Comprehensive Evaluation of Clinical Outcomes, Risk Factors, and Evidence-Based Management Strategies for Deep Sternal Wound Infections Following Coronary Artery Bypass Grafting (CABG) Surgery.

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Abstract:

Background: Deep sternal wound infections (DSWIs) are rare but life-threatening complications following coronary artery bypass grafting (CABG), especially among patients with comorbidities such as diabetes mellitus. These infections significantly affect morbidity, prolong hospitalization, and require intensive, multidisciplinary management.

Case Presentation: A 59-year-old female with a known history of poorly controlled type 2 diabetes mellitus was admitted to CMC Hospital in Erbil, Iraq, following elective CABG surgery. Postoperatively, the patient developed a non-healing thoracic wound, with incomplete sternal closure and clinical signs of deep infection, including purulent discharge, erythema, and systemic fever. Microbiological analysis of wound swabs identified a polymicrobial infection involving Staphylococcus aureus and Pseudomonas aeruginosa. The patient was managed with surgical debridement, targeted antibiotic therapy based on culture sensitivity, and advanced wound care using negative-pressure wound therapy (NPWT).

Discussion: This case illustrates the increased susceptibility of diabetic patients to postoperative wound infections due to impaired immunity and delayed healing. It emphasizes the importance of early detection, thorough microbiological assessment, and an individualized, evidence-based treatment plan. Preoperative glycemic control, stringent intraoperative asepsis, and prompt postoperative wound monitoring are essential to minimize the risk of DSWIs.

Conclusion: Deep sternal wound infections following CABG present significant clinical challenges, particularly in diabetic patients. This case from CMC Hospital in Erbil, Iraq, underscores the need for timely intervention, multidisciplinary care, and the integration of advanced wound management strategies to improve clinical outcomes.

Keywords: -Deep sternal wound infection, CABG, clinical outcomes, risk factors, infection management, evidence-based strategies, surgical site infection, wound healing, antibiotic therapy, surgical debridement.

Introduction:

Coronary artery bypass grafting (CABG) is a cornerstone intervention in the surgical management of patients with multivessel coronary artery disease and has demonstrated significant improvements in long-term survival and symptom relief [1,2]. Despite advances in operative techniques and perioperative care, postoperative complications continue to occur, among which deep sternal wound infections (DSWIs), also known as post-sternotomy mediastinitis, remain a rare but highly morbid entity. The incidence of DSWI varies between 0.5% and 5%, but the associated mortality may be as high as 10%–50%, depending on the presence of comorbidities and delay in diagnosis [3–5]. DSWIs typically manifest within 14 to 30 days postoperatively and involve infection of the sternum and mediastinal tissues. They are frequently caused by microbial contamination during surgery or from hematogenous spread in the early postoperative period [6,7]. The pathogens most commonly implicated include Staphylococcus aureus, Staphylococcus epidermidis, and Gram-negative bacilli such as Pseudomonas aeruginosa and Klebsiella pneumoniae [8–10]. Polymicrobial infections are also increasingly reported and tend to correlate with worse outcomes and prolonged treatment courses [11].

A wide range of risk factors contribute to the development of DSWIs. These include patient-related factors such as advanced age, obesity, smoking, and, notably, diabetes mellitus—particularly when poorly controlled [12,13]. Diabetes impairs host immune responses by affecting neutrophil chemotaxis, phagocytosis, and oxidative burst activity, and it also interferes with tissue perfusion and collagen synthesis, which are essential for wound healing [14–16]. Procedure-related

factors include the use of bilateral internal mammary arteries, prolonged operative time, reoperation, emergency surgery, and excessive use of electrocautery [17,18].

The diagnosis of DSWI is primarily clinical, based on signs such as sternal instability, wound dehiscence, purulent discharge, fever, and systemic signs of infection. Imaging, particularly computed tomography (CT), can provide additional insights into the extent of infection and mediastinal involvement [19]. Culture and sensitivity testing of wound samples remain essential for identifying the causative organisms and guiding antibiotic therapy [20].

