Clinical Infectious Diseases

BRIEF REPORT

Current Management of Cardiac Implantable Electronic Device Infections by Infectious Disease Specialists

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Management guidelines for cardiac implantable electronic device infections exist, but practice patterns of infectious disease (ID) specialists are not well known. We found that while many ID specialist practices mirror existing guidelines, a combination of complete device removal and prolonged antimicrobial therapy is favored when *Staphylococcus aureus* is involved.

Keywords. device-related infection; cardiac implantable electronic device; infectious disease specialists.

Cardiac implantable electronic devices (CIEDs) including percutaneous pacemakers, implantable cardioverter-defibrillators, and cardiac resynchronization therapy devices have revolutionized the management of arrhythmias and congestive heart failure. However, infections can complicate the use of these devices, with rates ranging from <1% to 4% [1–4]. Guidelines for treatment of CIED infections exist [5], but little is known about current practice patterns for these challenging infections.

METHODS

The Infectious Diseases Society of America's Emerging Infections Network (EIN) is a provider-based network of practicing infectious disease (ID) specialists in the United States and Canada, funded by the Centers for Disease Control and Prevention [6]. With input from a subset of experienced EIN members, we developed a 7-question multiple-choice query to assess ID specialist practice patterns related to the management of CIED infections based on commonly encountered clinical scenarios (Supplementary Material). This query was distributed by e-mail or facsimile with 2 weekly reminders. Our query process and EIN members are described elsewhere [6].

Nonresponse bias was assessed by comparing geographic and practice characteristics of nonrespondents and respondents. Respondents who had treated 1 or more CIED infections in the past year were included in further analyses, and respondents were not required to answer all questions. Categorical variables were compared using a χ^2 test or Fisher exact test with SAS, version 9.3 (Cary, North Carolina). *P* values <.05 were considered significant.

RESULTS

The electronic query was available to EIN members from 29 January 2015 through 22 February 2015. Of 1182 eligible respondents engaged in adult ID practice, 543 responded (46%). Nonrespondents (377/639; 59.0%) were more likely than respondents (269/543; 49.5%) to report <15 years of experience since ID fellowship ($P = .0024$). No other significant differences were identified. Most respondents were from the South Atlantic (18.6%), Pacific (17.1%), Mid Atlantic (15.8%), and East North Central (14.2%) regions, although every US region was represented. Most were employed by an academic institution (33.3%), in private practice (30.8%), or in a hospital or clinic setting (29.1%).

Of the 543 respondents, 360 (66.3%) had treated 1 or more patient with a CIED infection in the preceding year. Most had treated fewer than 5 (166/360; 46.1%) or 5–10 CIED infections (125/360; 34.7%). Not all respondents answered each question; the number of respondents for each question varied between 345 and 360.

Complete vs Partial Device Removal

When treating occult bacteremia in a patient with a CIED, 146/358 (46%) respondents preferred (ie, usually or almost always recommended) complete device removal. In contrast, only 25/345 (7%) preferred partial device removal. When bacteremia was attributable to a noncardiovascular infection (eg, pneumonia), fewer respondents (40/355; 11%) preferred complete device removal, and only 9/345 (3%) preferred partial device removal. For a patient with CIED-related pocket infection that required incision and drainage, most (293/359; 82%) preferred complete device removal; 102/347 (29%) also preferred partial device removal as an alternative. For lead-associated endocarditis, nearly all respondents (356/360; 99%) preferred complete device removal, whereas only 70/345 (20%) also preferred partial device removal as an alternative.

Nearly three quarters (73%) of respondents endorsed complete device removal in the setting of occult bacteremia due to *Staphylococcus aureus* (Figure 1). Almost half (47%) recommended the same even if a noncardiovascular source was identified. In contrast, fewer recommended complete device removal for non–*S. aureus* gram-positive (coagulase-negative *Staphylococcus*, *Enterococcus*) or gram-negative organisms (including

