Infections liées aux DECI (PM/DAI): l'ablation doit-elle être systématique ? Sinon, que faire ?

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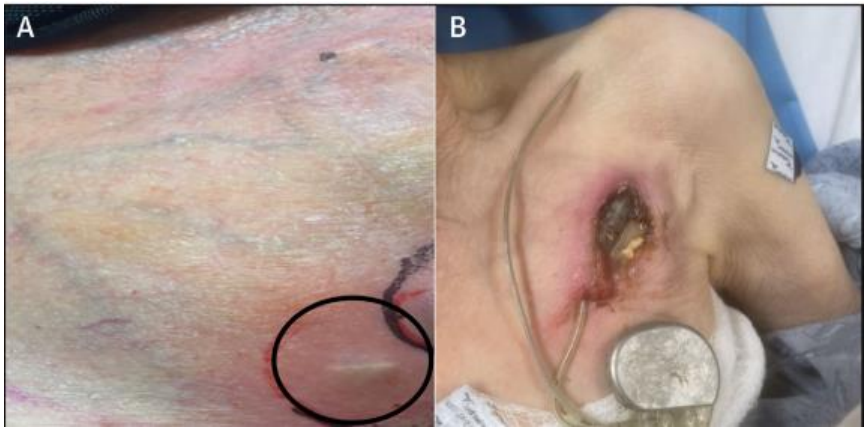
Introduction

- Fréquence relativement faible des infections de dispositif électronique cardiaque implantable (DECI) : 1-2% (+ élevée si défibrillateur et après remplacement de DECI)
- Nombreuses situations de gravité variable. Diversité des entités cliniques individualisées selon les « guidelines »
- Mortalité
  - Toutes infections confondues : 5,5% à J30, 14,6% à 1 an
  - Si endocardite : 14,7% à J30 et 23,2% à 1 an.
- Nécessité d'une prise en charge pluridisciplinaire.


A
B

Définition infection de DECI. Consensus EHRA 2019

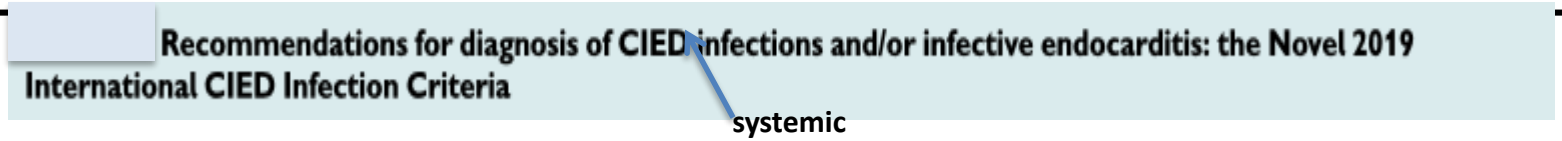
Table 5 Recommendations for diagnosis of CIED infections and/or infective endocarditis: the Novel 2019 International CIED Infection Criteria

- Major criteria ♥ E systemic
  - Microbiology
    - A. Blood cultures positive for typical microorganisms found in CIED infection and/or IE((Coagulase-negative staphylococci, S. aureus)
    - B. Microorganisms consistent with IE from 2 separate blood cultures:
      - a. Viridans streptococci, Streptococcus gallolyticus (S. bovis), HACEK group, S. aureus; or
      - b. Community-acquired enterococci, in the absence of a primary focus
    - C. Microorganisms consistent with IE from persistently positive blood cultures:
      - a. >_2 positive blood cultures of blood samples drawn >12 h apart; or
      - b. All of 3 or a majority of >_4 separate cultures of blood (first and last samples drawn >_1 h apart); or
      - c. Single positive blood culture for *Coxiella burnetii* or phase I IgG antibody titre >1:800

Définition infection de DECI. Consensus EHRA 2019

- **Major criteria** ♥E
  - **Imaging** positive for CIED infections and/or IE
    - D. Echocardiogram (including ICE) positive for:
      - a. CIED infection:
        - » i. Clinical pocket/generator infection
        - » ii. Lead-vegetation
      - b. Valve IE
        - » i. Vegetations
        - » ii. Abscess, pseudoaneurysm, intracardiac fistula
        - » iii. Valvular perforation or aneurysm
        - » iv. New partial dehiscence of prosthetic valve
    - E. [18F]FDG PET/CT (caution should be taken in case of recent implants) or radiolabelled WBC SPECT/CT detection of abnormal activity at pocket/generator site, along leads or at valve site
    - F. Definite paravalvular leakage by cardiac CT

Définition infection de DECI. Consensus EHRA 2019



- **Minor criteria**.
  - a. Predisposition such as **predisposing heart condition** (e.g. new onset tricuspid valve regurgitation) or injection drug use
  - b. **Fever** (temperature >38C)
  - c. **Vascular phenomena** (including those detected only by imaging): major arterial emboli, septic pulmonary embolisms, infectious (mycotic) aneurysm, in- tracranial haemorrhage, conjunctival haemorrhages, and Janeway's lesions
  - d. Microbiological evidence: **positive blood culture which does not meet a major criterion** as noted above or **serological evidence of active infection with organism consistent with IE** or **pocket culture or leads culture (extracted by non-infected pocket)**

