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Systematic Review

# Predominant Pathogens in Sternal Wound Infections Following Cardiac Surgery

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**Abstract**

Sternal wound infection (SWI) is a surgical incision infection that typically occurs within a month after cardiac surgery, with various pathogens responsible for its development. Risk factors such as obesity, COPD, prolonged ventilation use, poor nutrition, diabetes, re-exploration for bleeding, age, surgery duration, hospital stay, surgical type, and postoperative blood transfusion contribute to the formation of SWI. The mortality rates for SWI following heart surgery can range from 10% to 47%, indicating the severity of this complication. This review aims to identify the microbes involved in SWI and assess their role in patient management to reduce post-surgical mortality and morbidity. A systematic review was performed following PRISMA guidelines, searching databases like PubMed, Science Direct, and Google Scholar until September 6th, 2024. The inclusion criteria focused on retrospective case-control studies or randomized controlled trials involving adults diagnosed with SWI post-open heart surgery. Eight relevant studies were selected from an initial 10,596 references. The most commonly identified microbes in SWI cases were coagulase-negative Staphylococcus (CoNS) and Staphylococcus epidermidis, which are part of normal human skin flora. Risk factors such as obesity, diabetes, and critical preoperative status were found to increase the likelihood of developing SWI, indicating a complex interaction between patient characteristics and microbial factors.

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**Keywords:** *sternal wound infection, cardiac surgery, microbe.*

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## Introduction

There is a significant risk of infection from sternal wound for patients having sternotomy during cardiac surgery procedures. A surgical incision infection known as sternal wound infection (SWI) usually occurs within a month after cardiac surgery. The disease can be classified based on the depth of the infection. The incidence of superficial sternal wound infections involving the cutaneous tissue, subcutaneous tissue, and pectoralis fascia is 0.5% to 8% with morbidity rates ranging from 0.5% to 9%. Infections in superficial sternal wounds can usually be fully resolved with the use of intravenous antibiotics and local wound treatment. Deep SWIs, on the other hand, can involve muscle tissue, sternum, subchondral space and mediastinum. Although preventive efforts have advanced, the number of deep sternal wound infections is still high, ranging from 0.5% to 6.8%, with hospital mortality rates ranging from 7% to 47%. Fever, leukocytosis, and levels of C-reactive protein (CRP) are frequently unreliable indicators of infection. Major surgical reconstruction and repeated debridement may be necessary for certain patients.[1,2]

Additional risk factors that contribute to the formation of these infections include obesity, chronic obstructive pulmonary disease (COPD), and the long-term use of ventilation devices, poor nutrition, diabetes mellitus, re-exploration of bleeding event, age, duration of the surgery, duration of hospital stay, type of surgery, and postoperative blood transfusion. Risk factors include inadequate pre-operative procedures, blood transfusion, extended duration of surgery and perfusion time, sternal reattachment, postoperative hemorrhage, frequent electrocautery use, antimicrobial therapy, and intra-aortic balloon pump use. The elderly are the main population undergoing sternotomy, and age has a strong association with the likelihood of wound infection. This happens due to the elderly's limited tissue regeneration ability and systemic illnesses, which result in inadequate wound healing and increased susceptibility to infection. Obese patients have also been reported to develop SWI more frequently due to increased tension in the skin, greater body surface area, and thicker subcutaneous fat, insufficient blood supply of the subcutaneous tissue, and poor lymphatic function, which all have a negative impact on surgical wound healing. In addition, the absolute and relative insulin deficiency in diabetic patients will result in long-term hyperglycemia, which then forms a high-glucose local environment that will eventually lead to defense dysfunction, increasing the likelihood of infection and delaying wound healing.[1,2]

Coagulase-negative staphylococcus (CoNS) and Staphylococcus aureus are the most frequent organisms that cause SWI, followed by other gram positive bacteria and gram negative rod bacteria. The most prevalent microbe in SWI is Staphylococcus aureus, and increasingly linked to nasal colonization in patients.[3] Staphylococcus epidermidis is another significant pathogen in SWI, since approximately 75% of it strains are resistant to methicillin. The gram-positive, anaerobic bacteria Cutibacterium acnes, formerly known as Propionibacterium acnes, has low pathogenicity and slow growth. It is frequently observed on surgical wounds and in chest's sebaceous glands. Despite being regarded as a non-pathogenic component of the normal skin flora, C. acnes is currently known to be a significant pathogen in several kinds of surgical events. C. acnes has the ability to build biofilms, which improve its pathogenicity and could provide conditions conducive to other species. It also seems to be resistant to pre-operative skin disinfection using chlorhexidine in ethanol. Although these bacteria are often found in SWI cases, they can be missed as they require special culture conditions. During cardiac surgery, intravenous antibiotic prophylaxis is frequently administered to reduce the incidence of SWI.[4,5]