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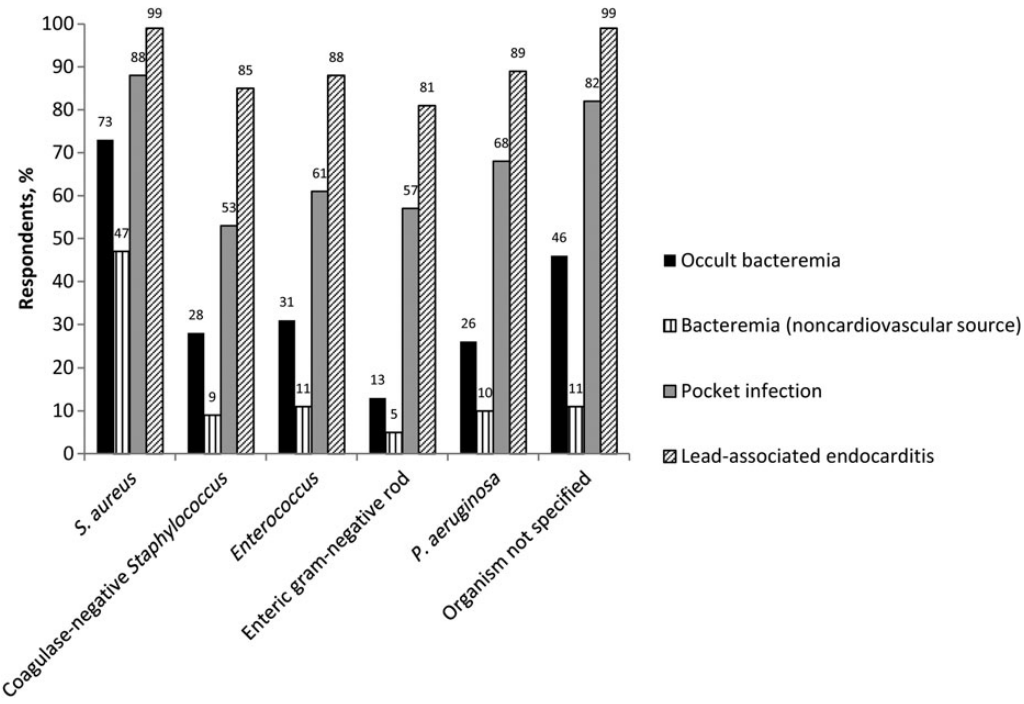

Figure 1. Preference for complete device removal, by causative microorganism and type of cardiac implantable electronic device infection.[a,b]
[a]Number of respondents for specified organisms (all groups), n = 360; [b]Number of respondents for "organism not specified" by group: occult bacteremia, n = 358; bacteremia (non-cardiovascular source), n = 355; pocket infection, n = 359; lead-associated endocarditis, n = 360.

Pseudomonas aeruginosa) in either situation. Most recommended complete device removal for pocket infection or lead-associated endocarditis irrespective of the causative microorganism.

Duration of Antimicrobial Therapy After Complete Device Removal

Respondents favored longer durations of antimicrobial therapy to treat occult bacteremia due to *S. aureus* compared with non–*S. aureus* gram-positive or gram-negative organisms in a patient with a CIED (Supplementary Figure 1). Two-thirds (64%) would treat *S. aureus* for 29 days or more; in contrast, only 34% ($P < .0001$) and 26% ($P < .0001$) would do the same for non–*S. aureus* gram-positive or gram-negative occult bacteremia, respectively. Almost half (49%) recommended 7–14 days and 28% recommended 15–28 days to treat a pocket infection after complete device removal. In the setting of lead-associated endocarditis, 75% favored 29–42 days while 11% favored more than 6 weeks following complete device removal.

Duration of Device Holiday

In the context of a CIED infection with bloodstream involvement (eg, lead-associated endocarditis) treated with complete device removal and antimicrobial therapy with resolution of bacteremia, the recommended duration for device holiday varied based on the indication for the CIED (Supplementary Figure 2). In a patient with a pacemaker-dependent arrhythmia who would otherwise require external or transvenous pacing, 58% were amenable to a device holiday of 6 days or less. In contrast, only 31% accepted a similarly brief device holiday for secondary prevention of sudden cardiac death (eg, prior episode of ventricular tachycardia or ventricular fibrillation) and only 27% for a patient requiring a device for primary prevention (eg, cardiomyopathy with depressed left ventricular ejection fraction).

Chronic Suppressive Antimicrobial Therapy for Retained CIED

In a patient with CIED lead-associated endocarditis where complete device removal is not possible, 334 (93%) reported they would treat with chronic suppressive oral antimicrobial therapy following an initial course of intravenous therapy. A majority (239/329; 73%) would continue suppression indefinitely; only 32 (10%) would suppress for 6 months or less.