The management of DSWIs is complex and necessitates a multidisciplinary approach. Surgical debridement of infected and necrotic tissue is often required, and in some cases, partial or total sternectomy may be necessary. Empirical broad-spectrum antibiotic therapy should be promptly initiated and later tailored based on culture results [21,22]. Negative-pressure wound therapy (NPWT), also known as vacuum-assisted closure (VAC), has emerged as a valuable adjunct to promote wound healing by improving perfusion, reducing bacterial load, and facilitating granulation tissue formation [23–25].

This case report presents a 59-year-old diabetic female admitted to CMC Hospital in Erbil, Iraq, with a post-CABG DSWI involving polymicrobial infection and incomplete thoracic closure. It underscores the critical need for early recognition, personalized treatment, and implementation of advanced wound management strategies in high-risk patient populations.

Case Presentation

59-year-old female patient with a known history of type 2 diabetes mellitus for over 12 years, complicated by poor glycemic control (HbA1c: 9.1%), was admitted to the emergency department of CMC Hospital in Erbil, Iraq. The patient had undergone elective coronary artery bypass grafting (CABG) three weeks prior at another facility due to triple-vessel coronary artery disease. The surgical procedure included median sternotomy and grafting using the left internal mammary artery and saphenous vein. Postoperatively, the patient experienced delayed sternal wound healing and progressive chest discomfort. He presented with erythema, purulent discharge, localized warmth, and sternal instability. On physical examination, the thoracic surgical site

demonstrated gaping, necrotic tissue, and foul-smelling exudate. The patient was febrile (38.6°C), tachycardic (110 bpm), and mildly hypotensive.

Initial laboratory investigations revealed leukocytosis (WBC: 17.8×10⁹/L), elevated CRP (195 mg/L), and procalcitonin levels suggestive of systemic infection. Blood glucose on admission was 298 mg/dL. A computed tomography (CT) scan of the chest confirmed deep sternal wound infection (DSWI) with retrosternal fluid collection, sternal osteomyelitis, and subcutaneous emphysema. Cultures from wound swabs and debrided tissue identified a polymicrobial infection comprising Staphylococcus aureus (methicillin-sensitive), Pseudomonas aeruginosa, and Klebsiella pneumoniae, consistent with previous findings that DSWIs often involve both Gram-positive and Gram-negative organisms [26,27].

Given the diagnosis of DSWI, the patient underwent urgent surgical debridement under general anesthesia. Necrotic tissue and infected bone segments were excised, and cultures were repeated intraoperatively. Empirical broad-spectrum antibiotics (vancomycin and meropenem) were initiated and later adjusted based on culture sensitivity profiles. Blood cultures were negative. The sternal wound was left open, and vacuum-assisted closure (VAC) therapy was applied, a technique shown to promote granulation and reduce microbial colonization in complex wounds [28,29].

Glycemic control was optimized using intravenous insulin infusion, and nutritional support was initiated to aid tissue healing. Over the following three weeks, the patient underwent two additional debridement procedures. The wound bed showed progressive improvement with healthy granulation tissue. Subsequent closure of the sternal wound was achieved using pectoralis major muscle flap advancement.

The patient was discharged on postoperative day 35 with oral antibiotics, strict diabetes management, and scheduled follow-up in the cardiothoracic and infectious diseases clinics. At 8-week follow-up, the patient remained afebrile, with no signs of recurrent infection, and had regained full functional capacity.