The mortality rates of sternal wound infections following heart surgery can vary from 10% to 47%, which presents a serious and potentially fatal consequence. Patients with SWI face disadvantages in both the short and long term, including higher re-hospitalization rates and longer hospital stays. Management of SWI involves a multidisciplinary approach including flap closure, vacuum-assisted closure therapy, surgical debridement, and sternal plate implantation. However, despite these interventions, the mortality rate remains high. Therefore, in order to effectively manage SWI patients and decrease the morbidity and mortality related to SWI following cardiac surgery, it is critical to recognize and address the risk factors as well as the microbes that cause infection. [6,7]

**Table 1.** Included Study Designs, Surgical Procedures, Risk Factors, and Microbes Involved.

| No | Author | Title | Type of Research | Procedure | Risk factors | Microbes Involved |
|---|---|---|---|---|---|---|
| 1 | Khalid E et al, 2023 | Sternal wound infection post open heart surgery: incidence, risk factors, pathogen and mortality | Retrospective study | Cardiac surgery | - Diabetes mellitus<br>- Need for blood transfusion<br>- Female gender<br>- Length of stay in hospital | SSWI:<br>- Coagulase-negative Staphylococcus (29.6%)<br>- Klebsiella pneumoniae (20.4%)<br>DSWI:<br>- Coagulase-negative Staphylococcus (26.9%)<br>- Staphylococcus aureus (19.2%)<br>- Pseudomonas aeruginosa (19.2%) |
| 2 | Pan L et al, 2017 | Deep sternal wound infection after cardiac surgery in the Chinese population: a single-centre 15-year retrospective study | Retrospective study | Cardiac surgery | - Body mass index<br>- Reoperation | Gram-negative bacteria (34%)<br>- Pseudomonas aeruginosa (8%)<br>- Acinetobacter baumannii (21%)<br>- Enterobacter cloacae (5%)<br>Gram-positive bacteria (37%)<br>- Staphylococcus aureus (24%)<br>- Methicillin resistant staphylococcus aureus (MRSA) (5%)<br>- Enterococcus faecalis (8%)<br>- Mixed Infection (29%) |
| 3 | Lemaignen et al, 2015 | Sternal wound infection post open heart surgery: incidence, risk factors, pathogen and mortality | Retrospective study | Cardiac surgery | - Obesity<br>- Diabetes mellitus<br>- Preoperative status<br>- Old age (>70 years old),<br>- Use of coronary artery graft (CABG),<br>- Serum creatinine | - Staphylococcus aureus (19.9%)<br>- Coagulase-Negative Staphylococci (CoNS) (7.9%)<br>- Pseudomonas aeruginosa (4.5%)<br>- Enterobacteriaceae (5.1%)<br>- Enterococcus spp. (1.7%)<br>- Polymicrobial Infections (9.6%). |
| 4 | Locke T et al, 2022 | A bundle of infection control measures reduces postoperative sternal wound infection due to Staphylococcus aureus but not Gram-negative bacteria: a retrospective analysis of 6903 patient episodes | Retrospective cohort study | Cardiac surgery | - CABG (Coronary Artery Bypass Grafting)<br>- Urgency of Operation<br>- Season.<br>- Gender Male<br>- Duration of Hospitalization Before Surgery | Gram-positive bacteria<br>- Staphylococcus aureus: 25.8%<br>Gram-negative bacteria : 34.3%<br>- Klebsiella spp. (28 kasus)<br>- Escherichia coli (19 kasus)<br>- Enterobacter spp. (18 kasus)<br>- Pseudomonas spp. (18 kasus)<br>- Proteus spp. (14 kasus) |

