

# Cardiovascular implantable electronic device infection: A complication of medical progress

**As more CIEDs are placed in older and sicker patients, more infections can be expected**

**T**HE TERM *cardiovascular implantable electronic device* (CIED) includes both permanent pacemakers and implantable cardioverter-defibrillators. These devices are being implanted in more people every year.<sup>1</sup> They have also become increasingly sophisticated, with newer devices capable of both pacing and cardioversion-defibrillation functions.<sup>2</sup> Patients receiving these devices are also increasingly older and have more comorbid conditions.<sup>3,4</sup> As more CIEDs are placed in older and sicker patients, infections of these devices can be expected to be encountered with increasing frequency.

*See related article, page 529*

In this issue of the *Cleveland Clinic Journal of Medicine* (page 529), Dababneh and Sohail<sup>5</sup> review CIED infections and provide a stepwise approach to their diagnosis and treatment.

## ■ HOW THE DEVICES BECOME INFECTED

CIEDs can become infected during implantation, in which case the infection presents early on, usually with pocket manifestations, or by secondary hematogenous seeding, in which case the infection generally presents with

endovascular manifestations. Dababneh and Sohail have elegantly outlined the risk factors that predispose to infection of these devices.

If there are no early complications, patients generally do well with these devices. However, many patients do fine with their first device but develop a pocket infection when the pulse generator is changed because of battery depletion or other reasons. When patients with a CIED develop bacteremia as a complication of a vascular catheter infection or other infection, particularly with *Staphylococcus aureus*, they are at increased risk of having the intravascular portion of their device seeded.

## ■ PATIENTS MAY NOT APPEAR VERY ILL AT PRESENTATION

Dababneh and Sohail divide the clinical presentations of CIED infection into two broad categories: pocket infection and endovascular infection with an intact pocket. This is a useful categorization, as it provides a clue to pathogenesis.

As the authors point out, most patients with CIED infection present first to their primary care physician when they develop symptoms. An understanding of this infection by primary care physicians will allow for early recognition and more timely treatment, thus avoiding unnecessary complications.

Patients with pocket infection may not appear ill, but this should not lead a clinician

\*The author has disclosed that he has received a research grant from Cubist, is a member of an advisory committee or review panel for Astellas, and has been a teacher or speaker for Forest.

doi:10.3949/ccjm.78a.11051

away from the diagnosis. A pocket hematoma is an important differential diagnosis in the early postoperative period after device implantation or pulse generator change, and it may be difficult to decide if pocket changes are from an uninfected hematoma or from an infection.

Patients with endovascular infection are more likely to have systemic symptoms such as fever, fatigue, and malaise. However, absence of systemic features does not necessarily exclude endovascular infection.

### ■ BLOOD CULTURES AND TEE ARE KEY DIAGNOSTIC TESTS

All patients with suspected CIED infection should have at least two sets of blood cultures checked, even if they appear to be reasonably well. If there is any suspicion of endovascular infection, echocardiography should be performed.

Transesophageal echocardiography (TEE) is far superior to transthoracic echocardiography (TTE) for detecting lead vegetations.<sup>6</sup> TEE should be carefully performed whenever endovascular infection is suspected, including all patients with positive blood cultures and all patients with systemic signs and symptoms.

Purulent drainage should be cultured, and when the device is removed, cultures of lead tips and pocket tissue should be done as well.

### ■ TREATMENT USUALLY REQUIRES COMPLETE DEVICE REMOVAL

A superficial infection in the early postoperative period may respond to antibiotic therapy alone. But in all other patients, the device must be removed to cure the infection. In referral centers, it is not unusual to see patients who have been referred after having been treated with antibiotics for weeks and sometimes months in the mistaken belief that the infection would be cured with antibiotics alone.

In some patients presenting with only pocket findings in the early postoperative period, it may be difficult indeed to tell if there is pocket infection. In such patients, it is not necessary to make a hasty decision to remove the device, but it is important to monitor them closely until the presence or absence of infection becomes clear. Also, erosion of the device through the skin represents pocket in-

fection even if the patient appears otherwise healthy.

When removing the device, it is necessary to remove the generator and all leads to treat the infection effectively.

If patients are device-dependent, it is usually safe to place a new device with the new pulse generator pocket in a different location from the infected one a few days after the infected device is removed.

### ■ AREAS OF UNCERTAINTY AND CHALLENGE

Although there is no controversy about the need for complete removal of infected devices in order to effect a cure, the appropriate duration of antibiotic therapy after device removal is less clear. Dababneh and Sohail provide a useful algorithm to help with this decision. Patients usually need a new device to replace the infected one and there is a legitimate reason for concern about undertreating, since one would not want the new device to become infected because of inadequate antibiotic therapy. When endovascular infection is suspected or documented, patients are probably best treated as they would be for infective endocarditis.

