Cardiovascular Implantable Electronic Device Associated Infections

Tejal Gandhi, MD[a,*], Thomas Crawford, MD[b], James Riddell IV, MD[a]

KEYWORDS

- Cardiovascular implantable electronic devices • Infection
- Management

There is a high incidence of cardiovascular disease among the United States' population and, subsequently, an increasing number of patients undergoing placement of cardiovascular implantable electronic devices (CIEDs) to improve quality of life and survival. The incidence of cardiovascular disease is highest among older adults and, consequently, recent population-based studies suggest that the mean age at CIED placement exceeds 70 years.[1,2] Based on large clinical trials, the American College of Cardiology and the American Heart Association (AHA) have issued guidelines with expanded indications for use of implantable cardioverter-defibrillators (ICDs) for primary prevention of sudden cardiac death and biventricular pacemakers (PPMs) for symptomatic improvement in patients with heart failure.[3,4] As a result, use of CIED has increased in the United States and worldwide.[5–7]

The management of CIED infections is clinically challenging and it results in substantial morbidity and mortality for patients.[8] This article presents an overview of cardiac device infections, including current epidemiology and specific host and procedural risk factors for the development of CIED infections. The microbiology will also be reviewed with a focus on both common and unusual pathogens. Finally, recent advances in the diagnosis and the multifaceted approach essential to successful management of CIED infection are considered.

The authors have nothing to disclose.

[a] Division of Infectious Diseases, University of Michigan Medical School, 3119 Taubman Center, 1500 East Medical Center Drive, SPC 5378, Ann Arbor, MI 48109, USA
[b] Division of Cardiovascular Medicine, Cardiovascular Center, University of Michigan Medical School, 1500 East Medical Center Drive, SPC 5856, Ann Arbor, MI 48109, USA
* Corresponding author.
E-mail address: tgandhi@med.umich.edu

Infect Dis Clin N Am 26 (2012) 57–76
doi:10.1016/j.idc.2011.09.001 **id.theclinics.com**
0891-5520/12/$ – see front matter

EPIDEMIOLOGY AND RISK FACTORS

When ICDs were first used in the 1980s, these devices were generally implanted by cardiac surgeons with the assistance of cardiologists.[9] At that time, procedures were quite complex because the large generators required implantation within the abdomen and tunneled leads were placed epicardially via thoracotomy. Infection rates using this approach were reported as high as 17%.[10] Over time, the generator size has decreased substantially, facilitating implantation in the pectoral region and insertion of transvenous leads through the subclavian vein in a single procedure. One study reported long-term infection rates associated with subcutaneous pectoral implantation at 0.5%, compared with an infection rate of 3.5% for abdominal implantations.[11] Another center reported a similarly low infection rate of 0.2% with pectoral implantation.[12] A more recent study, which used data from the National Hospital Discharge Survey (NHDS), estimated that 4.1% to 5.8% of CIED devices became infected between 2004 and 2006.[8]

Multiple studies confirm increasing implantation rates but, surprisingly, rates of CIED infection have increased disproportionately (**Fig. 1**).[8,13] To illustrate, a study of Medicare beneficiaries found a 42% increase in cardiac device implantation from 1990 to 1999, but the infection rate increased from 0.94 device infections per 1000 beneficiaries to 2.11 per 1000, reflecting a 124% increase during the same 10-year period.[13] Similarly, a study that reviewed NHDS data reported a 57% increase in infections but only a 12% increase in devices implanted between 2004 and 2006 (see **Fig. 1**).[8] Overall, CIED infections rates range between 0.2% and 5.8% with pectoral implantation, but these rates have exceeded predictions. Although the exact reasons for this increase remain unknown, more device use among older patients and others with comorbid conditions may provide a partial explanation.[6,14]

Multiple studies have evaluated potential host and procedural risk factors for CIED infection.[2,8,15–18] A study examining 4856 patients who had either a PPM or a ICD device implanted found comorbid conditions such as heart failure, diabetes, renal insufficiency, and anticoagulation to be significant risk factors for the development of CIED infection.[15] Renal insufficiency (creatinine clearance $\leq$60 mL per minute) was highlighted as a particularly strong risk factor with a prevalence of 42% in patients with CIED infection compared with 13% of control patients (odds ratio [OR] 4.8; CI 2.1–10.7). Others have associated chronic renal insufficiency with increased risk of CIED infection[8] and as a risk factor for increased mortality among patients with

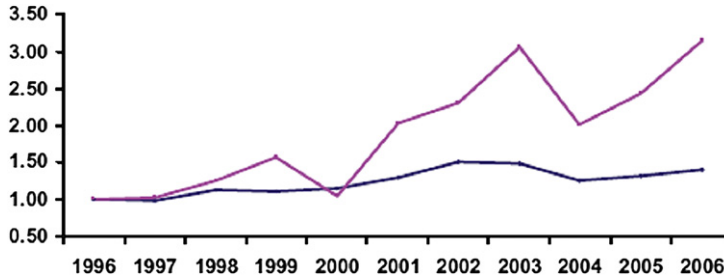

Fig. 1. Number of device-related infections related to the number of new implanted devices over time in the United States. (*purple line*) Number of infected implanted cardiac devices by year of hospitalization normalized to the year 1996. (*blue line*) Proportional increase in the number of devices implanted normalized to the year 1996. (*From* Voigt A, Shalaby A, Saba S. Rising rates of cardiac rhythm management device infections in the United States: 1996 through 2003. J Am Coll Cardiol 2006;48(3):590–1; with permission.)