| | | | | | | |
|---|---|---|---|---|---|---|
| 5 | Kotnis Gaska et al, 2018 | Sternal wound infections following cardiac surgery and their management: a single-centre study from the years 2016–2017 | Retrospective study | Cardiac surgery | - Obesity<br>- Length of hospital stay<br>- Diabetes Mellitus (DM)<br>- Smoking, Alcoholism, and Age | - Staphylococcus epidermidis (26.6%)<br>- Enterococcus faecium (12.2%)<br>- Staphylococcus aureus (11.4%).<br>- Klebsiella pneumoniae (8.4%)<br>- Pseudomonas aeruginosa (6.8%) |
| 6 | Lea A et al, 2023 | Incidence and predictors of sternal surgical wound infection in cardiac surgery: A prospective study | Prospective study | Cardiac surgery | - Diabetes Mellitus.<br>- Infection causes before surgery<br>- Length of stay in ICU | - Staphylococcus epidermidis (23%)<br>- Pseudomonas aeruginosa (14%)<br>- Staphylococcus aureus (13%)<br>- Enterococcus fecalis (10%)<br>- Escherichia coli (6.5%) |
| 7 | Fahad M et al, 2020 | Incidence, types and outcomes of sternal wound infections after cardiac surgery in Saudi Arabia | Retrospective study | Cardiac surgery | - Diabetes Mellitus<br>- Obesity<br>- Smoking<br>- Duration of Operation<br>- Gender<br>- Drug Usage<br>- Lipid Lowering | - Staphylococcus aureus (45%)<br>- Klebsiella spp. (12,5%)<br>- Pseudomonas aeruginosa (12,5%)<br>- Enterobacter spp. (10%).<br>- Escherichia coli (2,5%)<br>- Enterococcus spp. (2,5%)<br>- Serratia spp. (2,5%) |
| 8 | Marie Dubert et al, 2015 | Sternal Wound Infection after Cardiac Surgery: Management and Outcome | Retrospective study | Cardiac surgery | - EuroScore<br>- Gender<br>- Body mass index (BMI)<br>- Length of stay in ICU<br>- Clinical conditions such as severe sepsis or shock | - Coagulase-negative staphylococci (48%)<br>- Enterobacteriaceae (43%)<br>- Staphylococcus aureus (MRSA) (23%) |

## Methods

Here is the PRISMA flowchart. We conducted searches using predefined keywords in several search engines. In the initial search phase, we found 210 articles in PubMed, 4,594 in Science Direct, and 19,300 in Google Scholar. In the next phase, we applied criteria to the identified articles. This process resulted in a total of 10,596 articles. After removing non-PICO-compliant files and duplicates, we identified 12 articles. After title and abstract screening focusing on the research objectives, methods, and results relevant to our secondary research questions, 8 articles remained.