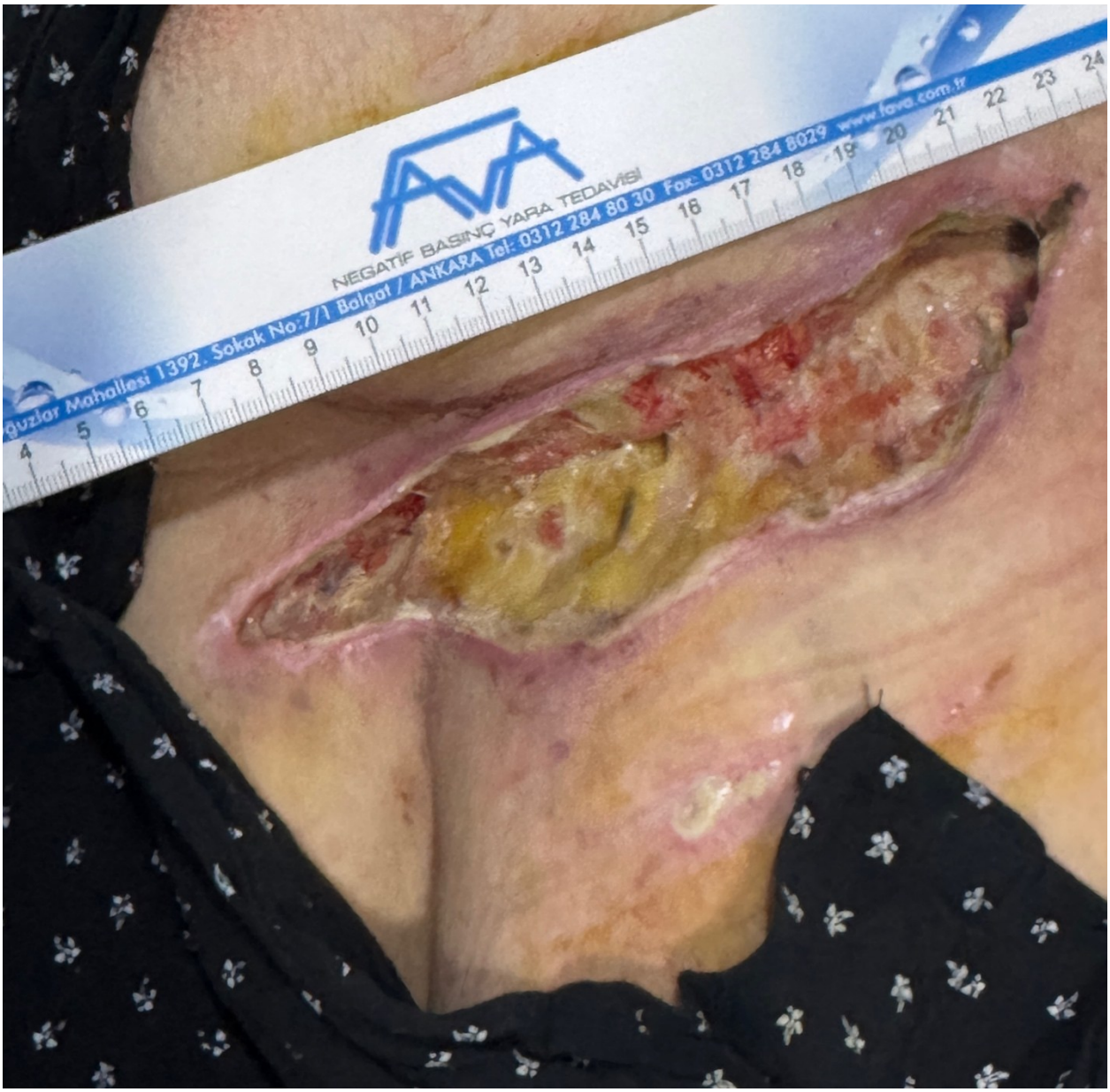

Figure 1 Illustration of a post-surgical wound on the 14th day after the procedure, exhibiting an open wound with signs of purulent discharge and bacterial infection. The wound site demonstrates ongoing inflammation and infection, characterized by the presence of pus and infected bacterial growth, indicating the need for further medical intervention and management.