DISCUSSION

Our study describes ID specialist practice patterns and perspectives related to the management of CIED infections in the United States, with a focus on approaches to device removal, duration of antimicrobial therapy and device holiday, and chronic suppression. We found that ID specialists favor complete device removal followed by longer durations of antimicrobial therapy when *S. aureus* is involved, tolerate shorter device holidays when a critical indication for device reimplantation exists, and accept indefinite chronic antimicrobial suppressive therapy when an infected CIED cannot be removed.

According to the 2010 American Heart Association (AHA) guidelines [5], complete device removal is recommended for

lead-associated endocarditis or pocket infection given the high rates of relapsed infection with retained hardware [7, 8]. Most respondents reported guideline-concordant practices. In patients with staphylococcal bloodstream infections but no evidence of lead-associated endocarditis or pocket infection, AHA guidelines likewise recommend complete device removal, and 73% of respondents agreed; just under half would recommend likewise even if a noncardiovascular source was identified. This practice pattern among ID physicians aligns with evidence supporting an increased risk of CIED infection associated with *S. aureus* bacteremia [9–11]. Given the option, respondents infrequently recommended partial device removal, perhaps as lead involvement can be difficult to exclude even with echocardiography. Similarly, while AHA guidelines suggest at least 14 days of antimicrobial therapy to treat bacteremia after device removal, our respondents favored longer durations (more than 29 days) for occult *S. aureus* bacteremia. This may reflect shifts in practice based on studies that demonstrated increased risk of relapsed *S. aureus* bacteremia with shorter treatment times [12, 13].

In the setting of bacteremia with or without lead vegetation, AHA guidelines suggest waiting until repeat blood cultures have been negative for 72 hours or more before inserting a new device and for 14 days or more if a valvular vegetation is present. We found that the minimum acceptable device-free interval prior to reimplantation after CIED infection with bloodstream involvement (eg, lead-associated endocarditis) also hinges on the indication for the CIED. More respondents accepted shorter device holidays (2–6 days) if the patient had a pacemaker-dependent arrhythmia compared with those needing a CIED for primary or secondary prevention of sudden cardiac death. This finding underscores competing factors involved in managing patients with CIED infections and the need to individualize recommendations.

Most respondents favored chronic suppressive oral antimicrobial therapy for patients with a retained infected CIED. Given the complexity and increased morbidity associated with these infections, it is unlikely that randomized trials will be undertaken to establish the true efficacy of this practice. That almost three quarters would support chronic suppression for an indefinite period suggests that clinicians perceive the benefit of prolonged antimicrobial use to outweigh the potential harm in these circumstances.

A limitation of our study was that we surveyed ID specialists who are participating in a volunteer sentinel provider network. Therefore, our study population may not represent all ID specialist practice patterns. Also, responses were self-reported and may be subject to recall bias. Finally, to maximize query completion, our questions did not cover the full range of unique comorbidities, technical considerations, and potential procedural risks that may need to be considered on an individual patient basis.

Despite widespread CIED use, infectious complications that require ID specialist care are infrequent, yet pose treatment dilemmas that are not always fully addressed in existing guidelines. Future research should include how ID specialist consultation impacts clinical outcomes associated with CIED infections and can inform practice guidelines. While complete device removal is recommended for occult *S. aureus* bacteremia, management in the setting of *S. aureus* bacteremia attributed to noncardiovascular infection and the optimal duration of antimicrobial therapy to prevent relapse should be revisited. Studies are needed to define the earliest interval after which a CIED can be reimplanted, particularly for patients who are pacemaker dependent or at high risk for ventricular arrhythmias. Finally, although indefinite chronic suppression for a retained infected CIED is widely accepted, whether a rational deescalation strategy following the period of greatest risk for infection relapse can be safe and practical merits further study.

Supplementary Data

Supplementary materials are available at http://cid.oxfordjournals.org. Consisting of data provided by the author to benefit the reader, the posted materials are not copyedited and are the sole responsibility of the author, so questions or comments should be addressed to the author.

Notes

Disclaimer. The findings and conclusions in the manuscript are those of the authors and do not necessarily represent the official position of the US Centers for Disease Control and Prevention (CDC) or the Department of Health and Human Services.

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