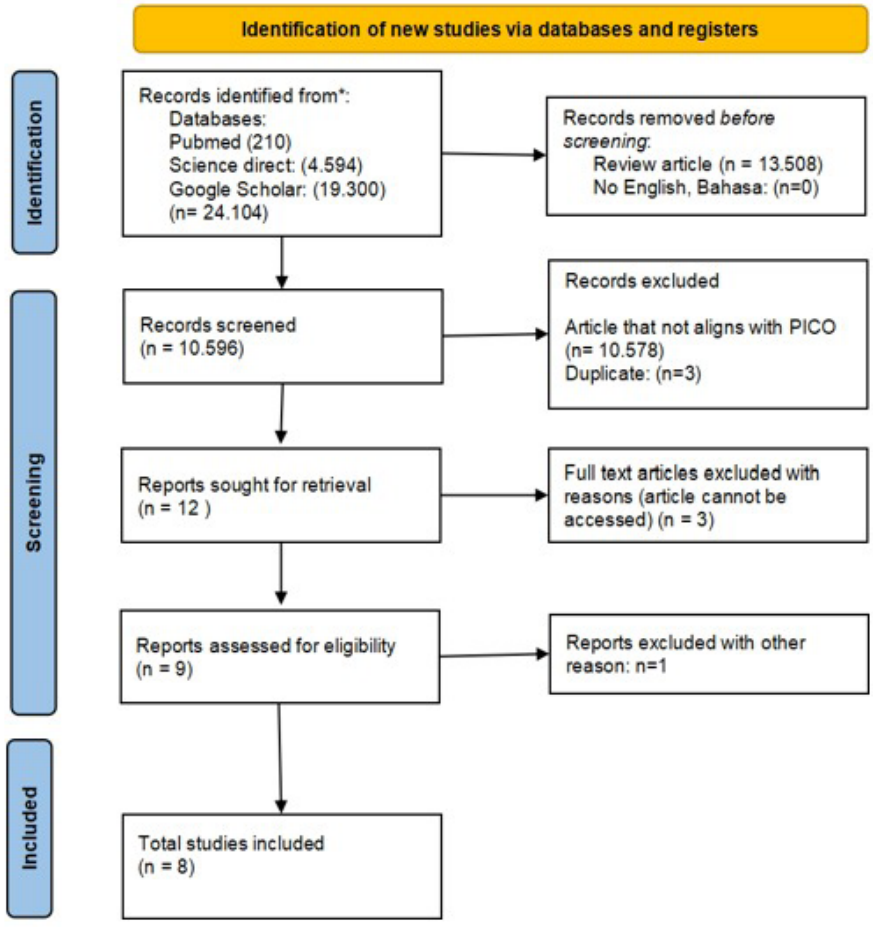


**Figure 1.** Flow chart showing the follow-up and inclusion process of the articles in the review.

## Types of Microbes

Microbes are a collection of microorganisms that thrive in an ecosystem. Numerous types of microorganisms have the ability to contaminate and colonize exposed subcutaneous tissue. If the tissue has lost its vitality (hypoxic, ischemic, or necrotic), and the body's immune system is weakened, the environment is ideal for microorganism growth.[8] The microbial composition of post-heart surgery SWI has been widely studied with various methods and provides varied results. Knowledge of microbes in post-cardiac surgery SWIs has mostly been investigated by microbial culture methods. Samples for culture are taken through several methods, including deep swabbing, tissue harvesting, and pus aspiration. This is done to ensure that the microorganisms present can be detected accurately.[9,10]

Postoperative SWI was dominated by coagulase-negative Staphylococcus (CoNS) bacteria, accounting for 28% of cases. The next most common bacteria was *Staphylococcus epidermidis*, found in 24.8% of cases, followed by Enterobacteriaceae spp in 24% of cases. In addition, *Staphylococcus aureus* was also reported in seven of the eight journals reviewed, with 22.6% of SWI cases due to this bacteria. In addition, there was also involvement of other bacterial strains in SWI such as *Acinetobacter baumanni* (21%), *Klebsiella pneumoniae* (14.4%), *Enterococcus faecium* (12.2%), *MRSA* (11%), *Enterococcus faecalis* (9%), *Escherichia coli* (6.5%), *Enterobacter cloacae* (5%), and Mixed Infection of 19.25%.[1,9-15]

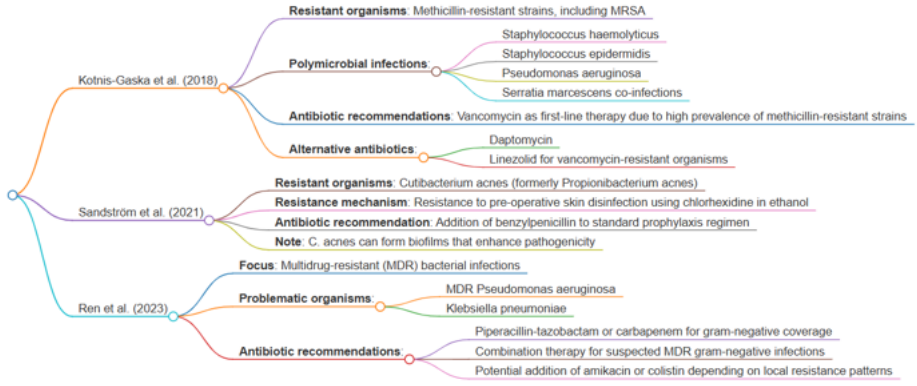


**Figure 2.** Microbial resistance mind map and list of antibiotics.

The landscape of microbial resistance in SWIs varies significantly across studies, highlighting the need for tailored antibiotic strategies. Kotnis-Gaska et al. reported a high prevalence of methicillin-resistant strains, including MRSA, in their cohort, leading to a recommendation of vancomycin as the first-line therapy, with daptomycin or linezolid reserved for vancomycin-resistant organisms.[1] In contrast, Sandström et al. (2021) focused on *Cutibacterium acnes* and its resistance to chlorhexidine-ethanol skin disinfection, advocating for the addition of benzylpenicillin to standard prophylaxis due to this organism's biofilm-forming capabilities.5 Locke et al. demonstrated the effectiveness of infection control bundles against *Staphylococcus aureus* but observed their limitations against Gram-negative bacteria, though specific antibiotic resistance patterns were not detailed. Ren et al. addressed the challenge of multidrug-resistant (MDR) bacterial infections, specifically highlighting MDR *Pseudomonas aeruginosa* and *Klebsiella pneumoniae*, and suggested the use of piperacillin-tazobactam or carbapenems for Gram-negative coverage, potentially combined with amikacin or colistin based on local resistance patterns.[13,17] While Lemaignen et al. (2015), Pan et al. (2017), Al-Ebrahim et al. (2023), and Dubert et al. (2015) provided valuable insights into risk factors and patient demographics associated with SWIs, they did not explicitly detail specific microbial resistance patterns in their excerpts. These varying findings underscore the importance of local surveillance data and consideration of prevalent resistant organisms when formulating antibiotic regimens and prophylactic strategies. The mind map of microbial resistance and the list of antibiotics that have just been visualized in Figure 2.

## Risk Factors

The results of data extraction from eight articles that met the inclusion criteria showed that various factors can affect the growth of microorganisms that cause sternal wound infection post-cardiac surgery. Both procedure-related and patient-related risk factors are included. Certain risk factors not only increase the probability of SWI but also cause wounds that are difficult to heal.[2,10] Of all the articles found, not all of them described the risk factors and exhibited the same results.

