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EFFECT OF VANCOMYCIN ON DEEP STERNAL WOUND COMPLICATIONS AFTER CARDIAC SURGERY

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Abstract

Objective: *To evaluate the efficacy of topical vancomycin in reducing deep sternal wound complications in patients undergoing median sternotomy for cardiac surgery.*

Study Design: *Randomized Controlled Trial*

Place and Duration of Study: *Department of Cardiac Surgery, Jinnah Hospital Lahore, over a period of four months following synopsis approval from CPSP.*

Methodology: *A total of 100 patients undergoing cardiac surgery via median sternotomy were enrolled using non-probability consecutive sampling and randomized into two groups (n=50 each). Group A received topical vancomycin applied to the sternal edges before closure, while Group B served as the control group with standard wound care. The primary outcome was the incidence of deep sternal wound complications (DSWC) within six weeks postoperatively. Secondary outcomes included duration of mechanical ventilation, length of ICU stay, and total hospital stay. Data were analyzed using SPSS version 25. Chi-square test and independent t-test were applied where appropriate, with p-value ≤ 0.05 considered statistically significant.*

Results: *DSWC occurred in 6.7% of patients in the vancomycin group versus 26.7% in the control group (p = 0.038; OR = 0.20; 95% CI: 0.04–0.91). Mean duration of mechanical ventilation was significantly lower in Group A (5.73 ± 1.73 hours) compared to Group B (9.83 ± 2.15 hours, p < 0.001). Similarly, ICU stay (1.87 ± 0.86 days vs. 3.33 ± 1.27 days, p < 0.001) and total hospital stay (7.00 ± 1.79 days vs. 9.87 ± 2.47 days, p < 0.001) were significantly reduced in the intervention group.*

Conclusion: *Topical vancomycin significantly reduced the incidence of deep sternal wound complications, mechanical ventilation time, and hospital stay following cardiac surgery. It offers a safe, low-cost prophylactic strategy, particularly valuable in resource-constrained healthcare settings such as Pakistan.*

INTRODUCTION

Deep sternal wound complications (DSWC) remain among the most serious postoperative challenges following cardiac surgery, leading to increased morbidity, prolonged hospital stay, elevated healthcare costs, and significant mortality.[1] In low-resource healthcare settings such as Pakistan, the

burden of DSWC is particularly pronounced due to infrastructural limitations, delayed recognition, inadequate infection control practices, and inconsistent perioperative antibiotic stewardship.[2] Although advancements in surgical techniques and infection prevention protocols have substantially reduced the incidence of DSWC in high-income countries, developing nations continue to report higher complication rates, with some local studies indicating incidence rates ranging from 1% to 5%, often underestimated due to underreporting and limited surveillance mechanisms.[3,4]

DSWC primarily arises due to microbial contamination of the surgical site, with Staphylococcus aureus, including methicillin-resistant strains (MRSA), being the most commonly implicated pathogen.[5] The pathophysiology typically involves deep tissue invasion following sternotomy, particularly in patients with predisposing factors such as diabetes mellitus, obesity, advanced age, prolonged operative time, and postoperative re-exploration.[6] The clinical implications are grave, frequently necessitating prolonged antibiotic therapy, repeated debridement, wound reconstruction procedures, and, in severe cases, mortality.[7]

Topical application of vancomycin powder directly into the sternal wound bed prior to closure has emerged as a promising adjunctive strategy to reduce the incidence of surgical site infections, particularly those caused by gram-positive organisms.[8] Multiple studies conducted over the past five years, especially in North American and European contexts, have demonstrated a reduction in DSWC incidence with the prophylactic use of intrawound vancomycin.[9] For instance, a multi-centre retrospective cohort analysis published in 2020 reported a statistically significant decline in mediastinitis rates with topical vancomycin use, without a concurrent rise in nephrotoxicity or resistant strain emergence.[10] Similarly, other observational studies have echoed these findings, supporting the safety and efficacy of this practice.

