

Topical vancomycin in combination with perioperative antibiotics and tight glycemic control helps to eliminate sternal wound infections

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Objective: This study was undertaken to determine whether topical vancomycin would further reduce the incidence of sternal infections in the presence of perioperative antibiotics and tight glycemic control.

Methods: A total of 1075 consecutive patients undergoing cardiac surgery from December 2007 to August 2013 receiving topical vancomycin (2.5 g in 2 mL of normal saline) applied as a slurry to the cut edges of the sternum were compared with 2190 patients from December 2003 to November 2007 who did not receive topical vancomycin. All patients received perioperative antibiotics (cefazolin 2 g intravenously every 8 hours and vancomycin 1 g intravenously every 12 hours) on induction of anesthetic and continuing for 48 hours; and intravenous insulin infusions to maintain serum blood glucose level between 120 and 180 mg/dL.

Results: Patients receiving topical vancomycin had less superficial sternal infections (0% vs 1.6%; $P < .0001$), deep sternal infections (0% vs 0.7%; $P = .005$), any type of sternal infection (0% vs 2.2%; $P < .0001$) and significantly less sternal infections of any type in patients with diabetes mellitus (0% vs 3.3%; $P = .0004$).

Conclusions: Topical vancomycin applied to the sternal edges, in conjunction with perioperative antibiotics and tight glycemic control, helps to eliminate wound infections in cardiac surgical patients. (*J Thorac Cardiovasc Surg* 2014;148:1035-40)

Although the incidence of sternal wound infections has decreased to 1% to 4% of all cardiac surgical patients, they are associated with increased morbidity and mortality and decreased long-term life expectancy.¹⁻⁴ Sternal wound infections prolong hospital stay and are now publically reported.^{5,6} They can raise hospital costs by as much as US\$62,000.⁷ The US Center for Medicine and Medicaid services no longer reimburse hospital costs incurred in the treatment of deep sternal wound infections after coronary artery bypass graft (CABG) surgery.⁸

Several methods have been successful in decreasing the incidence of sternal wound infections. These include the use of perioperative antibiotics, glycemic control with intravenous insulin infusions, and the avoidance of bone wax.⁹⁻¹³ These therapies have decreased, but have not eliminated sternal wound infections.

Previous studies have shown that topical antibiotics, used in a dry or powdered form, achieve much higher local

wound concentrations than are possible with systemic antibiotics and that this high concentration persists for several hours after the closure of the wound.¹⁴ Vander Salm and colleagues¹⁵ found that using topical vancomycin resulted in a significant decrease in sternal wound infections in patients undergoing cardiac surgical procedures. This study was therefore undertaken to determine whether topical vancomycin would further reduce the incidence of sternal wound infections in the presence of perioperative antibiotics and tight glycemic control.

METHODS

A total of 3265 consecutive patients undergoing cardiac surgical procedures using a full-length median sternotomy incision at the Boston Medical Center from December 2003 to August 2013 were included in the study. Institutional Review Board approval was obtained and the need for consent was waived because the study design was retrospective and relevant identifiers were stripped from the data.

Study Groups

All patients received perioperative antibiotics, consisting of cefazolin (2 g intravenously [IV] every 8 hours) and vancomycin (1 g IV every 12 hours) on induction of anesthetic and continuing for 48 hours after surgery. Intravenous insulin infusions were used starting at the time of induction of anesthetic and continuing for 24 hours to maintain serum glucose values between 120 and 180 mg/dL.¹⁰ From December 2007 to August 2013, 1075 consecutive patients received topical vancomycin. In these patients, after the median sternotomy, a slurry consisting of 2.5 g of powdered vancomycin (Eli Lilly Inc, Indianapolis, Ind) diluted in 2 mL of normal saline was prepared in the operative field and applied to both edges of the cut sternum. The same process was performed immediately before rewiring the sternum. This group of patients was compared with a cohort of 2190 patients from December 2003 to November 2007 in whom topical vancomycin was not used. These 2

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Abbreviations and Acronyms

CABG	= coronary artery bypass graft
CHF	= congestive heart failure
CPB	= cardiopulmonary bypass
ITA	= internal thoracic artery
MI	= myocardial infarction
PVD	= peripheral vascular disease
STS	= Society of Thoracic Surgeons

time periods were chosen because there were no changes in the preoperative, intraoperative, or postoperative protocols for patients undergoing cardiac surgery.

Surgical Technique

Surgical techniques were identical for both groups. All procedures were performed on heparin-bonded cardiopulmonary bypass circuits with a membrane oxygenator. The left internal thoracic artery (ITA) was harvested as a pedicle graft in all patients with a left anterior descending lesion greater than 50%. Bilateral ITAs were used at the discretion of the individual surgeon. The sternum was routinely closed with 4 figure-of-eight sternal cable wires. The fascia, subcutaneous layer, and skin layer were closed with running, monofilament, absorbable sutures. Antibiotic impregnated sutures were not used in any patient.