Risk factors for SWI have been studied extensively, but no consensus has been found. Frequently recognized risk factors include diabetes mellitus, obesity, reoperation, prolonged operation time and blood transfusion.[10,11] Specific studies highlight that diabetes significantly increases the risk of SWI, with odds ratios showing a strong association.[9,10] High blood sugar levels in DM can inhibit leukocytes from phagocytosis, thus making the wound susceptible to microbial infection, in addition to prolonging the process of wound healing. Supporting this finding further, the condition of DM followed by extended hospitalization days increases the likelihood of polymicrobial wound infection. Polymicrobial infections identified included *Staphylococcus haemolyticus*, *Staphylococcus epidermidis*, *Pseudomonas aeruginosa*, and *Serratia marcescens*.[1]

Obesity is also a significant patient-related risk factor for microbial infection of the sternal wound. Obese patients are at risk of experiencing sternal instability. Therefore, in older patients undergoing median sternotomy for cardiac surgery, sternal instability could lead to the development of DSWI.[1,11,12,15] However, in contrast to the study conducted by jahad et al obesity was found to have an insignificant contribution to the development of SWI.[9]

In addition, urgent surgical procedures and the need for reoperation have been associated with higher infection rates.[13,14] Other factors such as gender, and age are also described in some articles.[9,10] Based on gender, women may have a higher risk for infections caused by gram negative bacteria. This is attributed to anatomical factors such as breast tension on skin wounds.[13,15] Age may not be a reliable indicator of SWI risk, since Locke et al. study found no noticeable age difference between patients who had SWI and those who did not. Conversely, the Lemaignen et al. study revealed that patients older than 70 were linked to a higher risk of SWI.[12,13]

Risk factors associated with certain procedures such as coronary artery bypass grafting (CABG) procedures, especially those classified as urgent, have a higher chance of developing SWI. The prevalence of SWI after CABG was reported at 5.0%, compared to 2.0% for non-CABG cardiac surgery. In addition, this study highlights that urgent cases often require prolonged hospitalization before surgery, potentially increasing exposure to nosocomial infections.[9,13] The need for reoperation and complications such as prolonged ICU stay are also associated with increased length of stay, which affects the patient's recovery process.[14]

Other risk factor for SWI is the dressing technique used in closing the wounds. However, among the eight articles we reviewed, none provided specific information about the wound dressing types used for closing sternal wounds after cardiac surgery. The articles primarily focused on the microbiological aspects of sternal wound infections, risk factors, and general management approaches, rather than detailing specific dressing techniques. Management of SWI involves a multidisciplinary approach, including flap closure, vacuum-assisted closure therapy, surgical debridement, and sternal plate implantation.[6,7.]

## Discussions

After cardiac surgery, especially a median sternotomy, sternal wound infection (SWI) can be a dangerous and potentially fatal complication. This condition can substantially impact patient morbidity and mortality. SWI can be classified into two different groups according to the depth of infection: deep sternal wound infection (DSWI) can impact muscular tissue, sternum, substernum, and mediastinum, whereas superficial sternal wound infection (SSWI) only colonizes the cutaneous tissue, subcutaneous tissue, and profunda fascia. Once colonization occurs, pathogens can invade deeper tissues, including the sternum and mediastinum. DSWI develops as a result of this invasion, which prevents wound healing.[7,14]

Several risk factors can predict the occurrence of SWI. Obesity with body mass index (BMI) ≥30 kg/m², diabetes, age, history of undergoing a coronary artery bypass grafting procedure, are the most common risk factors for SWI.[7,14,16] Patients with DM followed by extended hospital days, increase the possibility of polymicrobial wound infections. Identified polymicrobial infections include *Staphylococcus haemolyticus, Staphylococcus epidermidis, Pseudomonas aeruginosa*, and *Serratia marcescens*.[1] In addition, surgical and perioperative factors also contribute to the development of SWI. Factors such as prolonged operating time, postoperative bleeding and reoperation are additional risk factors for SWI that can lead to increased morbidity and mortality in patients. In addition, preoperative skin preparation and postoperative wound care are also very important in preventing SWI.[3]

