysis of mortality rates.

Results

The characteristics of Groups I, II and III are shown in Table I.

The mortality rate in Group I was higher than that in Groups II and III ($P<0.005$ and $P<0.005$). The difference between the mortality rates of Groups II and III was not statistically significant ($P=0.193$).

The difference in LOS between each group was statistically significant (Group I vs Group II, $P<0.005$; Group I vs Group III, $P<0.001$; Group II vs Group III, $P<0.001$).

The total costs of antibiotics used to treat SSSIs in Groups I and II were US$39 593.53 and US$6910.13, respectively. Magnetic resonance imaging, computerized tomography and echocardiography were performed in one, 45 and two patients in Group I and 0, nine and one patients in Group II, respectively. The total costs of all radiological examinations in Groups I and II were US$14 745.24 and US$2975.47, respectively. Wound culture, blood culture and antibiotic susceptibility tests were performed in 241, 43 and 171 patients in Group I and 84, six and 63 patients in Group II, respectively. The total costs of microbiological examinations in Groups I and II were US$14 288.09 and US$4602.63, respectively. White blood cell count and C-reactive protein were performed in 885 and 705 patients in Group I and 454 and 298 patients in Group II, respectively. The total cost of these laboratory examinations in Groups I and II were US$18 243.75 and US$8277.35, respectively. Twenty-five patients were re-operated in Group I and the cost of re-operation per patient was US$7000–8000.

Extra costs per patient in Groups I and II are shown in Table II.

Discussion

In this study, the mortality rate in patients with DSSSIs was 19.2%. This was statistically significant compared with patients with SSSSIs and controls. The rate was largely consistent with other studies; 10%[4] and 22%.[5] Extra LOS in our study was 35 and 21 days for patients with DSSSIs and SSSSIs, respectively, and this was largely consistent with that reported from university or community hospitals; 17–30 days.[4–8]

The cost of SSIs following CABG has varying estimates. The extra cost of SSIs following cardiovascular surgery varied from US$6605 to 41 558,[5,7–9] and was reported to increase in patients who subsequently died.[5] Different settings, time periods and methodologies may affect the results. It is

Table II Extra cost/patient in Groups I and II

	Group I (US$)	Group II (US$)
Hospital stay	5180.35	3108.21
Antibiotics	761.41	191.95
Radiological examinations	283.56	82.65
Microbiological examinations	274.77	127.84
Other laboratory examinations	350.84	229.93
Total	6850.93	3740.58

difficult to capture the true economic impact of infection.

In this study performed in a private medical centre, the extra costs were US$6850.93 and US$3740.58 for patients with DSSSIs and SSSSIs, respectively. If we had also taken the cost of re-operation into account, the extra cost would be at least double for DSSSI. To our knowledge, there are no data about the economic impact of SSSSIs in the literature. This study found that although they did not affect the mortality rate, SSSSIs were associated with high cost.

When excluding re-operation costs for DSSSIs, the principal component of the extra costs for both DSSSIs and SSSSIs was the extra LOS in this study. As such, it is impossible not to agree with Cao who proposed a system of family sickbed service to allow these patients to be treated at home. In addition to saving costs, this would also avoid the risk of cross-infection.[10] This may be more applicable for patients with SSSSIs who do not need re-operation.

The costs of antibiotics per patient in our study were US$761.41 and US$191.95 for patients with DSSSIs and SSSSIs, respectively. This amount may decrease in the future as we have been restricting the use of antibiotics since March 2002. At our hospital, most antibiotics, especially those which are highly expensive and which require conservation such as glycopeptides, carbapenems, cefepime, piperacillin/tazobactam and intravenous quinolones, can only be prescribed by an infection control doctor.

The costs of re-operation, local wound care, and intravenous or intramuscular injections were not charged to the patients but were a great loss for the hospital. Another loss for the hospital was those patients who had their health care paid for by the Government. The Government paid a fixed price for CABG, and this did not increase with extra expenditures for patients. As the total amount of this fixed price was less than the extra cost calculated, the hospital lost money from the patients with SSSIs. So, SSSIs had an important effect on the budget for both patients and the hospital.

As a result, both DSSSIs and SSSSIs extend the LOS and increase the cost, and DSSSIs are significantly associated with a high mortality rate. These results suggest the need for improved infection control measures to reduce SSSIs following CABG.

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