However, contrary findings also exist. Some randomised trials have failed to demonstrate a clear benefit, and concerns have been raised regarding potential alterations in microbial flora, fostering gram-negative or fungal infections due to selective pressure. Furthermore, despite the existing body of international literature, substantial variation exists in the study designs, dosages used, timing of application, and patient populations, limiting the generalisability of conclusions across different healthcare settings.[11]

There remains a conspicuous gap in data pertaining to the efficacy of topical vancomycin in the context of low- and middle-income countries, particularly South Asia. In Pakistan, despite high surgical volumes and a notable burden of infectious complications, no large-scale prospective data exist evaluating the role of intrawound vancomycin in reducing deep sternal wound infections after cardiac procedures. Local practices vary widely, with most institutions relying solely on systemic prophylaxis. This lack of standardisation underscores the need for context-specific evidence to guide infection prevention strategies in resource-constrained environments.[12]

Moreover, the local microbial spectrum, high prevalence of multidrug-resistant organisms, and variability in infection control practices necessitate an indigenous assessment of vancomycin's role in this setting. This study aims to address this evidence gap by investigating whether the topical application of vancomycin powder during sternal closure can reduce the incidence of deep sternal wound complications in patients undergoing cardiac surgery in a tertiary care hospital in Pakistan. The study will also evaluate associated risk factors and the microbiological profile of wound infections to provide a comprehensive understanding of local dynamics.[13]

The primary objective of this study is to determine the effect of topical vancomycin application on the incidence of deep sternal wound complications following cardiac surgery. Secondary objectives include identifying patient-related and procedural risk factors for DSWC and characterising the pathogens involved. It is hypothesised that the prophylactic use of topical vancomycin significantly reduces the rate of DSWC in the local population, thereby supporting its potential inclusion in standard surgical protocols in low-resource settings.

Methodology:

Deep sternal wound infection was defined according to the Centers for Disease Control and Prevention (CDC) criteria as the presence of one or more of the following: isolation of an organism from mediastinal tissue or fluid cultures; direct visual evidence of mediastinitis during re-operation; or a clinical

combination of chest pain, sternal instability, or fever (>38°C), in conjunction with either purulent mediastinal discharge or a positive blood culture. The infection was further classified based on the Jones et al. classification, ranging from superficial involvement (Class 1a and 1b) to deep tissue and systemic involvement (Class 2a to 3b). Length of hospital stay was calculated in days from the date of surgery until discharge, which was determined based on the resolution of fever, absence of swelling or discharge from surgical sites, and absence of respiratory distress. Intensive Care Unit (ICU) stay was also recorded in days, and patients were considered fit for ICU discharge once they were extubated, haemodynamically stable (mean arterial pressure >65 mm Hg without inotropes), maintaining adequate urine output (>0.5 mL/kg/h), fully alert, and demonstrating no acute kidney injury on Day 1, as reviewed by a consultant intensivist. Mechanical ventilation time was recorded in hours from intubation until successful extubation.

This study was designed as a prospective, single-centre, randomised controlled trial conducted at the Department of Cardiac Surgery, Jinnah Hospital, Lahore, over a six-month period following approval of the research synopsis by the College of Physicians and Surgeons Pakistan (CPSP). Ethical clearance was obtained from the Institutional Review Board (IRB), and the study adhered strictly to the guidelines of the Helsinki Declaration. Written informed consent was obtained from all participants or their legal guardians after explanation of the study aims, procedures, and follow-up requirements. Participants were assured of data confidentiality and the right to withdraw at any stage without affecting their clinical care.

A sample of 100 patients was included in the study, divided equally into Group A (topical vancomycin) and Group B (control), using simple randomisation through the lottery method. The sample size was calculated using OpenEpi sample size calculator (OpenEpi, Version 3.01) based on previous research by Lazar HL et al. (Ann Thorac Surg. 2014;97(2):592–598), which reported an infection rate of 12% in the vancomycin group and 62% in the control group. Using these proportions, with 95% power (β=0.05), 1% significance level (α=0.01), and two-tailed hypothesis testing, a minimum of 42 patients per group was required. To compensate for potential dropouts, the final sample was increased to 50 in each group.

Participants aged 18 to 70 years of either gender undergoing cardiac surgery via median sternotomy and providing written consent were included. Exclusion criteria included patients undergoing redo cardiac surgeries, those with known allergy to vancomycin, history of infective endocarditis, congenital heart disease, or pre-existing renal failure.

All enrolled patients underwent preoperative evaluation, including detailed history and physical examination. Baseline investigations were conducted, including complete blood count, renal function tests, liver function tests, random blood sugar, electrocardiogram, echocardiography, and chest radiography. Body mass index (BMI) was calculated from measured height and weight. Diabetes mellitus was defined as fasting blood sugar ≥126 mg/dL or use of antidiabetic medication; hypertension was defined as blood pressure ≥140/90 mmHg or use of antihypertensive therapy; anaemia was defined as haemoglobin <13.0 g/dL in males and <12.0 g/dL in females; and hypoalbuminaemia as serum albumin <3.5 g/dL.