The presence of bacteria in sternal wounds is often exacerbated by patient comorbidities such as obesity, diabetes and COPD. These conditions weaken the immune system, allowing infection to develop more easily. The skin acts as the primary barrier against bacterial colonization. However, in conditions that weaken the immune system and damage the skin barrier, the skin barrier is disrupted, allowing bacteria to penetrate and colonize the skin. The breakdown of the skin barrier leads to changes in filaggrin and invlucrin regulation, lipid deficiency (cholesterol, free fatty acids, ceramide), increased water loss through the skin, and increased colonization activity. *Staphylococcus aureus* and *Streptococcus epidermidis* are normal flora on human skin, if there are comorbidity that impair the immune system and compromise skin barrier function, the risk of infection will increase significantly. Therefore,

understanding these dynamics is critical to developing effective strategies to prevent and treat SWI.[5,14]

The knowledge of microbes in post-cardiac surgery SWI has been mostly studied by microbial culture methods. Samples for culture are taken through several methods, including deep swabbing, tissue harvesting and pus aspiration. This is done to ensure that the microorganisms present can be detected accurately.[9,10] There are various microbiological profiles obtained from various studies related to SWI after cardiac surgery. The predominant bacteria in these SWI events are CoNS, followed by *Staphylococcus epidermidis* and Enterobacteriaceae spp. However, most studies report finding *Staphylococcus aureus* in their studies with significant frequency. There were also other bacterial strains found in smaller numbers such as *Acinetobacter baumanni, Klebsiella pneumoniae, MRS, Enterococcus faecium, Enterococcus faecalis, Enterobacter cloacae*, and *Escherichia coli*, as well as polymicrobial infections.[1,9-15]

The management of these infections is significantly influenced by the type of pathogen involved in SWI following cardiac surgery. *Staphylococcus aureus* and *Staphylococcus epidermidis*, which are commonly identified pathogens in SWI, often exhibit antibiotic resistance, particularly to methicillin and vancomycin. This resistance results in the need to use broader-spectrum antibiotics, which may increase the risk of other complications such as Clostridium difficile colitis, where long-term antibiotic use leads to an increased incidence of this condition. Vancomycin would be appropriate first-line therapy due to the high prevalence of methicillin-resistant strains. Alternatives could include daptomycin or linezolid, particularly in cases of vancomycin-resistant organisms.[1] Gram-negative bacteria, such as *Pseudomonas aeruginosa* and *Klebsiella pneumoniae*, also pose a challenge due to their multidrug-resistant (MDR) nature, which complicates treatment and increases the risk of multiple bacterial co-infections. Piperacillin-tazobactam or a carbapenem would provide appropriate coverage against most gram-negative pathogens. For suspected MDR gram-negative infections, combination therapy might be necessary, potentially adding amikacin or colistin depending on local resistance patterns. The presence of these MDR bacteria further calls attention to the need for early diagnosis and targeted antibiotic therapy, as well as strict adherence to aseptic technique during surgery to reduce the probability of infection. In addition, understanding patient-related risk factors, such as obesity and diabetes, is essential to select appropriate empirical antibiotic therapy and prevent polymicrobial wound infections.[1,17]

The role of prophylactic antibiotics in preventing SWI following cardiac surgery is multifaceted. Standard intravenous antibiotic prophylaxis is a cornerstone of care, with findings suggesting that augmenting this with agents like benzylpenicillin can further reduce deep SWI.[4,5] For high-risk patients, such as those with diabetes or obesity, a more targeted approach is essential, potentially involving broader coverage to address the increased likelihood of polymicrobial infections.[1,10,11] Furthermore, pre-operative strategies, including screening and decolonization of S. aureus nasal colonization, are valuable, though the resistance of C. acnes to standard skin disinfection necessitates reevaluation of current protocols. A critical consideration is the duration of prophylaxis; while extended coverage may benefit high-risk individuals, the rise of resistant organisms underscores the need for careful antibiotic stewardship to mitigate the selective pressure that prolonged use can exert. This creates a challenging clinical balance, requiring tailored approaches that optimize patient outcomes while minimizing the development of antibiotic resistance.[1,17] Therefore, by knowing the microbiological profile of SWI, clinicians can take a comprehensive therapeutic approach, including prophylactic antibiotic use, early diagnosis, and customized treatment strategies to effectively overcome antibiotic-resistant pathogens.

Based on the 8 articles we identified, we'll develop an empirical antibiotic regimen for SWI following cardiac surgery, along with periprocedural antibiotic prophylaxis recommendations.