Définition infection de DECI. Consensus EHRA 2019

- '**Definite**' CIED clinical **pocket/generator infection** = 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
- '**Definite**' CIED/**IE or systemic CIED infection** = presence of either 2 major criteria or 1 major + 3 minor criteria
- '**Possible**' CIED/**IE or systemic CIED infection** = presence of either 1 major + 1 minor criteria or 3 minor criteria
- '**Rejected**' CIED/**IE or CEID infection** diagnosis = patients who did not meet the afore mentioned criteria for IE

EHRA 2019

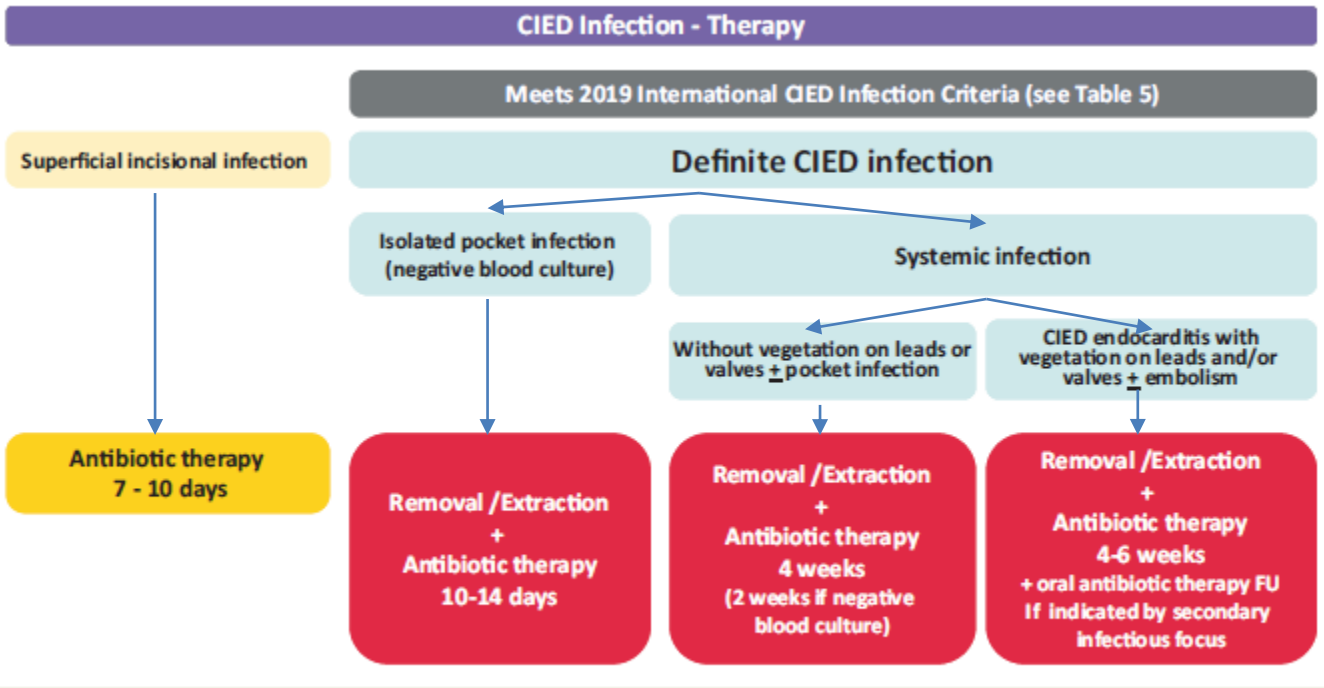


Figure 3 Therapeutic strategies for patients with CIED infections. CIED, cardiac implantable electronic device; FU, follow-up; IE, infective endocarditis.

Evolution of Society Guidelines in the Definitions and Diagnostic Tools for Cardiac Implantable Electronic Device Infection

	CIED Infection Definitions				Diagnostic Tools		
		CIED-IE Without Generator/Pocket Site Infection					
Guideline, Year	Generator/Pocket Site Infection With or Without Bloodstream Infection	Bloodstream Infection With Lead Vegetation	Bloodstream Infection With Valve Vegetation	Bloodstream Infection Without Evidence of Valve or Lead Vegetation[a]	Modified Duke Criteria	TEE	PET-CT
American Heart Association, 2003[5]	+	+	+	–	+/–[b]	+	–
American Heart Association, 2010[6]	+	+	+	–	–	+	–
British Heart Rhythm Society, 2015[7]	+	+	+	–	+/–[b]	+	+/–[c]
European Society of Cardiology, 2015[8]	+	+	+	–	+/–[b]	+	+/–[d]
Heart Rhythm Association, 2017[9]	+	+	+	+	–	+	+/–[d]
European Heart Rhythm Association, 2019[10]	+	+	+	+/–[e]	+	+	+
European Society of Cardiology, 2023[11]	+	+	+	+/–[e]	+	+	+

[a]No other explanation for bacteremia. [b]Modified Duke criteria could be used. [c]In the research setting only. [d]PET-CT could be used as an adjunctive therapy. [e]Based on modified Duke criteria.

