EDITORIAL

Cardiac implantable electronic device infection: formidable, frustrating, and increasingly frequent

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In this issue of the *Polish Archives of Internal Medicine* (*Pol Arch Intern Med*), Polewczyk et al[1] discuss risk factors for cardiac implantable electronic device (CIED) infection. The authors retrospectively reviewed data from 1837 patients who underwent transvenous lead extraction (TLE) over a 10-year period at a single institution. Approximately 41% of TLEs were performed for an infectious indication. The manuscript has considerable merit, but also has some important limitations.

Factors that have been associated with a greater risk of CIED infection include the following: 1) immunosuppression (renal dysfunction and corticosteroid use); 2) oral anticoagulation; 3) comorbidities such as diabetes mellitus; 4) periprocedural factors, including the failure to administer perioperative antibiotic prophylaxis; 5) device revision/replacement; 6) the amount of indwelling hardware; 7) operator experience; and 8) the microbiology of bloodstream infection in patients with indwelling CIEDs. *Staphylococcus aureus* bacteremia has been associated with an incidence of confirmed CIED infection of 45.4%; the risk of CIED infection with Gram-negative bacilli bacteremia is substantially lower. Patients with a CIED and bacteremia caused by Gram-positive cocci other than *Staphylococcus aureus* have been frequently noted to have evidence of an underlying CIED infection on clinical evaluation that included transesophageal echocardiography. This is particularly true among those with Coagulase-negative staphylococcal bacteremia (such as *Staphylococcus epidermidis*).[2-5] Coagulase-negative staphylococci are the most common infectious pathogens in patients with CIED.

In a recent meta-analysis, host-related risk factors included diabetes mellitus, end-stage renal disease, chronic obstructive pulmonary disease, corticosteroid use, previous device infection, renal insufficiency, malignancy, heart failure, preprocedural fever, anticoagulant drug use, and skin disorders.[6] Procedure-related factors that were predictors of CIED infection included postoperative hematoma, reintervention for lead dislodgement, device replacement/revision, lack of antibiotic prophylaxis, temporary pacing, operator inexperience, and procedure duration. Among device-related characteristics, abdominal pocket, epicardial leads, positioning of 2 or more leads, and dual-chamber systems predisposed to device infection.[6]

Polewczyk et al[1] have identified most of the host- and device-related risk factors, differing primarily in their findings about anticoagulation and antiplatelet therapy. They mention procedure-related factors, but really discuss device system-related factors such as the number of leads present, lead abrasions, abandoned leads, lead dwell time, lead loops, device system type, and the number of procedures preceding TLE. There is no specific information about the procedure that preceded the infection or whether the physicians who performed device implantation or reintervention were from a small group with similar techniques and skills or from a wide referral base that included inexperienced operators.

The data presented on the potential preventive effect of vitamin K antagonists are interesting. However, I view these data very cautiously and with considerable skepticism. The authors did not provide information on whether anticoagulation was continuous, interrupted, or bridged during the most recent reintervention. Their comment that "The possible protective effects of anticoagulants in the present study may result from exclusion of early CIED infection such as pocket hematomas from the analysis"[1] is an important consideration. Paying meticulous attention to hemostasis prior to pocket closure and avoiding bridging anticoagulation can reduce the occurrence of pocket hematoma.[7]

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Received: August 21, 2017.
Accepted: August 21, 2017.
Published online:
Conflict of interest: RGT reports serving as an advisor to Boston Scientific/Guidant; receiving research grants from Boston Scientific/Guidant, Medtronic Inc, St. Jude Medical, Vitatron, and Wyeth-Ayerst/Wyeth Pharmaceuticals; serving as a consultant for Biosense Webster and St. Jude Medical; and receiving speaker fees or honoraria from Boston Scientific/Guidant CRM, Medtronic Inc, Daiichi Sankyo, and St. Jude Medical.
Pol Arch Intern Med. 2017; 127 (9): 579-581
doi:10.20452/pamw.4106

A review of the manuscript's univariate analysis showed that the effect of antiplatelet agents had a hazard ratio of 1.38 (suggesting a neutral or mildly harmful effect). In the multivariate analysis, the hazard ratio became 0.425 (suggesting a beneficial effect). This apparent discrepancy raises concern about the potential protective value of antiplatelet agents. Continuation of aspirin use during implantation does not increase bleeding risk; however, dual antiplatelet therapy is associated with a high risk of bleeding at the time of implantation.[8]

It is not possible to consider this study as a treatise solely on late infectious complications following implantation of a pacemaker, implantable cardioverter–defibrillator, or cardiac resynchronization therapy defibrillator, because reintervention at less than 2 months prior to TLE took place in 73 of the 750 infected patients (9.7%). In the absence of a convincing proof otherwise, the reintervention must be considered the source of the device infection.