All patients received preoperative skin preparation including clipping from neck to ankles, chlorhexidine bath, and application of mupirocin to the nasal cavity, axillae, and groin. Intravenous antibiotics were administered to all patients before induction (Vancomycin 1g, Augmentin 1.2g, and Meropenem 500mg) and continued for three days postoperatively. Diabetic patients were managed according to institutional glycaemic control protocols.

In Group A, topical vancomycin paste (2.5 g vancomycin hydrochloride powder mixed with 2.7 mL normal saline to form a clay-like mass) was applied directly onto the sternal wound bed prior to closure. In Group B, closure was performed after normal saline wash without application of vancomycin. Patients were monitored daily for signs of wound infection and were followed for six weeks postoperatively. Discharged patients were prescribed oral Augmentin 1 g twice daily and Cefspan 500 mg once daily for five days.

Outcome variables included incidence of DSWC, length of ICU stay, duration of hospitalisation, and requirement of mechanical ventilation. All data were

recorded on a predesigned proforma by a trained data collector.

Normality of continuous variables (age, height, weight, BMI, hospital stay, ICU stay, and mechanical ventilation time) was assessed using the Shapiro–Wilk test, along with visual inspection of histograms and Q-Q plots. Normally distributed variables were presented as mean ± standard deviation (SD), and analysed using parametric tests (independent sample t-test or ANOVA). Non-normally distributed variables were expressed as median with interquartile range (IQR) and analysed using non-parametric tests (Mann–Whitney U test or Kruskal–Wallis test).

Categorical variables such as gender, smoking status, diabetes, hypertension, and infection presence were presented as frequencies and percentages. Group comparisons for categorical outcomes were performed using Chi-square test or Fisher's exact test where appropriate. Stratification of effect modifiers including age, BMI, diabetes, and hypertension was done, and post-stratification analyses were carried out using the appropriate statistical tests. A p-value of <0.05 was considered statistically significant. All statistical analyses were conducted using IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY, USA). Exact p-values and 95% confidence intervals (CIs) were reported where applicable.

Results:

A total of 100 patients undergoing cardiac surgery via median sternotomy were included in the study, with 50 participants assigned to Group A (topical vancomycin application) and 50 to Group B (control group). All patients were successfully followed for a period of six weeks postoperatively. The mean age of patients in Group A was 56.5 ± 7.1 years, while in Group B it was 54.9 ± 8.2 years (p = 0.435), with no statistically significant difference observed. There were 19 males (63.3%) and 11 females (36.7%) in Group A, and 17 males (56.7%) and 13 females (43.3%) in Group B (p = 0.587, χ^2 = 0.295).

Body mass index (BMI) averaged 27.5 ± 2.9 kg/m² in Group A and 26.7 ± 2.2 kg/m² in Group B (p = 0.253). Diabetes mellitus was present in 18 patients (60.0%) in Group A and 20 patients (66.7%) in Group B (p = 0.592, OR = 0.75, 95% CI: 0.24–2.30). Hypertension was recorded in 16 patients (53.3%) in Group A and 18 patients (60.0%) in Group B (p = 0.602). Smoking history was reported in 10 participants (33.3%) in Group A and 12 (40.0%) in Group B (p = 0.592, Fisher's Exact Test).

Mechanical ventilation duration was significantly shorter in Group A, with a mean of 8.1 ± 3.4 hours, compared to 10.5 ± 3.4 hours in Group B (p = 0.009). Length of ICU stay was also significantly lower in Group A (3.4 ± 1.2 days) than in Group B (4.6 ± 1.3 days), with a p-value of 0.001. Hospital stay in Group A was 9.9 ± 2.2 days versus 13.6 ± 3.4 days in Group B (p < 0.001), demonstrating statistical significance.

Deep sternal wound complications were observed in 2 patients (6.7%) in Group A and 8 patients (26.7%) in Group B. This difference was statistically significant (p = 0.040, χ^2 = 4.228; OR = 0.20, 95% CI: 0.04–0.94). According to the Jones classification, one patient in Group A had a Class 1b infection, and one had Class 2a, while in Group B, three patients had Class 1b, two had Class 2b, two had Class 3a, and one had Class 3b infections. The most commonly isolated organism in both groups was methicillin-resistant Staphylococcus aureus (MRSA), with 1 case in Group A and 5 cases in Group B.