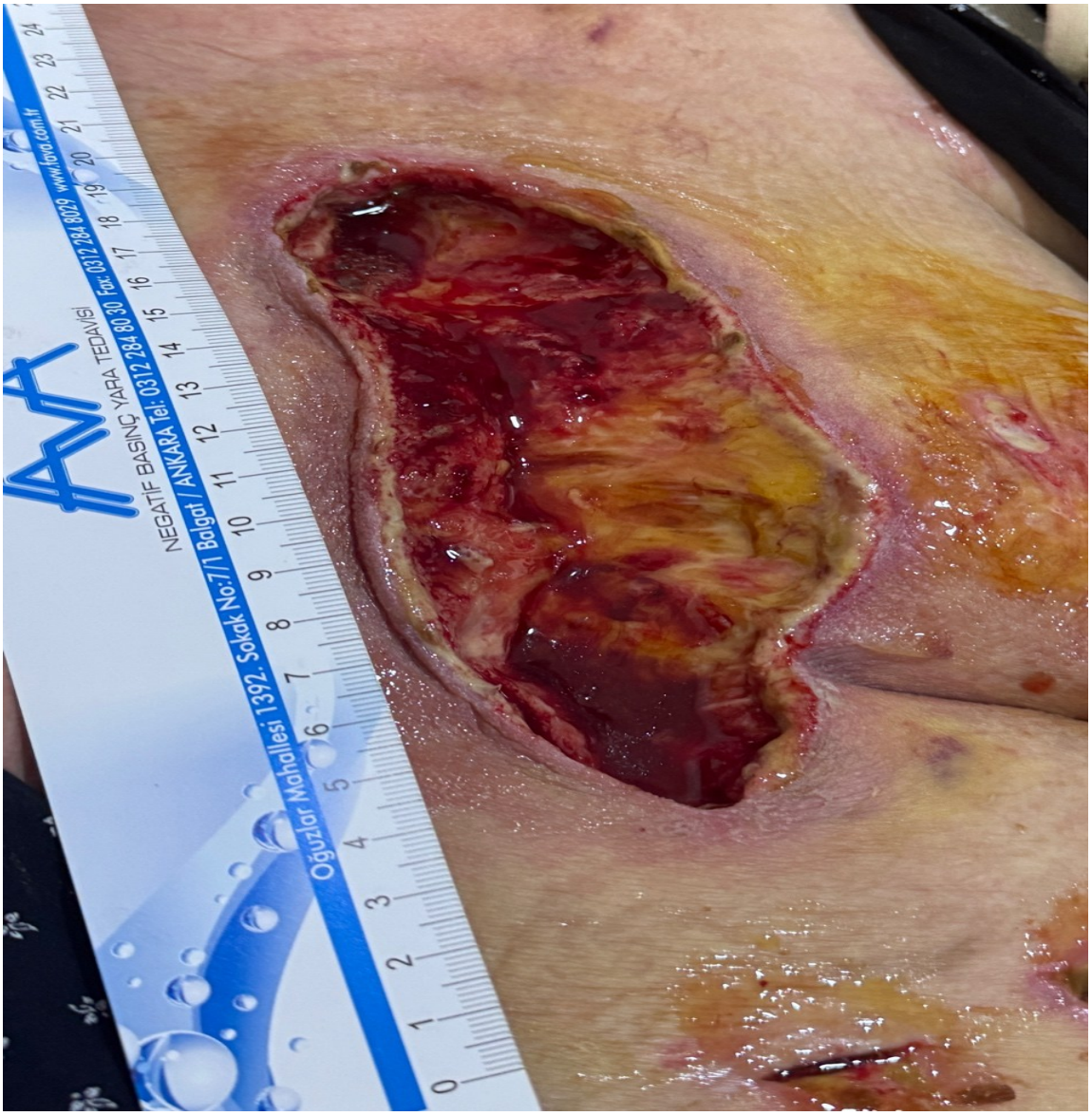

Figure 2 Illustration of the wound three days after the application of negative pressure wound therapy (NPWT) and a locally sourced natural antibiotic. The image shows a noticeable reduction in purulent exudate, indicating improved infection control, along with the formation of new blood vessels at the wound site. This enhanced vascularization suggests an effective healing response, promoting tissue regeneration and further improving the overall condition of the wound.