+ = included in the guideline; – = not included in the guideline; +/– = mentioned in the guidelines with special notation; CIED = cardiac implantable electronic device; CIED-IE = cardiac implantable electronic device-related infective endocarditis; PET-CT = [^{18}F] fluorodeoxyglucose positron emission tomography computed tomography; TEE = transesophageal echocardiography.

Facteurs de risque d’infection de DECI

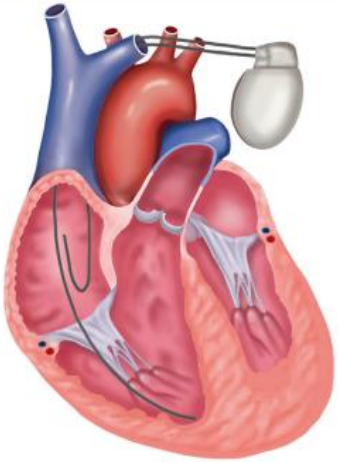
CENTRAL ILLUSTRATION Cardiac Implantable Electronic Device Infection: Risk Factors, Clinical Presentation, and Addressing Barriers

Risk Factors for CIED

Patient factors
- Renal dysfunction/hemodialysis
- Diabetes mellitus
- Heart disease/dysfunction
- Chronic corticosteroids
- Oral anticoagulation
- Immunocompromise-HIV, organ transplant, chemotherapy

Device factors
- >2 leads
- ICD/CRT
- Heart disease/dysfunction

Procedural factors
- Early reintervention
- Temporary pacing
- Fever ≤ 24 hours before implantation
- Unrecognized bacteremia or focus of infection
- Prolonged procedure duration



Key Stakeholders Involved in the ID/Diagnosis and Treatment of CIED Infections Include:

- Electrophysiologists
- Cardiologists
- Nephrologists
- Patients
- Cardiac surgeons
- Infectious disease specialists
- Device clinic staff
- Primary care physicians
- Hospitalists

Infection Type	Description	Signs/ Symptoms
Pocket infection	• Manifests as local occurrence where the device was implanted	• Skin redness • Pain/tenderness • Swelling/warmth • Drainage • Skin ulceration • Device erosion
Systemic infection	• >2 leads • ICD/CRT • Device revision or upgrade	• Fever/chills • Malaise • Nausea • Hypotension • Murmur on examination • Symptomatic HF

Barrier Type	Description	Recommendation
Identification	• Misdiagnosis with other infections and illnesses due to overlapping symptoms • Multidisciplinary issue with limited physician knowledge	• Integrate an electronic medical record alert (EMR) system
Referral	• Proximity/access to an extraction center • Fear of losing a patient to an extracting physician	• Creating a team structure to efficiently guide patients to appropriate experts including infectious disease specialists and device extraction specialists in a timely fashion
Extraction	• Patient age and comorbidities • Perceived complexity and high mortality risk of extraction procedure	• Educate key stakeholders about available evidence and guideline-directed therapy • Educate patients about extraction procedures as an option and potential complications if such a procedure is delayed • Build lead management teams

Lakkireddy DR, et al. J Am Coll Cardiol. 2023;81(13):1283-1295.

Cardiac implantable electronic device (CIED) infection may be related to various risk factors, and its clinical presentations can be highly variable. Key stakeholders in the diagnosis and management should be involved in all the steps of CIED infection management to address the barriers. CRT = cardiac resynchronization therapy; EMR = electronic medical record; ER = emergency room; ICD = implantable cardioverter defibrillator; ID = identification.

