JACC: CLINICAL ELECTROPHYSIOLOGY
VOL. 2, NO. 4, 2016

ISSN 2405-500X/$36.00
PUBLISHED BY ELSEVIER
http://dx.doi.org/10.1016/j.jacep.2016.01.019

Microbiology of Cardiac Implantable Electronic Device Infections

Ayman A. Hussein, MD, Yacoub Baghdy, MD, Oussama M. Wazni, MD, Michael P. Brunner, MD, Ghazal Kabbach, MD, Mingyuan Shao, MS, Steven Gordon, MD, Walid I. Saliba, MD, Bruce L. Wilkoff, MD, Khaldoun G. Tarakji, MD, MPH

ABSTRACT

OBJECTIVES This study reports a high-volume tertiary care center experience with the microbiology of cardiac implantable electronic devices (CIED) infections with assessment of temporal trends and profiles of late versus early infections.

BACKGROUND The rates of CIED infections have been increasing. With changing demographics, patient and device characteristics, prophylactic measures, and the wide use of broad-spectrum antibiotics, there is need for updated contemporary data on the microbiology of CIED infections.

METHODS The study included 816 consecutive patients with confirmed CIED infections who underwent transvenous lead extraction at our institution between the years 2000 and 2011. Blood cultures were obtained in addition of pocket swabs, pocket capsule, and leads.

RESULTS Staphylococcal species remained the most common pathogens in CIED infections (68.4%), especially coagulase-negative species (37.6%). Methicillin-resistant staphylococci were the pathogens in 33.8% of all CIED infections and accounted for 49.4% of all staphylococcal infections. Gram-negative pathogens were identified in 8.9% of cases, whereas 13.2% were with negative cultures. CIED infections related to streptococci (2.5%), enterococci (4.2%), anaerobes (1.6%), fungi (0.9%), and mycobacteria species (0.2%) were less common. Of pocket infections, 49.5% occurred more than 1 year after pocket manipulation, and 53.6% of these were related to coagulase-negative staphylococci. In contrast, most endovascular infections were related to *Staphylococcus aureus*. The proportions of culture negative infections have increased ($p < 0.0001$).

CONCLUSIONS The study provides contemporary data on the microbiology of CIED infections. The rates of methicillin resistance seem to be greater than those reported from the preceding decade. (J Am Coll Cardiol EP 2016;2:498–505)

The use of cardiac implantable electronic devices (CIED) has increased over the course of the past decade (1). In parallel, there has been an increase in CIED infections at a rate that seems to have followed a faster disproportionate trend to the rate of increase of newly implanted devices (2,3).

Despite increasing awareness of the seriousness of CIED infections, the institution of infection control practices, the administration of prophylactic antibiotics at the time of implants or system revisions, as well as improvement in CIED and lead design, CIED infections continue to occur and are life threatening (4,5).

Importantly, the demographics and risk factors of patients receiving CIED implants seem to have changed over time, which could explain the trends in CIED infection rates (4). CIED implant recipients are increasingly older and have multiple coexisting illnesses (6–8). Similarly, the implants of devices that are at higher risk of infection due to hardware burden or the inherent characteristics of their recipients, such as dual chamber pacemakers and defibrillators or cardiac resynchronization therapy devices, have increased over time (7,9). Importantly, a significant and increasing proportion of such devices are implanted in patients who are older than 70 or 80 years of age (10,11).

Listen to this manuscript's audio summary by *JACC: Clinical Electrophysiology* Editor-in-Chief Dr. David J. Wilber.

From the Section of Cardiac Electrophysiology and Pacing, Cleveland Clinic Foundation, Cleveland, Ohio. The authors have reported that they have no relationships relevant to the contents of this paper to disclose.

Manuscript received October 30, 2015; revised manuscript received December 28, 2015, accepted January 21, 2016.

With changing demographic, patient, and device characteristics, the institution of measures to prevent CIED infections and the wide use of broad-spectrum antibiotics, it remains unknown whether there has been a parallel change in the epidemiology of microorganisms in CIED infections over time. Similarly, although many infections are thought to be related to the index implant procedures or system revisions, a significant number of pocket or endovascular infections occur more than 1 year after device-related interventions, and it remains unknown whether there are microbiological differences in early versus late CIED infections.

SEE PAGE 506

This study reports a 12-year experience with the microbiology of CIED infections from a high-volume tertiary care center and assesses temporal trends of pathogens and the microbiological profiles of late versus early infections.

METHODS

All 816 consecutive patients with confirmed CIED infections who underwent device and transvenous lead extraction or removal at the Cleveland Clinic between 2000 and 2011 were included. The clinical features, characteristics, and presentation of device infection were entered into a prospectively maintained data registry. All patients were evaluated and followed by an electrophysiologist and an infectious disease specialist from the infective endocarditis and cardiac device infection service. In our practice, we have established a multidisciplinary center for the management of CIED infections that includes, but is not limited to, cardiac electrophysiologists, infectious disease specialists, cardiac imaging specialists, radiologists, and cardiac surgeons.

The microbiological profiles and temporal trends were assessed in the overall population, which was then categorized into 2 groups based on the initial clinical presentation for the comparison of microbiology in early and late infections. The first group included patients who presented with signs and symptoms of device pocket infection with or without systemic symptoms. The second group included patients with endovascular infections who had systemic signs and symptoms of infection and a clinical history supported by microbiology and in most patients by echocardiographic imaging. In patients with clinical features of endovascular infection, transesophageal echocardiographs were obtained. In all patients, a clinical consensus was reached between the managing electrophysiologist and the infectious disease specialist regarding the need for device and lead extraction.

Blood cultures were obtained from all patients before the extraction procedures and before the initiation of antibiotic therapy at our institution. For patients who were referred from other institutions on antibiotic therapy, every effort was made to obtain all culture data from the referring institutions, and these were updated in our clinical records. At the time of the extraction procedure, device pocket swab cultures were sent when there was evidence of purulent drainage in the pocket. The fibrotic capsule was excised fully in all patients and

ABBREVIATION AND ACRONYM

CIED = cardiac implantable electronic devices

TABLE 1 Baseline Characteristics of 816 Consecutive Patients Who Underwent Lead Extraction or Removal for Device Infection at the Cleveland Clinic, 2000 and 2011 (N = 816)

Age, yrs	69.3 ± 15.0
Female	26.4
Caucasian	88.3
Weight, kg	84.6 ± 22.2
Heart failure	48.2
Ischemic cardiomyopathy	30.1
Dilated cardiomyopathy	11.5
Coronary disease	53.1
Valvular heart disease	10.2
Hypertension	59.7
Diabetes mellitus	31.9
Dyslipidemia	43.8
Stroke	10.2
TIA	2.6
Peripheral vascular disease	11.4
Venous thromboembolism	12.0
COPD	16.0
Liver disease	3.4
ESRD	7.9
Atrial fibrillation	44.3
Prior CABG	29.2
Prior valve surgery	10.0
Prior endocarditis	3.3
Steroid use	2.7
Pacemaker	48.2
Defibrillator	51.8
Pacemaker dependent	20.5
Coronary sinus lead	15.2
Number of leads	2 (2-3)
Prior pocket reintervention	36.7
Anticoagulant therapy	31.6
Positive cultures	
Pocket swab	44.2
Blood	54.5
Pocket tissue	52.9
Lead	63.9
Hardware only, other cultures negative	8.7

Values are mean ± SD, %, or median (interquartile range).

CABG = coronary artery bypass graft; COPD = chronic obstructive pulmonary disease; ESRD = end-stage renal disease; TIA = transient ischemic attack.