Definition of Sternal Infections

The criteria used for the definition and classification of sternal wound infections were according to the Centers for Disease Control and Prevention.¹⁶ Depths 1 and 2 were defined as a superficial infectious process limited to the subcuticular and subcutaneous layers with no involvement of the sternal bone. Depths 3 and 4, which involved the sternal bone or wires and collections beneath the sternum, were considered deep infections. A wound was considered infected only if a positive culture for an organism was obtained. Reported infections included all infections that developed within 1 year of surgery.

Risk Factors

Patient risk factors were defined according to the Society of Thoracic Surgeons (STS) Adult Cardiac Surgery Database.¹⁷ These included those factors that have been shown to be associated with a high risk for postoperative wound infection and included age, weight, diabetes mellitus, renal failure, congestive heart failure (CHF), peripheral vascular disease (PVD), female gender, chronic obstructive lung disease, cardiogenic shock, myocardial infarction (MI), ejection fraction, urgency of surgery, need for steroids, and smoking.¹⁸

Statistical Analysis

Data are presented as absolute values, percentages, and the mean \pm standard deviation. The Fisher exact test and χ^2 test were used to test statistical significance for the incidence of sternal wound infections between the groups. The small incidence of wound infections in the total cohort of patients did not allow for meaningful multivariable analyses using models for binary outcomes. Therefore, a propensity-matched score using a greedy matching algorithm was computed to reduce the selection bias due to the retrospective nature of the study. The variables used for propensity score matching included ejection fraction, age, CHF, PVD, endocarditis, diabetes, type of surgery, urgency of surgery, smoking, previous MI, preoperative steroids, preoperative creatinine, preoperative weight, crossclamp time, and cardiopulmonary bypass (CPB) time. Analyses were performed using SAS version 9.2 software (SAS Institute, Inc, Cary, NC).

RESULTS

The results are summarized in [Tables 1 to 3](#).

Patient profiles are reviewed in [Table 1](#). There was no difference between the groups in age, gender, the incidence of an MI, CHF, diabetes mellitus, PVD, chronic obstructive lung disease, the need for permanent dialysis, weight, serum creatinine level, or the urgency of surgery. Patients receiving topical vancomycin were more likely to have been active smokers (29% vs 19%; $P < .0001$) and undergone surgery for endocarditis (5% vs 3%; $P = .002$). Ejection fraction was slightly higher in the topical vancomycin group ($53.1\% \pm 12.5\%$ vs $51.5\% \pm 13.7\%$; $P = .001$).

Most patients underwent isolated CABG surgery ([Table 2](#)). There was a lower incidence of isolated CABG surgery and a higher incidence of isolated valve procedures in the patients receiving topical vancomycin. There was no difference in the incidence of the use of a single ITA (61% vancomycin vs 63% no vancomycin) or a double ITA (3% vancomycin vs 3% no vancomycin). The crossclamp times were 72 ± 33 minutes with no vancomycin versus 67 ± 28 minutes with vancomycin ($P < .001$) and the CPB times were 113 ± 40 minutes with no vancomycin versus 105 ± 48 minutes with vancomycin ($P < .001$).

The incidence of sternal infections is shown in [Table 3](#). Patients receiving topical vancomycin had no superficial infections (0% vs 1.6%; $P < .0001$), no deep sternal infection (0% vs 0.7%; $P = .005$), or any type of sternal infection (0% vs 2.3%; $P < .0001$) compared with the patients in whom topical vancomycin was not used. This was particularly evident in patients with diabetes mellitus; patients in this group receiving topical vancomycin had no infections (0%) compared with an incidence of 3.3% in patients not receiving topical vancomycin ($P = .0004$).

For the 444 patients receiving topical vancomycin who were propensity matched to 444 patients not receiving vancomycin, the estimated difference of any sternal infection was 1.1%. This was statistically significant ($P = .02$) in those analyses that accounted for the lack of statistical independence imposed by the matching.

DISCUSSION

Our results have shown that topical vancomycin, in combination with perioperative antibiotics and tight glycemic control eliminated both superficial and deep sternal wound infections in patients undergoing a median sternotomy during cardiac surgery. Both groups of patients had a similar incidence of those risk factors that were shown by Fowler and colleagues to predict the incidence of postoperative wound infections.¹⁸ Our findings are in keeping with other studies that have shown that topical vancomycin reduces sternal wound infections. Vander Salm and colleagues¹⁵ found that the use of topical vancomycin prepared as a slurry, similar to our technique, in conjunction with

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