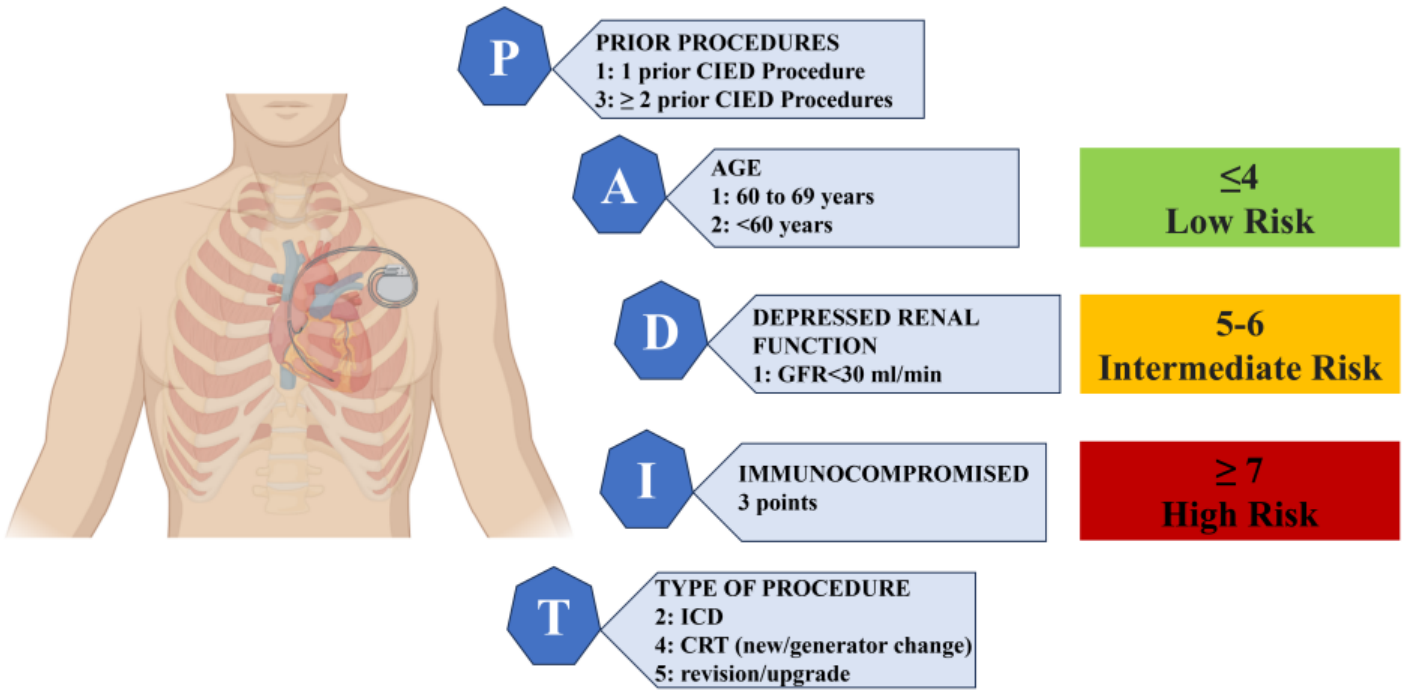


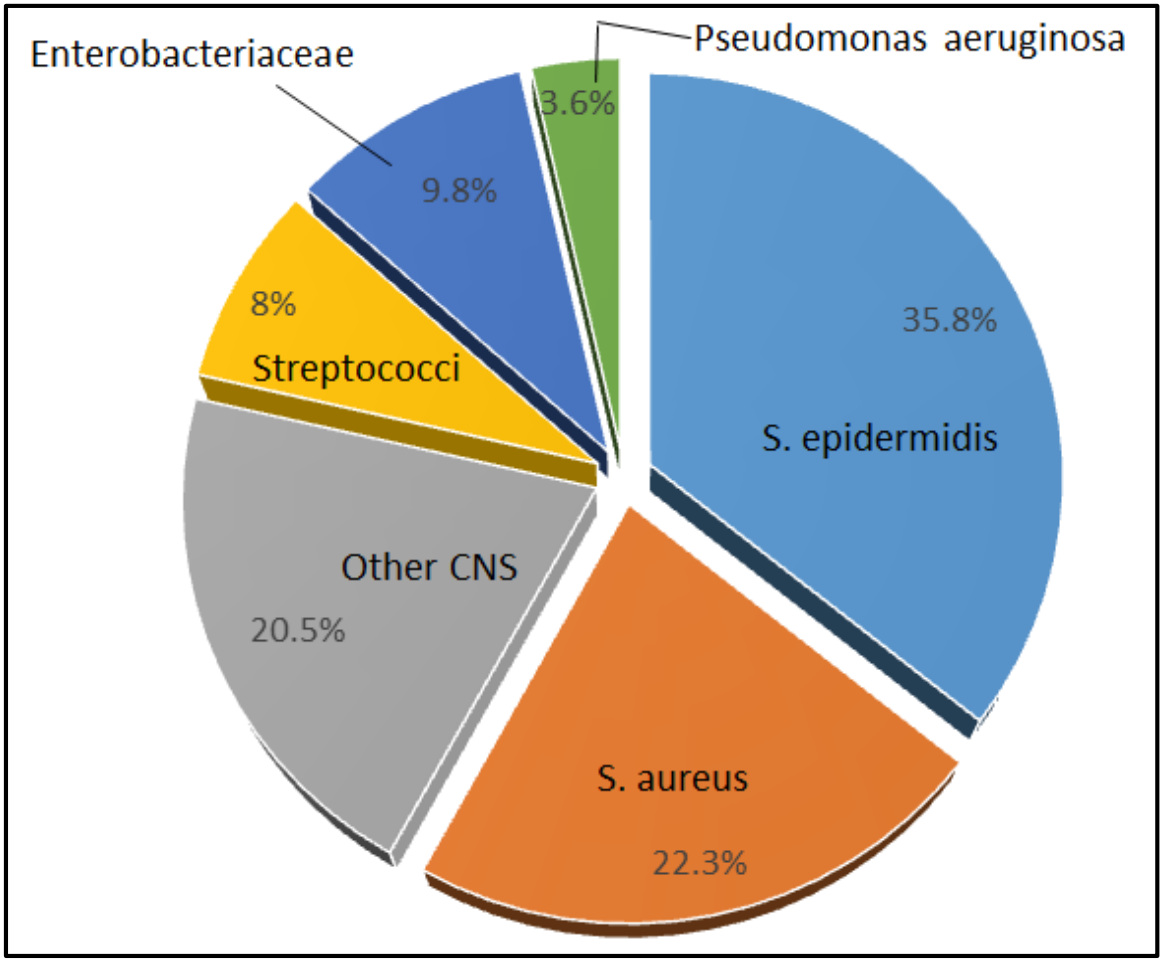
Fig. 2. The PADIT risk score includes five independent predictors of device infection: P: prior procedures, A: age, D: depressed renal function, I: immunocompromised status, and T: procedure type, classifying the patient in low, intermediate, and high risk for CIED infection. Immunocompromised status was defined as individuals who were either undergoing therapeutic interventions that suppress their innate resistance to infections, such as immunosuppressive treatments, chemotherapy, radiotherapy, and prolonged or recent high-dose steroids; or individuals afflicted by pathologies like leukemia, lymphoma, or HIV infection. Abbreviations: CIED, cardiac implantable electronic devices; GFR, glomerular filtration rate; ICD, implantable cardioverter defibrillator; CRT, cardiac resynchronization therapy; HIV, human immunodeficiency virus.