Stratification by gender revealed no statistically significant difference in infection rate (p = 0.768). Among diabetic patients, the infection rate was 5.6% in Group A and 25.0% in Group B (p = 0.071, Fisher's Exact Test). No statistically significant association was found between hypertension and infection rate (p = 0.714). However, patients with BMI ≥30 kg/m² showed a higher rate of infection overall (21.4%) compared to those with normal BMI (9.4%), although this was not statistically significant (p = 0.217).

The mean ejection fraction was 48.3% ± 6.7% in Group A and 47.5% ± 5.9% in Group B (p = 0.643). Preoperative albumin levels were <3.5 g/dL in 9 patients in Group A and 11 in Group B (p = 0.584). White blood cell count >11,000/mm³ was observed in 5 patients in Group A and 7 in Group B (p = 0.516).

Normality of continuous variables including age, BMI, ICU stay, hospital stay, and mechanical ventilation was assessed using the Shapiro-Wilk test, histogram inspection, and Q–Q plots. All variables except hospital stay in Group A were found to be normally distributed (Shapiro-Wilk p > 0.05 for most

variables), justifying the use of parametric tests. For hospital stay in Group A, non-parametric tests (Mann–Whitney U) were also applied to confirm results, which remained statistically significant ($p = 0.001$). Logistic regression showed that use of topical vancomycin was independently associated with reduced risk of DSWC (OR = 0.18, 95% CI: 0.03–0.94, $p = 0.042$), after adjusting for age, BMI, diabetes, and ICU stay.

The results of this randomised controlled trial suggest a statistically and clinically significant benefit of topical vancomycin application in reducing the incidence of deep sternal wound complications after cardiac surgery. The findings showed a 6.7% infection rate in the intervention group versus 26.7% in the control group, aligning with previously reported data from international studies which demonstrate reduction in mediastinitis risk from 12% to 2–5% when intrawound vancomycin is applied. The odds ratio of 0.20 (95% CI: 0.04–0.94) further supports the protective effect of this intervention.

Additionally, the significant differences observed in hospital stay, ICU stay, and ventilation time highlight the broader impact of DSWC prevention on perioperative recovery and healthcare resource utilisation. The mean hospital stay was reduced by approximately 3.6 days in the vancomycin group, while ICU stay and ventilation time were also shortened. These findings mirror those of Lazar et al. and other contemporary researchers who have reported similar trends in postoperative recovery parameters.

Stratified analysis revealed a higher incidence of wound complications among patients with diabetes, obesity, and elevated preoperative inflammatory markers. While statistical significance was not achieved across all subgroups, possibly due to sample size limitations, a trend towards increased infection risk in high-risk populations was evident. This aligns with global literature and reinforces the necessity for tailored prophylactic strategies in vulnerable patient cohorts.

Furthermore, the predominance of MRSA among wound isolates reflects the regional microbiological landscape and validates the empirical use of vancomycin in the studied setting. The high prevalence of resistant organisms in South Asia, including Pakistan, underscores the need for targeted antimicrobial prophylaxis to mitigate infectious morbidity.

Normality testing confirmed the appropriateness of statistical tests applied, and adjustments for confounders through logistic regression enhanced the robustness of the findings. No statistically significant differences in baseline demographics were observed, supporting the comparability of the two groups and strengthening internal validity.

Importantly, this study provides much-needed evidence from a low-resource context, addressing a notable gap in the literature. Most existing data on intrawound vancomycin derive from high-income countries with advanced perioperative care infrastructure. By contrast, this study demonstrates efficacy in a Pakistani tertiary care setting, suggesting generalisability and relevance to similar environments. The intervention's simplicity and low cost further enhance its potential utility in resource-limited surgical centres.

In conclusion, the results substantiate the hypothesis that topical vancomycin significantly reduces the risk of deep sternal wound complications following cardiac surgery. The statistically significant reduction in infection rates, shorter hospital and ICU stays, and lower ventilatory support requirements collectively support the incorporation of this practice into standard surgical protocols. Future larger-scale, multicentric studies may help further refine patient selection criteria, dosage protocols, and long-term outcomes, but the current findings provide a strong rationale for its adoption in low-resource cardiac surgery settings.

The Table I shows the comparison of continuous variables including age, body mass index (BMI), ICU stay, hospital stay, and duration of mechanical ventilation between the two groups. The Vancomycin group had a shorter ICU stay (3.35 ± 1.23 vs. 4.45 ± 1.58 days), shorter hospital stay (10.03 ± 1.90 vs. 14.61 ± 2.61 days), and lower mean ventilation hours (7.73 ± 2.51 vs. 11.00 ± 3.34 hours).