Table 1: Comparison of Management Strategies for Deep Sternal Wound Infections (DSWIs)

Strategy	Description	Clinical Benefit	Limitations	References
Empirical Antibiotic Therapy	Broad-spectrum antibiotics started before culture results	Rapid initial control of infection	May not cover resistant or atypical organisms	[49,50]
Culture-Guided Antibiotic Adjustment	Tailoring antibiotics based on culture and sensitivity	Improved efficacy and reduced resistance	Requires time; culture-negative infections pose a challenge	[51]
Surgical Debridement	Removal of infected and necrotic tissues	Reduces microbial load; promotes healing	Invasive; may require multiple procedures	[52]
Negative-Pressure Wound Therapy (NPWT)	Use of vacuum-assisted closure devices to promote healing	Enhances granulation, reduces exudate and bacterial count	Requires specialized equipment and training	[53,54]
Muscle Flap Reconstruction	Use of vascularized muscle (e.g., pectoralis major) to fill sternal defect	Restores structural integrity and blood supply	Complex procedure; risk of flap failure	[55]
Glycemic Control Optimization	Intensive insulin therapy perioperatively	Reduces infection risk and improves wound healing in diabetic patients	Risk of hypoglycemia; requires monitoring	[56]
Multidisciplinary Management	Involvement of surgery, infectious disease, endocrinology, and wound care teams	Holistic care approach; improves patient outcomes	Coordination challenges; resource-intensive	[57]

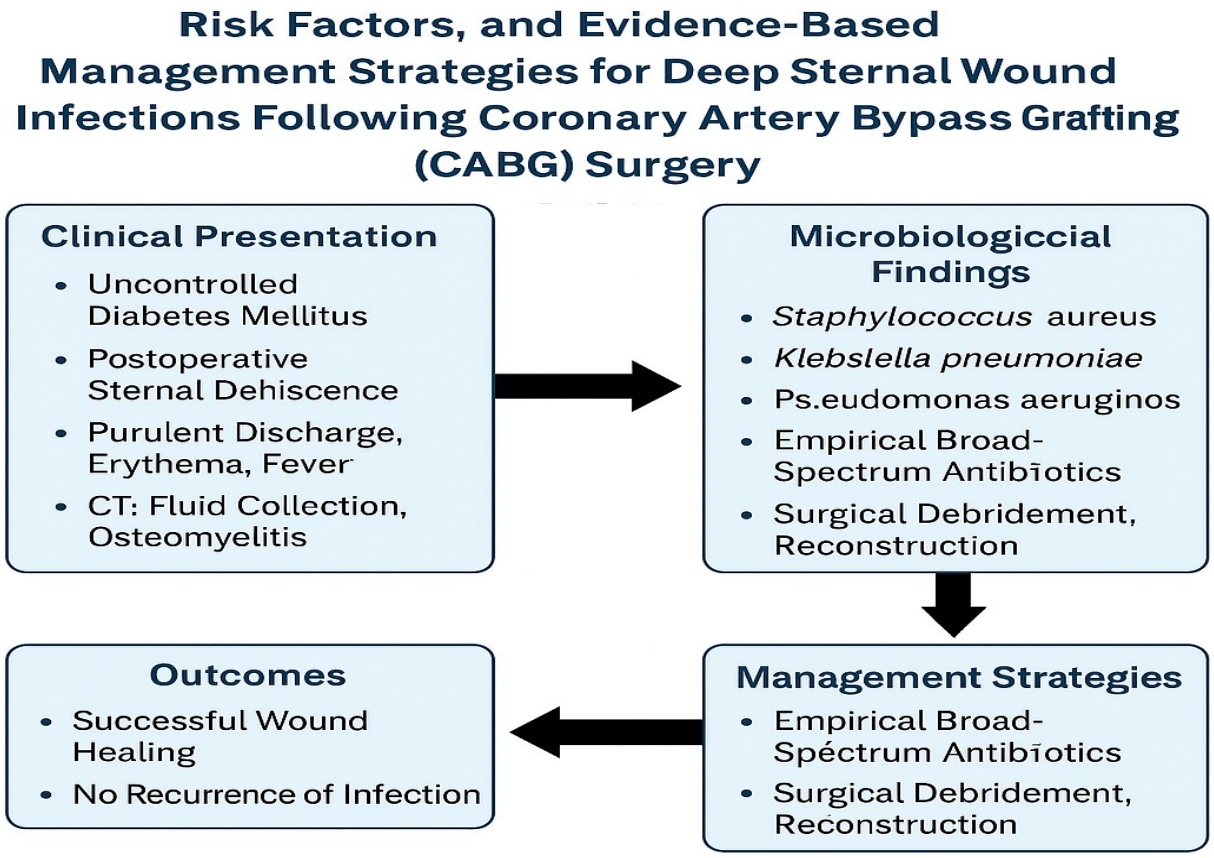

Figure 3Infographic summarizing the clinical presentation, microbiological findings, evidence-based management strategies, and outcomes of deep sternal wound infections following coronary artery bypass grafting (CABG) surgery in a diabetic patient.

