

REVIEWS

An overview of the latest management of cardiac device infections

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ABSTRACT

Over the past decades, implantation of cardiac devices has increased dramatically not only in the United States (US) but worldwide. Despite the known benefits of cardiac devices and the greater ease in implantation, the incidence of cardiac device infection (CDI) is increasing. Cardiac device include permanent pacemaker (PPM), implantable cardioverter defibrillator (ICD), and cardiac resynchronization therapy (CRT) with or without ICD. This paper is to present an overview of the latest management of CDI including epidemiology, types of CDI, causative agents and risk factors. Diagnosis and treatment options for CDI will be reviewed. In addition, the role of nurses in the prevention of CDI will be discussed.

Key Words: Cardiac device implantation, Cardiac device infection, Prevention

1. OBJECTIVE

The objective of this paper is to present an overview of the latest management of cardiac device infection (CDI) including epidemiology, types of CDI, causative agents and risk factors. Diagnosis and treatment options for CDI will be reviewed. In addition, the role of nurses in the prevention of CDI will be discussed. For the purpose of this paper cardiac devices will include permanent pacemaker (PPM), implantable cardioverter defibrillator (ICD), and cardiac resynchronization therapy (CRT) with or without ICD.

2. EPIDEMIOLOGY

Over the past decades, implantation of cardiac devices has increased dramatically not only in the United States (US) but worldwide.^[1,2] In 2010, an estimated 650,000 people in the US had cardiac device implanted.^[3] This practice has been shown to improve patient outcomes including quality

of life and survival among certain group.^[4] However, despite the know benefits of cardiac devices and the greater ease in implantation, the incidence of CDI is increasing. Baddour *et al.*^[1] earlier reported that there was a 210% increase in CDI from 1993 to 2008. Recent data show that the incidence of cardiac device-related infection ranged from 0.5%-4.8%.^[5] There has been a steady rise of CDI at a rate of 2.5% per year in 2008 compared to 1.5% per year in 2004.^[1,6] More importantly, about 3% of high risk patients who have cardiac device implanted will develop CDI.^[6,7] CDI is associated with morbidity, mortality and increased cost.^[6] Additionally, it is estimated that the average cost to care for someone with CDI infection is \$54,926.^[8]

2.1 Causative agents

Microorganisms causing CDI may be acquired endogenously from the skin of the patient or exogenously from hospital en-

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vironment including hospital staffs.^[1] *Staphylococcus aureus* and *Staphylococcus epidermidis* are the two most common pathogens for pocket infection and device-related endocarditis.^[9] Gram negative bacilli, *Candida*, and *Corynebacterium* species are some of the least common pathogens identified in CDI.^[1]

2.2 Risk factors

Individuals considered at high risk for developing CDI include those with history of diabetes, renal insufficiency, congestive heart failure; previous history of infection or those who are having an upgrade or revision procedures of their cardiac device.^[6,7] Additional risk factors include individuals with immunocompromised state, such as those receiving long term corticosteroid therapy, and those on oral anticoagulation. Factors such as low operator experience and the increased amount of hardware implanted may increase a patient's risk to developing CDI.^[1]

3. CATEGORIES OF CDI

There are two categories of CDI: (1) pocket infection or deeper infection, and (2) primary or secondary infection. *Pocket infection* refers to infection involving the subcutaneous pocket, the area under the skin where the cardiac device is implanted, and a subcutaneous segment where the device leads are positioned.^[1] Perioperative contamination of the device with skin flora is the most common source of this subcutaneous infection.^[10] At the same time, skin erosions could also be a portal for contamination.^[10] Deeper infection involves the transvenous portion of the lead, which is associated with bacteremia and/or endovascular infection.^[10] In primary infection, the device is the main source of infection, mainly due to contamination at the time of implant; whereas in secondary infection the cause of bacteremia is from different source such as from a urinary tract infection, pneumonia or hospital-acquired infection.^[10,11]

4. DIAGNOSIS

4.1 Signs and symptoms

CDI presentation may vary from local inflammatory changes to signs of systemic toxicity. Patients may complain of pain and/or discomfort at the site of implantation. At the same time, vague symptoms such as malaise, fatigue, anorexia and fever of unknown origin may also be noted.

4.2 Recommendations for diagnosis

Identifying the causative organism, by sending for blood culture and sensitivity, is of utmost importance in the diagnosis of CDI. Patient should have at least two sets of blood cultures drawn prior to start of antibiotic therapy.^[1] The lead tip of the cardiac device and pocket swab should also be sent for gram

stain and culture when explanted. It is recommended that transesophageal echocardiogram should be performed to rule out valvular endocarditis.^[1] Patient experiencing fever of unknown origin should be referred to cardiologist or infectious disease for further evaluation.

5. MANAGEMENT

Management of CDI involves several approaches that include: (1) removal of the cardiac device, (2) use of antimicrobial therapy, (3) re-implantation of new device after successful treatment of CDI, and (4) preventative measures. Decision to choose which type of care should be individualized and may include more than one approach.