Entités cliniques

- **Extériorisation du matériel** : effraction cutanée avec exposition à la vue du boitier et/ou des sondes, sans signes d'inflammation
- **Infection du site d'implantation = signes locaux d'inflammation**
  - **superficielle** : **dans les 30 jours** suivant l'implantation, sans fièvre et sans autres signes généraux, limitée à la peau et au tissu sous-cutané de la zone d'incision et n'atteignant pas le fascia et/ou les muscles
  - **profonde** : toute **collection au contact du matériel** avec ou sans fièvre
- **Infection de sonde(s) = « ~~endocardite » sur sonde(s)~~ :** végétation visualisée par échocardiographie et/ou hyperfixation sur le trajet d'une sonde (Pet scan/ scintigraphie aux leucocytes marqués)
- **Endocardite** (sous-entendu valvulaire) définie selon les guidelines de l'ESC 2015 modifiés en 2023.

Données microbiologiques

Données de la littérature:
Staphylocoques : 60 à 80% des cas, quel que soit le délai de survenue
- Staphylocoques à coagulase-négative : prédominent si infection de loge
- polymicrobien dans 13% des cas



Bactéries isolées de culture de la partie distale des sondes (123 souches)
Eric Bonnet et al. ENDO 06. Journées Nationales d'Infectiologie. Lyon 2019.

Microbiology of cardiac implantable electronic device (CIED) infections

Organism	CIED endocarditis Number of patients (%)* [1-4]	All CIED infections (pocket and bloodstream) Number of pathogens (%)[5]
Coagulase-negative staphylococci	228 (38)	183 (44)
Staphylococcus aureus	178 (30)	148 (36)
Enterobacteriaceae	37 (6)	18 (4)
Streptococci	41 (7)	12 (3)
Pseudomonas	6 (1)	12 (3)
Other gram-negative bacteria	–	8 (2)
Candida	11 (2)	2 (<1)
Enterococci	25 (4)	20 (5)
Corynebacterium	2 (<1)	2 (<1)
Cutibacterium (formerly *Propionibacterium*) *acnes*	1 (<1)	1 (<1)
Listeria	1 (<1)	–
Anaerobes	4 (<1)	5 (1)
Micrococci	1 (<1)	–
Mycobacterium spp	–	2 (<1)
Apergillus	–	1 (<1)
Other	37 (6)	–
Culture negative	34 (5)	–

* Polymicrobial infection occurred in 5% of cases.[6]

70 à 80%

Méti-R (en France):
S. aureus : 15-20%
SCN : 40-50%

References:

1. *Arber N, Pras E, Copperman Y, et al. Pacemaker endocarditis. Report of 44 cases and review of the literature. Medicine (Baltimore) 1994; 73:299.*
2. *Duval X, Selton-Suty C, Alla F, et al. Endocarditis in patients with a permanent pacemaker: a 1-year epidemiological survey on infective endocarditis due to valvular and/or pacemaker infection. Clin Infect Dis 2004; 39:68.*
3. *Klug D, Lacroix D, Savoye C, et al. Systemic infection related to endocarditis on pacemaker leads: clinical presentation and management. Circulation 1997; 95:2098.*
4. *Cacoub P, Leprince P, Nataf P, et al. Pacemaker infective endocarditis. Am J Cardiol 1998; 82:480.*
5. *Tarakji KG, Chan EJ, Cantillon DJ, et al. Cardiac implantable electronic device infections: Presentation, management, and patient outcomes. Heart Rhythm 2010; 7:1043.*
6. *Mateos Gaitán R, Boix-Palop L, Muñoz García P, et al. Infective endocarditis in patie ble electronic devices: a nationwide study. Europace 2020; 22:1062.*

Pourquoi enlever le matériel ?