Difficulties arise when patients with a CIED develop bacteremia with no echocardiographic evidence of device infection. Finding the source of bacteremia is very important because a diagnosis of CIED infection indicates that the device has to be removed. When there is a clear alternative explanation for the bacteremia, the CIED does not have to be removed. The type of bacterium helps clinicians to gauge the likelihood of CIED infection and to decide on the appropriate course of action. These cases should always be managed in conjunction with an infectious disease specialist and a cardiac electrophysiologist.

Another concern is secondary seeding of an uninfected CIED caused by bacteremia from another source. This concern is particularly acute with *S aureus* bacteremia. When patients with a CIED and *S aureus* bacteremia have been studied, endovascular CIED infection was documented in about half, although only a few had evidence of pocket inflammation.<sup>7,8</sup> This suggests that the devices were seeded via the endovascular route.

**Absence of systemic features does not necessarily exclude endovascular infection**

Medical procedures such as dialysis and total parenteral nutrition require frequent intravascular access—often facilitated by leaving an indwelling vascular catheter in place. Frequent entry into the intravascular compartment puts patients at substantial risk of bloodstream infection, and in patients with a CIED this can be complicated by device infection. In patients with a CIED and an indwelling vascular catheter who develop bacteremia, determining the source of the bacteremia is particularly challenging, as is the treatment. Thus, preventing endovascular infection in such patients is extremely desirable, but there are no easy solutions.

**REFERENCES**


1. **Zhan C, Baine WB, Sedrakyan A, Steiner C.** Cardiac device implantation in the United States from 1997 through 2004: a population-based analysis. *J Gen Intern Med* 2008; 23(suppl 1):13–19.
2. **Hayes DL, Furman S.** Cardiac pacing: how it started, where we are, where we are going. *J Cardiovasc Electro-physiol* 2004; 15:619–627.
3. **Lin G, Meverden RA, Hodge DO, Uslan DZ, Hayes DL, Brady PA.** Age and gender trends in implantable cardioverter defibrillator utilization: a population based study. *J Interv Card Electrophysiol* 2008; 22:65–70.
4. **Uslan DZ, Tleyjeh IM, Baddour LM, et al.** Temporal trends in permanent pacemaker implantation: a population-based study. *Am Heart J* 2008; 155:896–903.
5. **Dababneh SR, Sohail MR.** Cardiovascular implantable electronic device infection: a stepwise approach to

**PLACING CIED INFECTIONS IN PERSPECTIVE**

The vast majority of patients with a CIED never develop a device infection. Those unfortunate enough to have a CIED infection have little choice other than to have the device removed, but those diagnosed early and treated appropriately generally do well. The development of CIEDs has been an important advance in the practice of cardiac electrophysiology. An appropriate understanding of CIED infection and its treatment will help optimize the diagnosis and management of this complication when it does occur.

- diagnosis and management. *Cleve Clin J Med* 2011; 78:529–537.
6. **Victor F, De Place C, Camus C, et al.** Pacemaker lead infection: echocardiographic features, management, and outcome. *Heart* 1999; 81:82–97.
  7. **Chamis AL, Peterson GE, Cabell CH, et al.** *Staphylococcus aureus* bacteremia in patients with permanent pacemakers or implantable cardioverter-defibrillators. *Circulation* 2001; 104:1029–1033.
  8. **Uslan DZ, Sohail MR, St Sauver JL, et al.** Permanent pacemaker and implantable cardioverter defibrillator infection: a population-based study. *Arch Intern Med* 2007; 167:669–675.

**ADDRESS:** Nabin K. Shrestha, MD, MPH, Department of Infectious Disease, G21, Cleveland Clinic, 9500 Euclid Avenue, Cleveland, OH 44195; e-mail shrestn@ccf.org.



**LET US HEAR FROM YOU**

- Let us hear your opinions about the *Cleveland Clinic Journal of Medicine*.
- Do you like current articles and sections?
- What topics would you like to see covered and how can we make the *Journal* more useful to you?

**PHONE** 216.444.2661  
**FAX** 216.444.9385  
**E-MAIL** ccjm@ccf.org  
**WWW** http://www.ccjm.org

CLEVELAND CLINIC JOURNAL OF MEDICINE  
 Cleveland Clinic  
 1950 Richmond Rd., TR404  
 Lyndhurst, Ohio 44124