5.1 Removal of cardiac device

Complete removal of the device without delay, regardless of when antimicrobial therapy is initiated, is highly recommended due to the high incidence of infection relapse with retained hardware.^[1] Additional recommendations to completely remove cardiac device include patients with definitive CDI with evidence of endocarditis or sepsis, presence of pocket infection, and presence occult staphylococcus bacteremia. Pocket infection includes abscess formation, device erosion, skin adherence, or chronic draining coronary sinus (it evolves from decompression of an acute infection and erosion of chronic pocket through the skin) without involvement of the lead(s) or device.^[1] Cardiac device that is removed is subsequently discarded and never reused.

5.2 Antimicrobial therapy

The use of antimicrobial therapy is an adjunct to removal of cardiac device. Treatment options are based on whether the blood culture result is positive or negative. The choice of antimicrobial is based on identification and in vivo susceptibility results of the infecting pathogen.^[1] However, Vancomycin should be given empirically until microbiology results become available. This drug is continued in patients who are not candidates to β -lactam, as well as patients whose infection is due to oxacillin-resistant staphylococci.^[1] For patients with oxacillin-susceptible infection, cefazolin or nafcillin could be used.^[1] The duration of treatment after removal of cardiac device varies from 7-10 days for cardiac device erosion without inflammatory changes; 10-14 days for pocket site infection; and at least 14 days for bloodstream infection.^[1] For patients with complicated infections (such as endocarditis, osteomyelitis or septic thrombophlebitis) or persistent bloodstream infection despite removal of cardiac device, antimicrobial therapy should be continued for at least 4-6 weeks.^[1]

Long-term suppressive antimicrobial therapy should be con-

sidered in select patients who have CDI and are not candidates for removal of their cardiac device.^[1] This include patients who refused removal of their cardiac device or their life expectancy is limited.^[1] However, patients must have stable cardiovascular status, clinical improvement with initial treatment and clearance of bloodstream infection before long-term antimicrobial therapy is considered.

5.3 New cardiac device implantation

Re-implantation of a new cardiac device must be based on a careful patient evaluation of the need for the device. If re-implantation is necessary, the alternative location to use should be contralateral not ipsilateral to the extraction site.^[1] In case of patients with positive blood cultures prior to removal of their old device, a repeat blood culture must be performed after removal of the device and must be negative for 72 hours before re-implanting a new device. In addition, a new transvenous lead placement should be delayed for 14 days after removal of cardiac device when valvular infection remains evident.^[1]

6. PREVENTION

Prevention is key towards controlling the incidence of CDI.^[1] Pre-operatively, patient must be free of infection prior to implantation of a cardiac device. Parenteral antibiotic using first generation cephalosporin, such as cefazolin, should be administered one-hour before incision.^[1] Alternately, Vancomycin may be used in patients who are allergic to cephalosporin, and in some centers with high incidence of oxacillin resistance among staphylococci; antibiotic must also be administered two hours before incision.^[1] During implantation, meticulous aseptic technique must be observed at all times by all hospital staffs. During the immediate post-operative period, the use of low molecular weight heparin should be avoid to prevent hematoma. In the US, prophylactic antibiotic regimen is recommended to patient post-cardiac device implantation.^[1] At discharge, ambulatory follow-up care includes surveillance - by instructing patients to call or see their cardiologist at the earliest sign of developing infection such as fever or local inflammation. To date, there is no recommendation in the use of antibiotic prophylaxis for dental or other invasive procedures not directly related to cardiac device manipulation to prevent CDI.^[1]

7. ROLE OF NURSES

Nurses play an integral role in the care of patients before, during and after cardiac device implantation. One of the most important roles for nurses is to recognize the early signs and symptoms of CDI. Nurses must gain knowledge and skills in identifying the early manifestations, including those who are at high risk for developing CDI in order to initiate immediate treatment measures.

During implantation, it is the responsibility of the nurses to ensure strict implementation of sterile procedures, based on institutional policies and current evidence. Sterile practices by the medical and nursing staffs must be enhanced during the perioperative period. At the same time, nursing personnel must ensure quality control of the environment and all of the equipment that may be used in the procedure. Since patients will be expected to receive prophylactic antibiotics to protect them from organisms, it is vital for nurses to make sure that the patient receives the proper dosage of the antibiotic and in a timely manner. Nurses may participate in active surveillance designed to identify unique risk factors their patients may have.^[12]

Nurses also continue to reinforce universal precaution guidelines including vigorous handwashing and wearing sterile gloves when caring for the patient's wound post-implantation. It is imperative for nurses to provide detailed health education or instructions to the patients and family members prior to discharge. Health education includes monitoring of early signs and symptoms of infection. Nurses also has the obligation to reflect and improve their practice. Nurses reflecting on their practice may be able to detect areas of improvement and suggest strategies that could limit infection rate. Active surveillance continues post-operatively, in which nurses follow up on the patients for any incidence of infection.^[12]

8. CONCLUSIONS

With the increasing life expectancy and improvement in patient outcomes from heart disease, the number of people who will have cardiac device implantation will continue to rise. Nurses are expected to care for patients with cardiac devices in all stages of cardiac device implantation. More importantly, nurses have an increasing expectation to continuously improve their skills, making it imperative to be kept abreast with the current management of these patients.

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