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VIEWPOINT
Arrhythmias

Cardiac device infection: removing barriers to timely and adequate treatment

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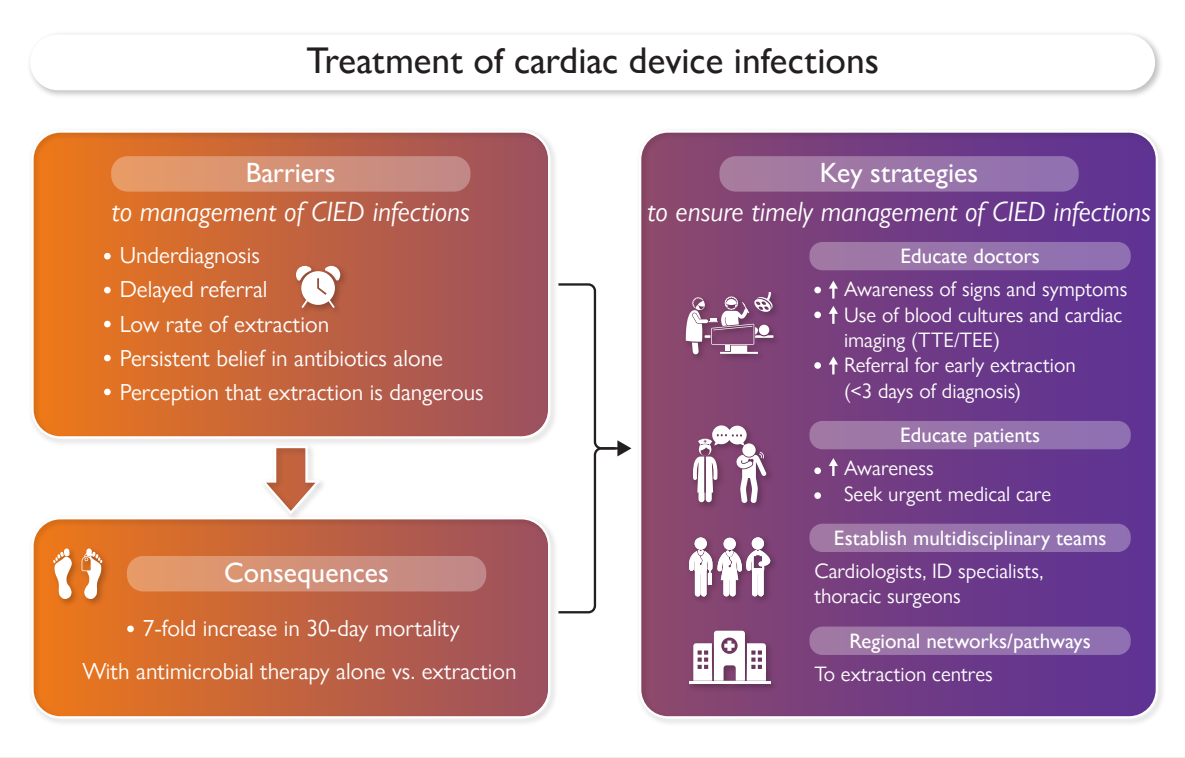
Graphical Abstract



Addressing barriers to timely and adequate treatment of cardiac device infections can save lives. CIED, cardiac implantable electronic device; ID, infectious disease; TEE, transoesophageal echocardiograms; TTE, transthoracic echocardiograms.

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Introduction

Infection related to cardiac implantable electronic devices (CIEDs) occurs in ~1%–3% of cases during the device lifetime.[1] These include pocket infection, systemic infection, and infective endocarditis, and although uncommon, they have a considerable impact, including hospitalization, 1-year mortality rates as high as 25%, and increased healthcare costs.[2] The incidence of CIED infection has been rising over the past 20 years,[3] underscoring the need for both prophylactic measures and early diagnosis and management of suspected infections.[4,5]

Prevention of device infection should focus on the actionable risk factors outlined in the European Heart Rhythm Association (EHRA) guidance summary.[5] Higher risks of pocket CIED infections have been associated with CIED reoperations, young age, and a more complex type of CIED, whereas systemic infections have been associated with risk factors for bacteraemia such as severe renal insufficiency, erysipelas, dermatitis, and lupus erythematosus.[6] The risk of CIED infection is not limited to the first year after device implantation; in fact, 30%–70% of device infections occur beyond 12 months.[1,6,7]