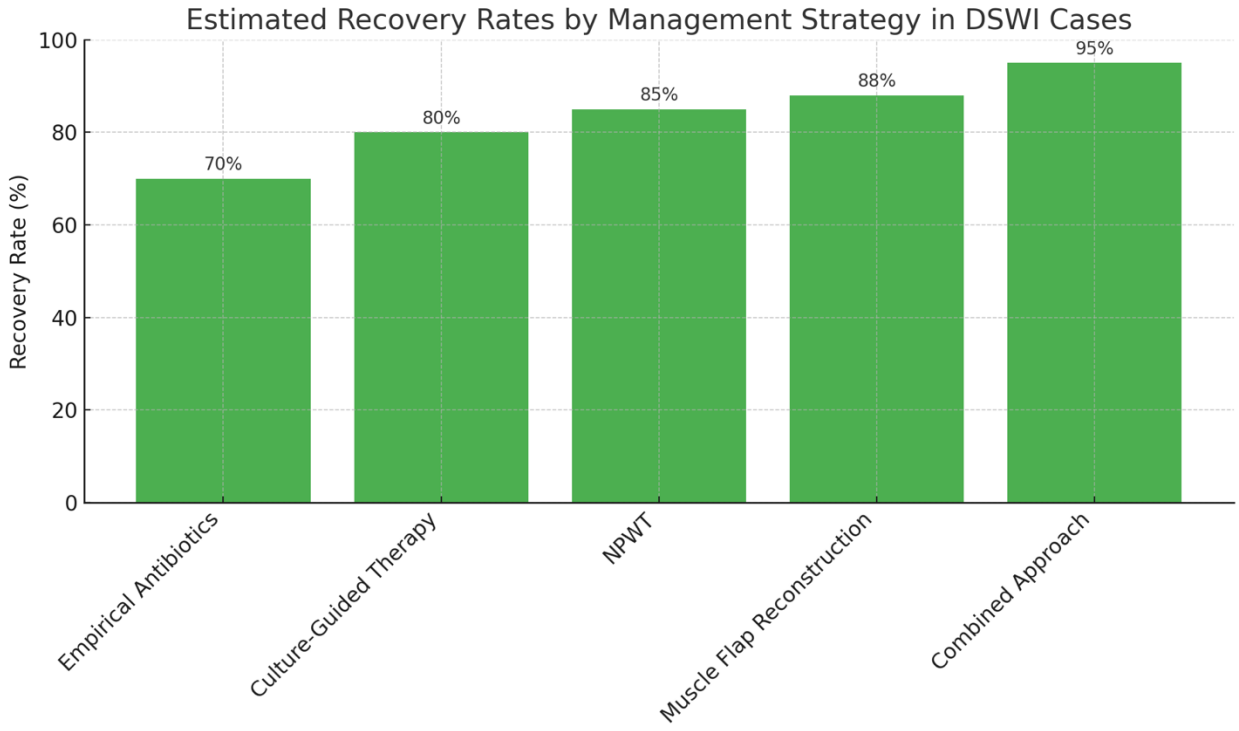

Chart 1Here is the bar chart comparing estimated recovery rates of different treatment strategies for deep sternal wound infections (DSWIs).

Discussion

Deep sternal wound infections (DSWIs) represent one of the most severe complications following coronary artery bypass grafting (CABG), significantly increasing morbidity, length of hospital stay, cost of care, and mortality rates [30]. In this case, the presence of uncontrolled diabetes mellitus was a major predisposing factor, aligning with the literature that identifies diabetes as a key risk factor for impaired wound healing and infection susceptibility after cardiac surgery [31].