- Si infection de DECI avérée, pas de guérison avec une antibiothérapie seule en raison de la présence de biofilm sur le matériel (sondes, boitier)
- Peu de complications lors ou dans les suites de l'extraction du matériel

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Outcomes of complete removal versus conservative therapy in cardiac implantable electronic device infections – A systematic review and Meta-analysis[1]

Tulio Caldonazo [a,b,*,2], Johannes Fischer [a,2], Alena Spagnolo [a], Michele Dell'Aquila [b], Hristo Kirov [a], Panagiotis Tasoudis [c], Ricardo E. Treml [d], Dominique Vervoort [e,f], Michel Pompeu Sá [g,h], Torsten Doenst [a], Mahmoud Diab [a,i], Stefan Hagel [j]

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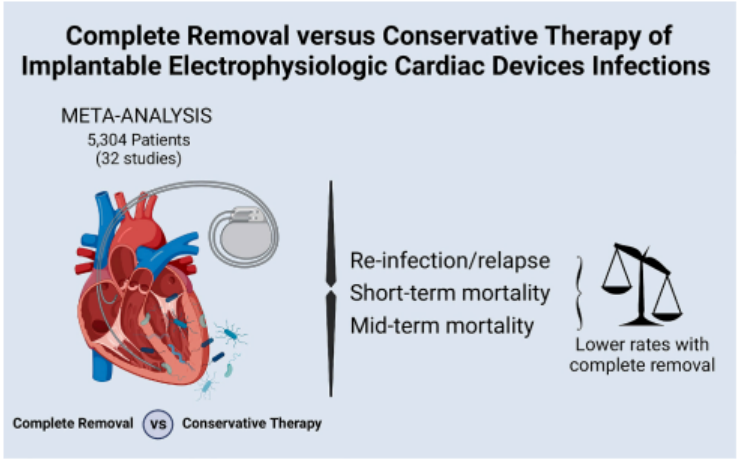


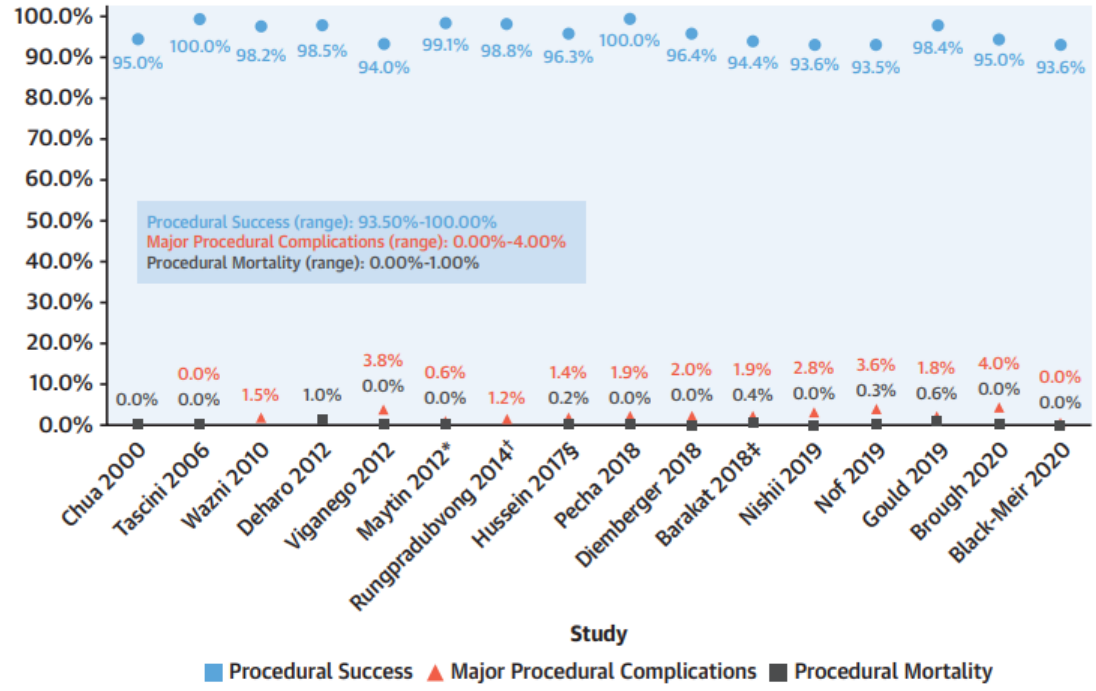
Fig. 2. (Central Picture). Graphical abstract showing the main findings of the analysis.

Table 2
Outcomes summary.