A matter of urgency

The cornerstone of management of CIED infections is extraction of the complete system (excluding superficial wound infections, which are not device infections). The EHRA international clinical practice recommendations for the diagnosis and management of CIED infections (2021) emphasized the need for prompt removal of the device and all associated components.[4]

Failure to diagnose and refer cases to centres with expertise in CIED infection and complete lead extraction is associated with poorer patient outcomes and increased healthcare costs.[2,8,9] The use of antimicrobial therapy alone for CIED infection has been associated with increased mortality at 30 days [hazard ratio (HR) 6.97; 95% confidence interval (CI) 1.36–35.60] and at 1 year (HR 1.61; 95% CI 0.37–6.86).[10] In contrast, early removal was associated with lower mortality risk compared with delaying or not extracting the device (*Graphical Abstract*).[9–11] In a nationwide cohort study, only 11.5% of 25 303 patients with CIEDs and endocarditis, admitted between 2016 and 2019, were managed with device extraction.[9] Extraction was associated with a lower risk of mortality [odds ratio (OR) 0.47; 95% CI 0.37–0.60] compared with no extraction. In another cohort study, the 1-year risk of mortality was significantly lower (HR 0.35; 95% CI 0.16–0.75; $P = .007$) with immediate extraction (4 days) compared with delayed device removal (16 days).[10] However, these data are observational with inherent limitations.

The continuing gap between EHRA recommendations and clinical practice

To improve care for patients with a CIED, there is an urgent need to address the widespread gaps in knowledge that result in underdiagnoses, delayed referral for extraction, and an insistent belief in antibiotic therapy alone.[9,10] As many as 40%–90% of patients with CIED infections are unlikely to undergo device extraction.[10,12,13] In the large survey of patients with CIED infections, 85% did not undergo an extraction.[9] This is in sharp contrast to the findings from a worldwide survey conducted by EHRA in mid-2018, in which 62% of physicians ($n = 242$) stated they would completely remove the device in cases of suspected pocket infection (in the absence of contraindications or high-risk factors).[12] One might argue that the survey was based on hypothetical cases rather than real-world practice. However, a retrospective study of 145 patients in France from 2014 to 2019 with definite CIED infection found that device removal was performed in only 66.2% of cases.[13]

Patients with a CIED will typically see a general cardiologist or a primary care physician for routine management. In a 2020 EHRA/European Society of Cardiology survey, half of the physicians ($n = 336$) who manage such patients but do not perform extractions were uncomfortable with diagnosing and referring, and 75% were uncomfortable managing extraction or post-extraction care.[14] Of greater concern was that many physicians perceived extraction as a complex procedure (44%), with a high risk of mortality (77%).[14] However, this is not the case, as demonstrated by data from a Europe-wide registry showing a 96.7% success rate for transvenous lead extraction and only a 0.5% rate of procedure-related mortality.[15] A more recent single-centre case series reported high success rates in both patients who had implants for more than 10 years (95.6%) and those with younger implants (99.6%).[16]

These data demonstrate that one of the main barriers for device extraction is inadequate detection and diagnosis of device infections largely due to lack of awareness among physicians and patients.[14] Another barrier is delayed referral or non-referral to an expert extraction centre. This may be related to lack of access to a centre, cost, or lack of knowledge about optimal treatment and the efficacy and safety of device extraction procedures. Delayed removal may also be related to lack of access to an operating theatre. These barriers can be decreased by widespread education of physicians and patients via healthcare systems, cardiac societies, and patient advocacy associations regarding the diagnosis and optimal management of CIED infections. Awareness, early referral, and extraction could be facilitated by establishing multidisciplinary teams including cardiologists, electrophysiologists, infectious disease (ID) specialists, and thoracic surgeons, as well as developing regional networks and pathways for referring patients with device infections to extraction centres.