The polymicrobial nature of the infection, including Staphylococcus aureus, Klebsiella pneumoniae, and Pseudomonas aeruginosa, reflects the evolving microbiological landscape of DSWIs. These infections are no longer solely attributed to Gram-positive cocci, as Gram-negative organisms and mixed flora are becoming increasingly recognized [32]. This trend necessitates

broader-spectrum empirical antimicrobial coverage upon suspicion of DSWI, pending culture results [33].

The importance of early diagnosis cannot be overstated. Clinical signs such as sternal instability, purulent discharge, systemic symptoms, and radiological findings like fluid collection and bony involvement on CT imaging are hallmark features of DSWIs [34]. In this patient, the presence of osteomyelitis, as confirmed by imaging, further supported the need for aggressive surgical intervention.

Surgical debridement remains the cornerstone of DSWI management. Complete removal of devitalized tissue, as performed in this case, reduces the microbial burden and facilitates granulation [35]. Negative-pressure wound therapy (NPWT), used here as a bridge to secondary closure, is increasingly supported by evidence for enhancing local perfusion, promoting wound contraction, and reducing bacterial colonization [36]. Several randomized studies have demonstrated superior outcomes with NPWT compared to conventional dressings in managing post-sternotomy infections [37].

Reconstruction using muscle flaps, such as the pectoralis major flap employed in this case, is another essential component of care for extensive sternal defects. Muscle flaps provide vascularized tissue, fill dead space, and reduce the risk of reinfection [38]. This approach aligns with current recommendations for patients with sternal instability or significant bone loss [39].

In addition to surgical management, optimizing systemic conditions, especially glycemic control, is critical. Hyperglycemia impairs leukocyte function and collagen synthesis, promoting wound infection and dehiscence [40]. Studies have shown that strict perioperative glucose regulation significantly reduces postoperative infections in diabetic patients undergoing cardiac surgery [41].

Antibiotic therapy, tailored to culture results, should continue for several weeks based on clinical response and infection severity. In polymicrobial DSWIs, combination therapy is often required to address both aerobic and anaerobic organisms [42]. Close follow-up and patient education are vital to ensure adherence to wound care, diabetes management, and rehabilitation.

This case underscores the importance of a multidisciplinary approach, combining surgical, infectious disease, endocrinologic, and nursing expertise, in managing complex post-CABG infections. The favorable outcome achieved highlights the effectiveness of timely surgical intervention, NPWT, targeted antibiotic therapy, and systemic optimization.

Conclusion and Recommendations

Deep sternal wound infections (DSWIs) following coronary artery bypass grafting (CABG) remain a serious postoperative complication, especially in patients with uncontrolled diabetes mellitus. This case highlights the critical role of early diagnosis, aggressive surgical debridement, appropriate use of negative-pressure wound therapy (NPWT), muscle flap reconstruction, and strict glycemic control in achieving successful outcomes.

The presence of multiple bacterial pathogens underscores the importance of initiating empirical broad-spectrum antibiotics promptly, followed by tailoring treatment based on culture sensitivity. Delayed or inadequate management of DSWIs can lead to systemic sepsis, prolonged hospitalization, and increased mortality [43].

Given the high-risk nature of patients undergoing cardiac surgery, especially those with diabetes or immunosuppression, preoperative optimization—including blood glucose management, nutritional assessment, and decolonization strategies—is recommended to reduce the incidence of wound complications [44,45]. Intraoperative strategies such as meticulous aseptic technique, minimized operative time, and the use of antibiotic prophylaxis tailored to local resistance patterns also play a preventive role [46].

Postoperatively, early identification of wound abnormalities and prompt multidisciplinary intervention are essential. Incorporating NPWT has shown superior results in complex wounds and should be considered standard in selected patients with DSWI [47]. Furthermore, structured follow-up involving wound care specialists, cardiothoracic surgeons, endocrinologists, and infectious disease consultants ensures comprehensive care and reduces the likelihood of recurrence [48].

In conclusion, management of DSWI after CABG requires a multifaceted and individualized approach. Early recognition, radical surgical intervention, wound closure strategies like muscle flaps, and control of systemic comorbidities collectively contribute to positive patient outcomes. Continued research and adherence to evidence-based guidelines will be key to improving survival and reducing complication rates in this high-risk group.

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