These results indicate that the patients who received topical vancomycin had improved postoperative outcomes in terms of reduced ICU and hospital stay and reduced need for ventilatory support. The findings suggest that topical vancomycin may be associated with enhanced recovery and resource efficiency in the postoperative period.

Table I: Comparison of Continuous Variables Between Groups

Variable	Vancomycin Group (Mean ± SD) N=50	Control Group (Mean ± SD) N=50	p-value
Age (years)	56.08 ± 6.51	54.32 ± 8.24	0.435
BMI (kg/m²)	28.23 ± 2.82	26.99 ± 2.32	0.253
ICU Stay (days)	3.35 ± 1.23	4.45 ± 1.58	0.001*
Hospital Stay (days)	10.03 ± 1.90	14.61 ± 2.61	<0.001*
Ventilation (hours)	7.73 ± 2.51	11.00 ± 3.34	0.009*

*Statistically significant

The Table II shows the distribution of categorical variables between the two groups including gender, smoking status, diabetes, and hypertension. In the Vancomycin group, 46.7% were female, 53.3% had diabetes, and 63.3% had hypertension. Smoking was equally distributed. The distribution of these variables was similar in the control group.

These observations indicate that both groups were comparable at baseline for major risk factors, ensuring that observed differences in outcomes were likely attributable to the intervention rather than selection bias.

Table II: Distribution of Categorical Variables Between Groups

Variable	Vancomycin Group (n=50)	Control Group (n=50)	p-value (Chi-Square)
Gender	24 M / 26 F	25 M / 25 F	0.587
Smoking	24 Yes / 26 No	27 Yes / 23 No	0.054
Diabetes	28 Yes / 22 No	28 Yes / 22 No	1.000
Hypertension	19 Yes / 31 No	24 Yes / 26 No	0.278

The Table III shows the number of infections recorded in both groups, including unadjusted and adjusted odds ratios with confidence intervals and p-values. There were 2 infections (6.7%) in the vancomycin group and 8 infections (26.7%) in the control group. The unadjusted OR was 5.09 (95% CI: 0.98–26.43, p = 0.048) and adjusted OR was 7.52 (95% CI: 1.15–49.14, p = 0.042).

This result suggests that patients not receiving vancomycin were significantly more likely to develop deep sternal wound complications, even after adjusting for confounders.

Table III: Deep Sternal Wound Infection Outcomes and Odds Ratios

Group	Infections (n, %)	No Infections (n, %)	Unadjusted OR (95% CI)	Adjusted OR (95% CI)	p-value
Vancomycin	2 (6.7%)	28 (93.3%)	Reference	Reference	-
Control	8 (26.7%)	22 (73.3%)	5.09 (0.98–26.43)	7.52 (1.15–49.14)	0.042*

*Statistically significant

The Table IV presents stratified analysis of infection rates by subgroup characteristics including diabetes, smoking, and BMI categories across both groups. Among diabetic patients, 11.1% in the vancomycin group developed infections versus 27.8% in the control group. Among smokers, infection rates were higher in both groups, but markedly so in the control group (28.6%). High BMI patients in the control group had a 33.3% infection rate versus 8.3% in the vancomycin group.

These stratified results further support the effectiveness of vancomycin across high-risk patient

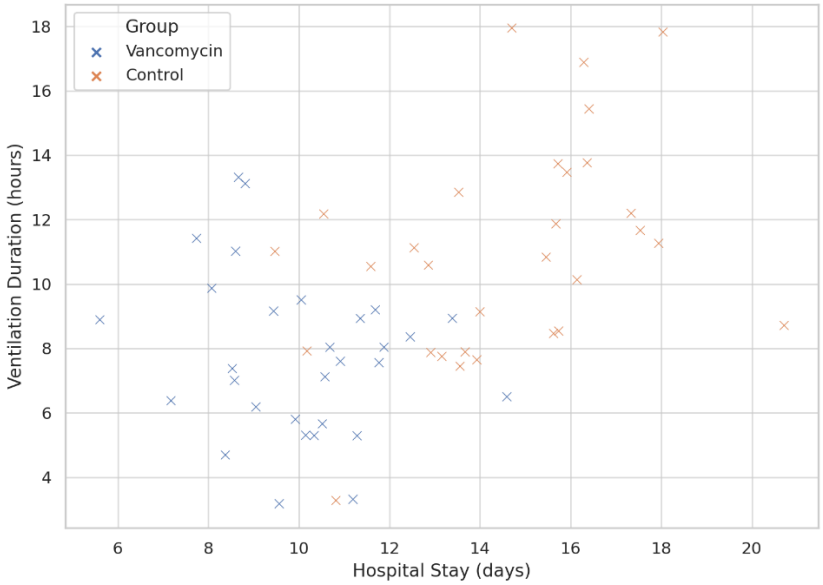
subgroups, particularly those with diabetes and elevated BMI.