First-line therapy:

- Vancomycin (15-20 mg/kg IV q12h, adjusted based on renal function and trough levels)
  - o Target trough levels: 15-20 µg/mL for serious infections
  - o Duration: Until culture results are available, then de-escalate as appropriate

PLUS

- Piperacillin-tazobactam (4.5g IV q6h, adjusted for renal function) OR
- Meropenem (1g IV q8 h) if high local prevalence of ESBL-producing organisms

Targeted Therapy Based on Culture Results :

Gram-positive organisms:

1. Methicillin-resistant Staphylococcus (MRSA, MR-

CoNS):
   - Continue vancomycin OR
   - Switch to daptomycin (6-8 mg/kg IV q24h) OR
   - Linezolid (600mg IV/PO q12h) if vancomycin MIC >1.5 µg/mL
2. Methicillin-sensitive Staphylococcus (MSSA, MS-CoNS):
   - De-escalate to cefazolin (2g IV q8h) OR
   - Nafcillin/oxacillin (2g IV q4h)
3. *Enterococcus faecalis*:
   - Ampicillin (2g IV q4-6h) if susceptible
   - Vancomycin if ampicillin-resistant
4. *Enterococcus faecium*:
   - Continue vancomycin if susceptible
   - Linezolid or daptomycin if vancomycin-resistant

Gram-negative organisms:
1. Enterobacteriaceae (E. coli, Klebsiella, Enterobacter):
   - De-escalate based on susceptibilities to the narrowest effective agent
2. *Pseudomonas aeruginosa*:
   - Cefepime (2g IV q8h) OR
   - Ceftazidime (2g IV q8h) +/- aminoglycoside
3. *Acinetobacter baumannii*:
   - Carbapenem if susceptible
   - For MDR strains: combination therapy with colistin (loading dose 5mg/kg, then 2.5mg/kg q12h) plus another agent based on susceptibilities

Polymicrobial infections:
- Continue broad-spectrum coverage tailored to susceptibilities
- Consider surgical consultation for debridement if not improving

Duration of Therapy:
- Superficial SWI: 7-10 days
- Deep SWI without osteomyelitis: 2-4 weeks
- Deep SWI with osteomyelitis: 6 weeks minimum
- Mediastinitis: 6-8 weeks

Standard Periprocedural Antibiotic Prophylaxis:
- First-line: Cefazolin 2g IV within 60 minutes before incision (3g if patient >120kg)
   - Additional dose if procedure >4 hours
   - Post-procedure doses for 24-48 hours

For β-lactam allergic patients:
- Vancomycin 15 mg/kg IV (start infusion 60-120 minutes before incision) PLUS
- Gentamicin 5 mg/kg IV (single dose)

For high-risk patients (obesity, diabetes, prolonged preoperative stay):
- Consider adding benzylpenicillin to standard prophylaxis as per the Sandström et al. study
- Screen for and decolonize S. aureus nasal carriers (mupirocin nasal ointment + chlorhexidine body wash for 5 days preoperatively)

Considerations for specific patient populations:
- MRSA colonization: Add vancomycin to standard prophylaxis
- High BMI (≥30): Consider higher dosing and longer duration (48h)
- Diabetic patients: Strict glycemic control (target 140-180 mg/dL) plus standard prophylaxis.

## Conclusions

The most common microbes found in cases of sternal wound infection after cardiac surgery were coagulase-negative Staphylococcus (CoNS) followed by *Staphylococcus epidermidis*, which is the normal flora of human skin. In addition, the presence of obesity, diabetes, and critical preoperative status was related to a higher risk of SWI, explaining that there is a complex interaction between patient factors and microbial involvement.

### Study Limitations

One limitation of this study is the small sample size. This study only looked at 8 studies, it possibly missing other relevant research. The lack of standardized microbiological techniques across studies could also affect the consistency of microbial identification. While some information on antibiotic resistance was presented, comprehensive data across all identified pathogens was lacking.

## List of Abbreviations

| | |
|---|---|
| BMI | Body mass index |
| CABG | Coronary artery bypass grafting |
| CoNS | Coagulase-negative staphylococcus |
| COPD | Chronic obstructive pulmonary disease |

| | |
|---|---|
| CRP | C-reactive protein |
| DM | Diabetes mellitus |
| DSWI | Deep sternal wound infection |
| MDR | Multidrug resistant |
| SWI | Sternal wound infection |