Cardiologists must become comfortable with diagnosing and managing patients with cardiac implantable electronic device infections

Patients with signs of infection may present to the emergency department, their primary care physician, or their general cardiologist. These healthcare professionals must be alerted to the possibility of CIED infection and learn the signs of infection.[4] It is imperative in any case of infection to establish the presence of a CIED and to consider it as a potential source of infection even before results of a blood culture or cardiac imaging are available.

The EHRA recommendations define a definite CIED clinical pocket/generator infection with the following criteria: 'generator pocket shows swelling, erythema, warmth, pain, and purulent discharge/sinus formation OR deformation of pocket, adherence, and threatened erosion OR exposed generator or proximal leads'.[4] While infections should be strictly defined according to the 'Novel 2019 International CIED Infection Criteria' described in the EHRA recommendations, clinicians

should *suspect* an infection if the patient presents with signs of inflammation or discharge at the site, abnormal changes in the pocket, or unexpected exposed components of the device. Unexplained fever or positive blood cultures should raise awareness of CIED infection and prompt early evaluation of the patient with a CIED.

Signs and symptoms of an infection may be subtle, and prompt cardiac imaging including transoesophageal echocardiography (TEE) should be considered. Although false-positive results can be seen on imaging, this is uncommon, and such patients warrant referral to an expert device centre for urgent evaluation. The recommendations provide appropriate steps for blood culture, imaging, antibiotic use, and referral for complete device and lead extraction.[4] Importantly, it is recommended that the device be removed as soon as possible and ideally within 3 days of diagnosis of a CIED infection.[4] Pocket haematoma should not be punctured (risk for infection), nor should pocket infections be evacuated (extraction required), so the practice of referring these cases to general surgeons for surgical intervention should be avoided.

Cardiologists must educate their patients to recognize cardiac implantable electronic device infections

A key component in successfully addressing the gaps related to the diagnosis and optimal management of CIED infection is patient involvement. Patients should be thoroughly educated to better recognize the signs and symptoms of infection, to seek medical care if an infection is suspected, and to routinely inform healthcare workers that they have a CIED (particularly if presenting to the emergency department).

Results of a 2021 patient survey conducted by the Arrhythmia Alliance underscore the lack of engagement between healthcare professionals and patients regarding potential infection.[17] A striking 61% of patient respondents stated they were unaware of the signs and symptoms of CIED infection, and 64% stated that they had not been informed about the infection risk by their physician when receiving the device.[17] The importance of cardiologists in patient education and management of CIED infections is highlighted by the fact that 45% of patients said they responded to infection symptoms by calling a cardiologist, whereas only 36% stated they went to the emergency department.[17]

In early 2022, the American Heart Association-led CIED Infection Summit identified tailored education materials as an actionable solution to improve communication between patients and clinicians and to facilitate engaged and well-informed CIED infection care (https://www.heart.org/en/professional/quality-improvement/national-cied-infection-initiative/). Following device implantation, both written and oral instructions should be given to patients and should include a clear description of the signs and symptoms of infection, the daily examination of their incision site, and proper wound care. The potential for infection during the long term should also be discussed. Patient education materials related to CIED infection are available from a number of credible websites including the EHRA, Arrhythmia Alliance, British Heart Foundation, and Heart Rhythm Society.

Summary

An essential message for all physicians who may be exposed to patients with CIED infections is that early referral for complete system removal equates to lower morbidity and mortality. Moreover, cardiologists should ensure that all patients with CIEDs are aware of the potential risk for infection even over the long term, the signs and symptoms, and the fact that early treatment including system removal improves survival.

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Declarations

Disclosure of Interest

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Corrigendum

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Corrigendum to: MitraClip single-leaflet detachment and consequent migration in atrial functional mitral regurgitation

This is a corrigendum to: Jooyeon Lee and others, MitraClip single-leaflet detachment and consequent migration in atrial functional mitral regurgitation, *European Heart Journal*, Volume 44, Issue 31, 14 August 2023, Page 3021, https://doi.org/10.1093/eurheartj/ehad249

In the originally published version of this manuscript, there was an error in the third sentence. This should read: "[…] single leaflet detachment of the posterior leaflet […]" instead of: "[…] single leaflet detachment of the anterior leaflet […]".

This error has been corrected in the article.