Outcome	Number of Studies	Number of Patients	Effect Estimate (95%CI, *p*-value)
Re-infection/ relapse	13	1100	OR = 0.02, 95%CI 0.01–0.06, p < 0.0001
Short-term mortality	10	952	OR = 0.40, 95%CI 0.23–0.69, p = 0.01
Mid-term mortality	19	4543	OR = 0.52, 95%CI 0.34–0.78, p = 0.002

CI = confidence interval, OR = odds ratio.

FIGURE 2 Clinical Outcomes for Cardiac Implantable Electronic Device Extractions in Patients With Cardiac Implantable Electronic Device Infection



Extraction for cardiac implantable electronic device infection is associated with high procedural success (majority of studies showing rates of >95%), low major procedural complication (between 0% to 4%), and very low procedural mortality (0% to 1%). *Results reported for the local infection cohort. †Results reported for the early extraction cohort. ‡Results reported for the normal renal function group. §Results reported for patients without abandoned leads.

Indications de l’ablation du matériel

Recommandations internationales

Treatment—CIED management		AHA 2010	BHRS 2015	ESC 2015	AHA 2015	HRS 2017	EHRA 2019
Early post-implantation inflammation	In superficial or early inflammation, the CIED can initially be left *in situ*.	✓	✓	NA	NA	NA	8
Isolated pocket infection/erosion	The CIED must be removed completely within 2 weeks after diagnosis	✓	✓	NA	NA	NA	8
CIED lead infection	Complete device system must be removed in CIED lead infection.	✓	✓	NA	NA	✓	8
CIED infective endocarditis	Complete removal is mandatory in CIED infective endocarditis	✓	✓	✓	✓	✓	8
Occult bacteraemia	Complete device removal is recommended in occult bacteraemia	✓	NA	NA	NA	✓	8
Device reimplantation	New transvenous lead implant should be postponed if possible, to allow a few days or weeks of antibiotic therapy	✓	✓	✓	NA	✓	10
Device reimplantation	The replacement device implantation should not be ipsilateral to extraction site. Preferred locations are contralateral side, iliac vein, or epicardial	✓	✓	NA	NA	✓	10