## References


1. Kotnis-Gaska A, Mazur P, Olechowska-Jarzab A, Stanisz A, Bulanda M, Undas A. Sternal wound infections following cardiac surgery and their management: A single-centre study from the years 2016-2017. *Kardiochirurgia i Torakochirurgia* Pol. 2018;15(2):79-85. https://doi.org/10.5114/kitp.2018.76472
2. Song Y, Chu W, Sun J, Liu X, Zhu H, Yu H, et al. Review on risk factors, classification, and treatment of sternal wound infection. *J Cardiothorac Surg*. 2023;18(1):1-13. https://doi.org/10.1186/s13019-023-02228-y
3. Cotogni P. Deep sternal wound infection after cardiac surgery: Evidences and controversies. *World J Crit Care Med*. 2015;4(4):265. https://doi.org/10.5492/wjccm.v4.i4.265
4. Schiraldi L, Jabbour G, Centofanti P, Giordano S, Abdelnour E, Gonzalez M, et al. Deep sternal wound infections: Evidence for prevention, treatment, and reconstructive surgery. *Arch Plast Surg*. 2019;46(4):291-302. https://doi.org/10.5999/aps.2018.01151
5. Sandström N, Magnusson A, Wickbom A, Friberg Ö. Addition of benzylpenicillin to antibiotic prophylaxis reduces deep sternal wound infection after cardiac surgery. *Infect Prev Pract*. 2021;3(3). https://doi.org/10.1016/j.infpip.2021.100161
6. Perezgrovas-Olaria R, Audisio K, Cancelli G, Rahouma M, Ibrahim M, Soletti GJ, et al. Deep Sternal Wound Infection and Mortality in Cardiac Surgery: A Meta-analysis. *Ann Thorac Surg*. Jan 2023;115(1):272-80. https://doi.org/10.1016/j.athoracsur.2022.04.054
7. Ali U, Bibo L, Pierre M, Bayfield N, Raichel L, Merry C, et al. Deep Sternal Wound Infections After Cardiac Surgery: A New Australian Tertiary Center Experience. *Hear Lung Circ*. 2020;29(10):1571-8. https://doi.org/10.1016/j.hlc.2020.02.003
8. Bowler PG, Duerden BI, Armstrong DG. Wound microbiology and associated approaches to wound management. *Clin Microbiol Rev*. 2001;14(2):244-69. https://doi.org/ 10.1128/CMR.14.2.244-269.2001
9. Al Majid FM, Buba F, Barry M, Alsharani F, Alfawzan F. Incidence, types and outcomes of sternal wound infections after cardiac surgery in Saudi Arabia: A retrospective medical chart review. *Saudi Med J*. 2020;41(2):177-82. https://doi.org/10.15537/smj.2020.2.24843
10. Al-Ebrahim KE, Alsheikh AS, Ramadan SAL, Alshehri AM, Aljehani BN, Rami AA, et al. Sternal Wound Infection Following Open Heart Surgery: Incidence, Risk Factors, Pathogens, and Mortality. *Heart Surg Forum*. 2023;26(1):E134-40. https://doi.org/10.1532/hsf.5355
11. Pan L, Mo R, Zhou Q, Wang D. Deep sternal wound infection after cardiac surgery in the Chinese population: A single-centre 15-year retrospective study. *J Thorac Dis*. 2017;9(9):3031-7. https://doi.org/10.21037/jtd.2017.08.41
12. Lemaignen A, Birgand G, Ghodhbane W, Alkhoder S, Lolom I, Belorgey S, et al. Sternal wound infection after cardiac surgery: Incidence and risk factors according to clinical presentation. *Clin Microbiol Infect* [Internet]. 2015;21(7):674.e11-674.e18. https://doi.org/10.1016/j.cmi.2015.03.025
13. Locke T, Parsons H, Briffa N, Stott M, de Silva TI, Darton TC. A bundle of infection control measures reduces postoperative sternal wound infection due to Staphylococcus aureus but not Gram-negative bacteria: a retrospective analysis of 6903 patient episodes. *J Hosp Infect [Internet]*. 2022;126:21-8. https://doi.org/10.1016/j.jhin.2022.03.006
14. Arribas-Leal JM, Rivera-Caravaca JM, Hernández-Torres A, Jiménez-Aceituna A, Moral- Escudero E, Pérez-Andreu J, et al. Incidence and predictors of sternal surgical wound infection in cardiac surgery: A prospective study. *Int Wound J*. 2023;20(4):917-24. https://doi.org/10.1111/iwj.13938
15. Dubert M, Pourbaix A, Alkhoder S, Mabileau G, Lescure FX, Ghodhbane W, et al. Sternal wound infection after cardiac surgery: Management and outcome. *PLoS One*. 2015;10(9):1- 11. https://doi.org/10.1371/journal.pone.0139122
16. Gao J, Wang H, Liu X, Song X, Zhong X. Surgical site wound infection, and other postoperative

problems after coronary artery bypass grafting in subjects with chronic obstructive pulmonary disease: A meta-analysis. *Int Wound J*. 2023;20(2):302-12. https://doi.org/10.1111/iwj.13877
17. Ren J, Duan S, Wu Y, Wen M, Zhang J, Liu Y, et al. Multidrug-resistant bacterial infection in adult patients following cardiac surgery: clinical characteristics and risk factors. *BMC Cardiovasc Disord*. 2023;23(1):1-9. https://doi.org/10.1186/s12872-023-03488-1.