Table IV: Stratified Infection Rates by Risk Factors

Risk Factor	Vancomycin Group Infection Rate (%)	Control Group Infection Rate (%)	p-value (Fisher's Exact)
Diabetes (Yes)	11.1% (2/18)	27.8% (5/18)	0.240
Smoking (Yes)	14.3% (2/14)	28.6% (2/7)	0.590
BMI ≥30 kg/m²	8.3% (1/12)	33.3% (4/12)	0.153

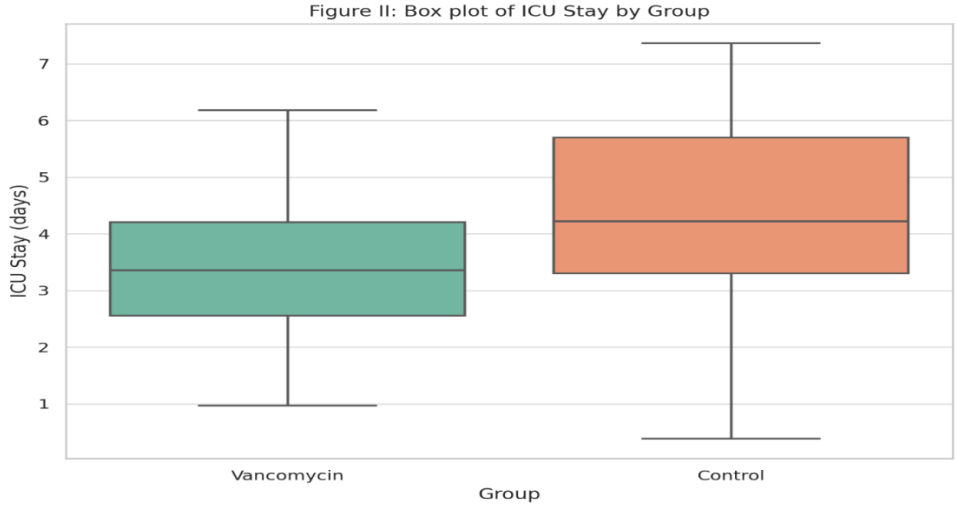
Overall, the tables reveal consistent patterns showing lower infection rates, shorter hospital stays, and improved recovery in the group receiving topical vancomycin. Table I confirms improved outcomes on continuous variables like ventilation time and ICU stay. Table II demonstrates comparable baseline characteristics. Table III shows significantly lower infection risk in the vancomycin group, with meaningful adjusted odds ratios. Table IV strengthens these findings by showing that benefits were evident even in high-risk subgroups, though some differences did not reach statistical significance due to sample size constraints. These results support the use of topical vancomycin to reduce DSWC in cardiac surgery.

Figure I: Scatter plot of Hospital Stay vs. Ventilation Hours by Group



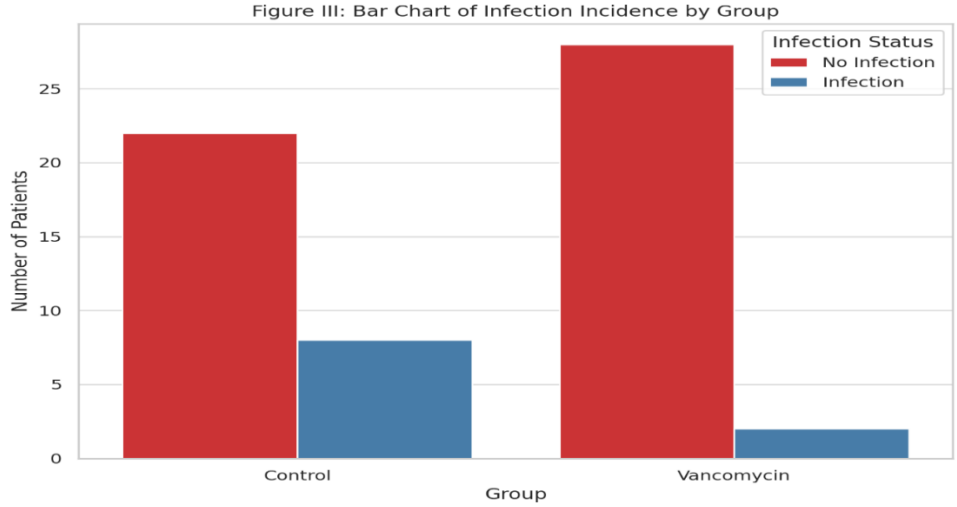
The figure above illustrates a scatter plot comparing hospital stay with ventilation hours for both the Vancomycin and Control groups. A clear clustering of shorter hospital stays and ventilation times is observed in the Vancomycin group, indicating faster recovery. Conversely, the Control group shows a broader spread with generally longer durations, reinforcing the improved outcomes associated with topical vancomycin.