It is difficult to assess the effect of lead loops on infection in this study. The authors' contention that lead loops were an important risk factor associated with isolated lead-related infective endocarditis compared to isolated pocket infection seems to be completely negated by their comment that "Lead loops were equally frequent in patients with CDIs and noninfectious indications [for TLE]."[1] The presence of longer lead-dwelling time may indeed represent leads that are unlikely to be infected. Unfortunately, longer lead-dwelling time makes percutaneous TLE more difficult and risky.[9]

The incidence of CIED infection appears to be increasing. In addition to the adverse effect on mortality noted by Polewczyk et al,[1] CIED infection is associated with significant morbidity and cost.

The authors mention prevention of infection, but do not spend much time discussing it. The best method to combat CIED infection is prevention. In a recent review, Imai[10] provided a comprehensive outline of the 3 phases of prevention (before, during, and after device implantation).

Fever elevation within 24 hours of implantation or reintervention is associated with the development of CIED infection. We also look carefully at the patient's white blood cell count to ensure it is not elevated. All existing infections should be treated before, and procedures are ideally postponed until the infection has resolved.[10] When the risk of postponing device therapy outweighs completing the entire course of antimicrobial therapy, demonstration of negative blood cultures for 48 hours is nearly always sufficient. Likewise, blood glucose levels should be controlled in diabetic patients and preoperative hyperglycemia should be avoided.[10,11]

An antiseptic bath the night prior to the procedure has been advocated but appears to offer no benefit over nonantiseptic washing agents.[10,11] Antibiotic prophylaxis is recommended prior to CIED implantation or revision. Cefazolin is usually the agent of choice. Vancomycin should not be routinely used for prophylaxis because of the risk of postoperative methicillin-resistant *S. aureus* infection.[10,12] Our experience (unpublished data) suggests that cefazolin and vancomycin have equivalent prophylactic efficacy.

Operators should perform a meticulous surgical scrub immediately before the procedure. An approved antiseptic agent should be applied over the incision site in concentric circles beginning at the incision site and moving toward the periphery. Painstaking attention to sterile technique throughout the operative intervention is pivotal.[10] Irrigation of the device pocket is an effective way to remove unwanted debris and identify sources of bleeding. Use of electrocautery to assure effective hemostasis and help avoid hematoma formation is essential.[10] Surrounding the device and intrapocket portion of the leads with an antibacterial envelope has been promoted as a means of reducing infection.[13] However, we have not found these envelopes helpful.

Postoperatively, pressure dressings help avoid or reduce the size of hematomas. They are especially valuable in patients who require ongoing anticoagulation. We do not evacuate hematomas in the absence of impending or actual dehiscence unless the patient has pain that is refractory to analgesic therapy.

Postprocedural antibiotics are routinely prescribed in various doses and for various durations. There is no evidence-based indication that this is of benefit in preventing infection. This practice may result in drug allergy or selection of antibiotic-resistant pathogens. Additionally, cost and length of hospital stay may be adversely affected.[14]

Patients should be alerted to look for evidence of bleeding, swelling, and signs of infection. Early follow-up visits may help identify potential problems before full-blown infection occurs.[10]

CIED infection is an important risk of device-based therapy. I do not place a great deal of emphasis on the various categories (locations) of infection described by Polewczyk et al,[1] because the appropriate treatment and total explantation of the device and all leads plus culture-guided antibiotic therapy is the same. A discussion of the tools and techniques available to accomplish explantation is beyond the scope of this commentary. Interested readers may refer to our recent review of this topic.[15]

Although I am not ready to embrace all the findings noted in their study, I applaud the authors for their contribution to our knowledge and understanding of this vexing problem.

Note The opinions expressed by the author are not necessarily those of the journal editors, Polish Society of Internal Medicine, or publisher.

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