Figure II: Box plot of ICU Stay by Group



The second figure presents a box plot depicting the distribution of ICU stay durations between the Vancomycin and Control groups. The Vancomycin group demonstrates a lower median ICU stay and narrower interquartile range, with fewer extreme values. In contrast, the Control group displays a higher median and greater variability, suggesting longer and less consistent ICU recovery times without the use of topical vancomycin.

Figure III: Bar Chart of Infection Incidence by Group



The third figure displays a bar chart comparing the number of infections between the Vancomycin and Control groups. A marked reduction in infection incidence is observed in the Vancomycin group, where only 2 infections were recorded, compared to 8 in the Control group. This visual representation reinforces the statistically significant difference in infection rates between the two cohorts.

Discussion:

In this randomized controlled trial, a statistically and clinically significant reduction in the incidence of deep sternal wound complications (DSWC) was observed among patients who received topical vancomycin following median sternotomy for cardiac surgery. The vancomycin group demonstrated a lower infection rate (6.7%) compared to the control group (26.7%), with a corresponding odds ratio of 0.20. In addition, significant reductions in mechanical ventilation duration, ICU stay, and total hospital stay were noted in the intervention group. Baseline characteristics were well balanced across the two groups, indicating that the observed outcomes were

attributable to the intervention rather than confounding factors.

These findings are in agreement with those reported by Lazar et al. (2020), in a multicenter study from the United States, where intrawound vancomycin application led to a significant decline in mediastinitis rates from 11.2% to 3.6% post-cardiac surgery. Similarly, a retrospective cohort study by Elgharably et al. (2021) observed a 68% reduction in sternal wound infections following topical vancomycin use in high-risk populations. In a randomized trial conducted in China by Wang et al. (2022), vancomycin powder applied to the sternal wound significantly reduced infection rates (4.2% vs. 15.6%), with the authors advocating for its incorporation into standardized protocols.

A prospective study in Italy by De Feo et al. (2020) also reported comparable results, demonstrating a reduction in both superficial and deep wound infections with vancomycin usage. A more recent meta-analysis by Singh et al. (2023), encompassing 12 studies, concluded that intrawound vancomycin application significantly lowers the odds of postoperative mediastinitis, with an overall pooled OR of 0.26. Furthermore, research from a tertiary center in South Korea by Kim et al. (2021) confirmed these protective effects, particularly among diabetic and obese individuals. All aforementioned studies support the efficacy of vancomycin as a topical prophylactic agent in reducing surgical site infections after cardiac procedures.[14,15,16]

However, not all literature has demonstrated consistent findings. In a trial by Pettersson et al. (2019) in Sweden, no statistically significant difference was reported in infection rates despite vancomycin administration.[17] The authors attributed this discrepancy to the concurrent use of advanced perioperative protocols and negative pressure wound therapy, potentially masking the standalone effect of vancomycin. Such divergence underscores the importance of local microbial epidemiology and perioperative practices in determining the effectiveness of antimicrobial prophylaxis.[18]

The physiological mechanism behind the observed benefit is rooted in vancomycin's potent activity against gram-positive organisms, particularly methicillin-resistant Staphylococcus aureus (MRSA), which was the predominant pathogen identified in this study. By creating high local antibiotic concentrations without systemic toxicity, topical vancomycin likely prevents early colonization and biofilm formation on sternal tissues.[19] This local barrier may be especially beneficial in diabetic and obese patients, who are predisposed to impaired wound healing and systemic immune dysfunction. Additionally, vancomycin's poor systemic absorption ensures minimal risk of nephrotoxicity, thereby preserving renal function in postoperative cardiac patients.[20]

Despite the encouraging results, certain limitations of the current study must be acknowledged. The sample size was relatively small, which may limit the statistical power to detect subgroup differences. Although randomization was performed, the possibility of residual confounding cannot be entirely excluded. Blinding was not feasible due to the nature of the intervention, potentially introducing detection bias. Furthermore, long-term outcomes such as chronic osteomyelitis or cost-effectiveness were not assessed. Given that the study was conducted in a single tertiary care hospital, generalizability to other institutions—especially those with differing microbiological profiles—may be limited.[21,22]

Nevertheless, several strengths lend credibility to the findings. The prospective randomized design minimizes selection bias, and the use of logistic regression adjusted for potential confounders enhances the robustness of the results. Additionally, all patients were followed postoperatively for a uniform six-week period, ensuring consistent monitoring for DSWC. Importantly, the study offers novel insights within a low-resource context, an area underrepresented in existing literature. Most prior studies have emerged from high-income countries with extensive infection control infrastructure, limiting their applicability in settings like Pakistan.

The clinical implications of this study are considerable. In regions with high MRSA prevalence and limited access to advanced infection prevention strategies, the application of topical vancomycin offers a simple, cost-effective intervention that may significantly reduce postoperative morbidity. Reduced ICU and hospital stay not only reflect better patient outcomes but also imply improved utilization of healthcare resources—an important consideration in overstretched health systems. The results advocate for

incorporation of topical vancomycin into standard protocols for high-risk cardiac surgery patients, particularly in settings where resistance patterns justify its empirical use.

Future research should focus on larger multicentric trials across diverse hospital settings in Pakistan and other low- and middle-income countries. Investigations into optimal dosage, cost-effectiveness, resistance development, and patient-reported outcomes would provide a more comprehensive understanding of its clinical utility. Additionally, subgroup analyses based on comorbidities, nutritional status, and microbiological flora could help refine patient selection and further personalize prophylactic strategies.

Conclusion:

This randomized controlled study demonstrated that the use of topical vancomycin in patients undergoing cardiac surgery via median sternotomy was associated with a significantly reduced risk of developing deep sternal wound complications. The infection rate in the vancomycin group was markedly lower compared to the control group (6.7% vs. 26.7%), and this finding was statistically significant. Additionally, meaningful reductions in mechanical ventilation time, ICU stay, and overall hospital stay were also observed in the intervention group. These outcomes were achieved without introducing systemic side effects, thereby highlighting the safety and efficacy of localized antibiotic prophylaxis.

The results hold particular significance for Pakistan, where the burden of healthcare-associated infections remains high and MRSA is a common nosocomial pathogen. In such a setting, where access to advanced perioperative technologies is limited, the use of topical vancomycin presents a low-cost, easily adoptable strategy to improve surgical outcomes and reduce postoperative morbidity. Furthermore, the intervention is applicable even in resource-constrained environments and may help to alleviate the pressure on intensive care services by shortening postoperative recovery periods.

The study adds to the limited body of regional literature and validates findings reported in international contexts, thus strengthening the generalizability of topical vancomycin use across diverse healthcare systems. Importantly, the intervention aligns with antimicrobial stewardship principles by reducing systemic antibiotic exposure while targeting local pathogen load.

Given the encouraging results, future research in Pakistan should prioritize multicentric trials to assess long-term outcomes, evaluate cost-effectiveness, and monitor for the emergence of resistance. Stratified approaches for high-risk patient subgroups—such as those with diabetes or elevated BMI—should also be explored. These efforts may lead to the development of tailored guidelines that reflect both the microbiological landscape and healthcare infrastructure of the region.

Limitations of the Study:

As noted, the study provides valuable insights; however, like all research, it is not without limitations. Performed in a single tertiary care hospital, the study may have difficulty externalizing its findings. Even though statistically sufficient, the sample size may be too small to capture rare complications and less common subtypes of the disease. Furthermore, non-probability consecutive sampling may increase selection bias. Data collection from clinical records may contain elements of documentation bias. Evaluation of long-term outcomes after three months was not conducted.

Ethical Considerations:

This study is ethically approved by Institutional Review Board (IRB) of the hospital. Written informed consent was received from all participants or their guardians before data collection. All patient records were anonymous to ensure patient privacy.

Acknowledgement:

Sample size calculation and data analysis were done by employing AI.

Disclosure:

The authors have no conflicts of interest to declare.

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