NA : Not available

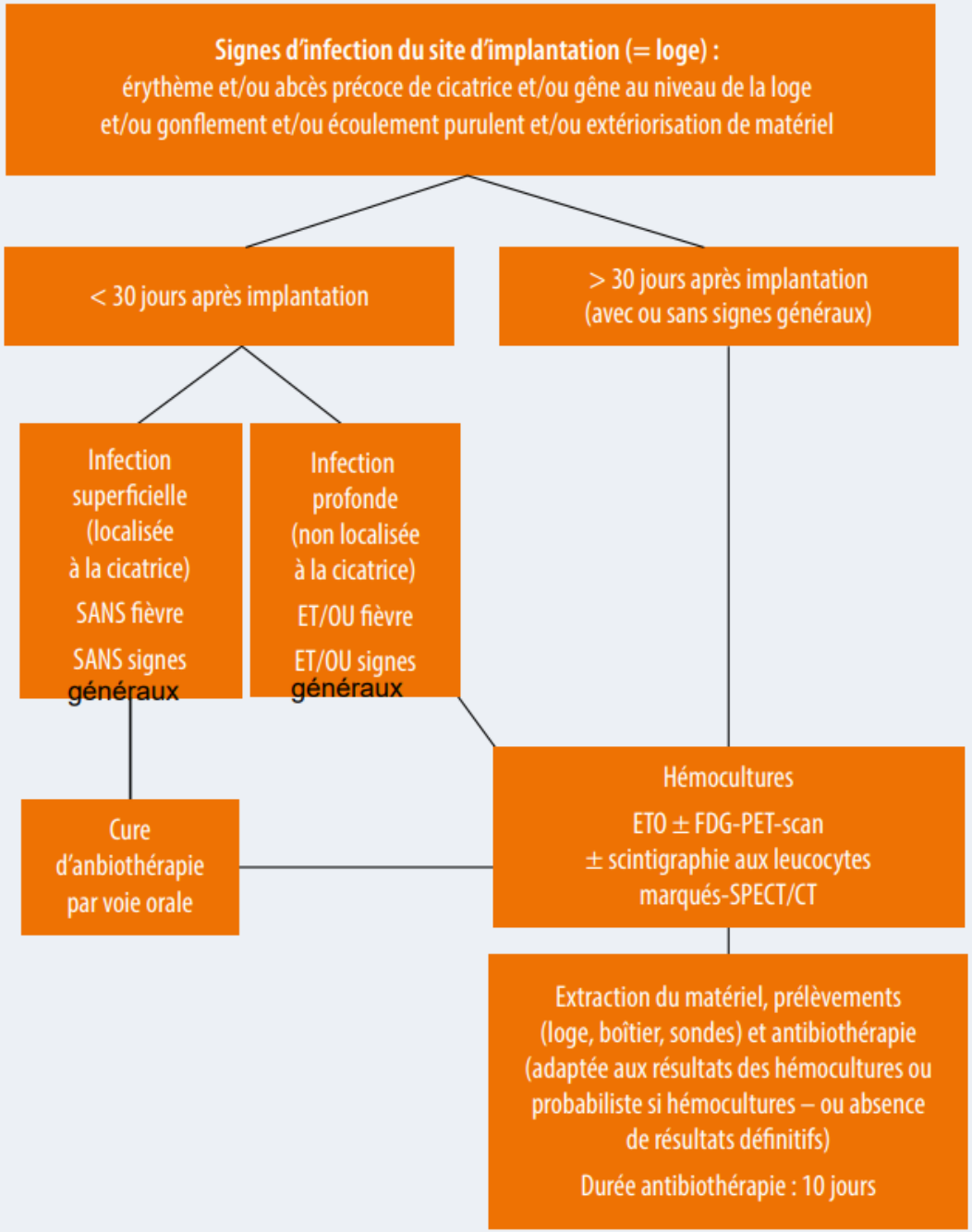


Figure 1. Arbre décisionnel en cas de signes d'infection de loge.

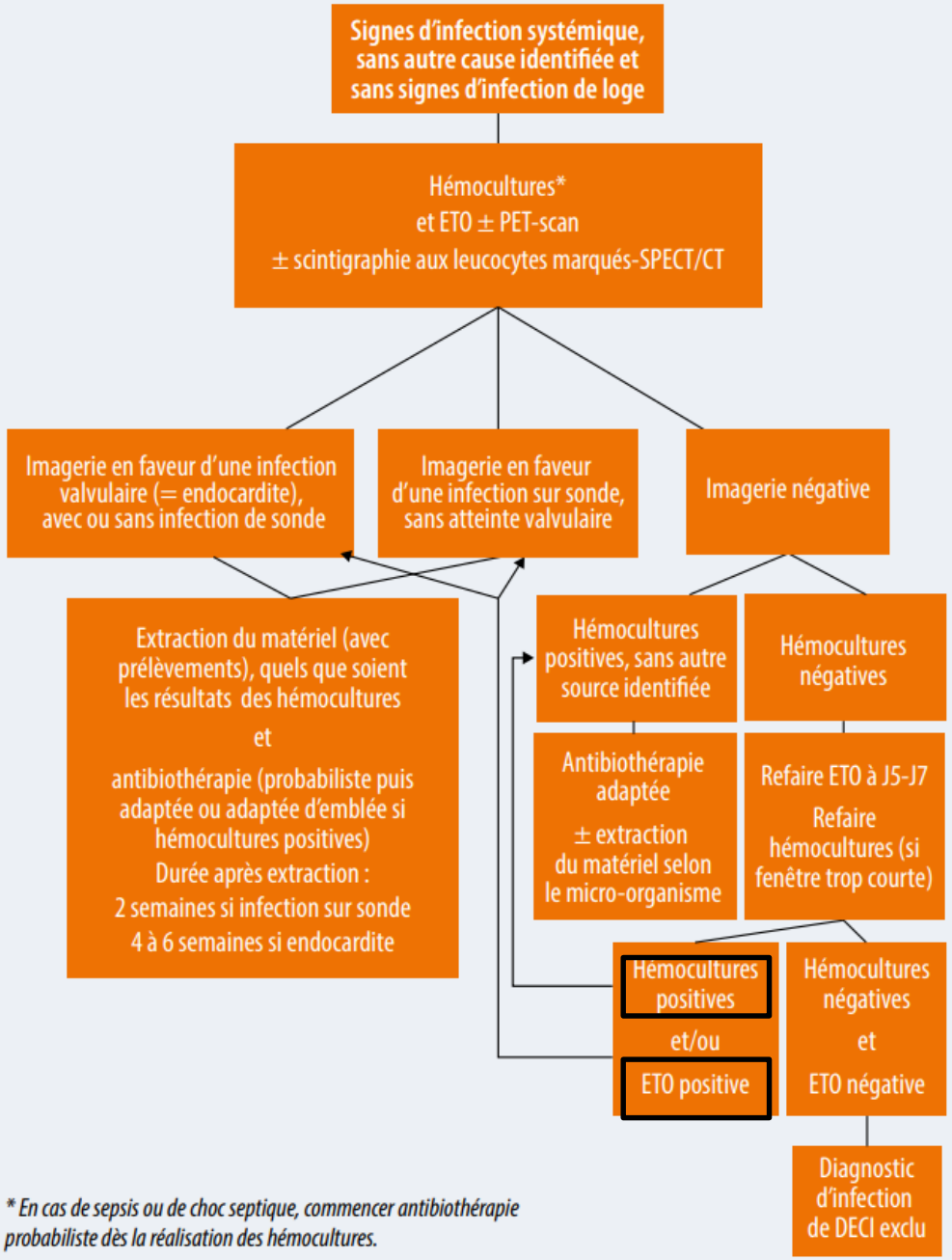
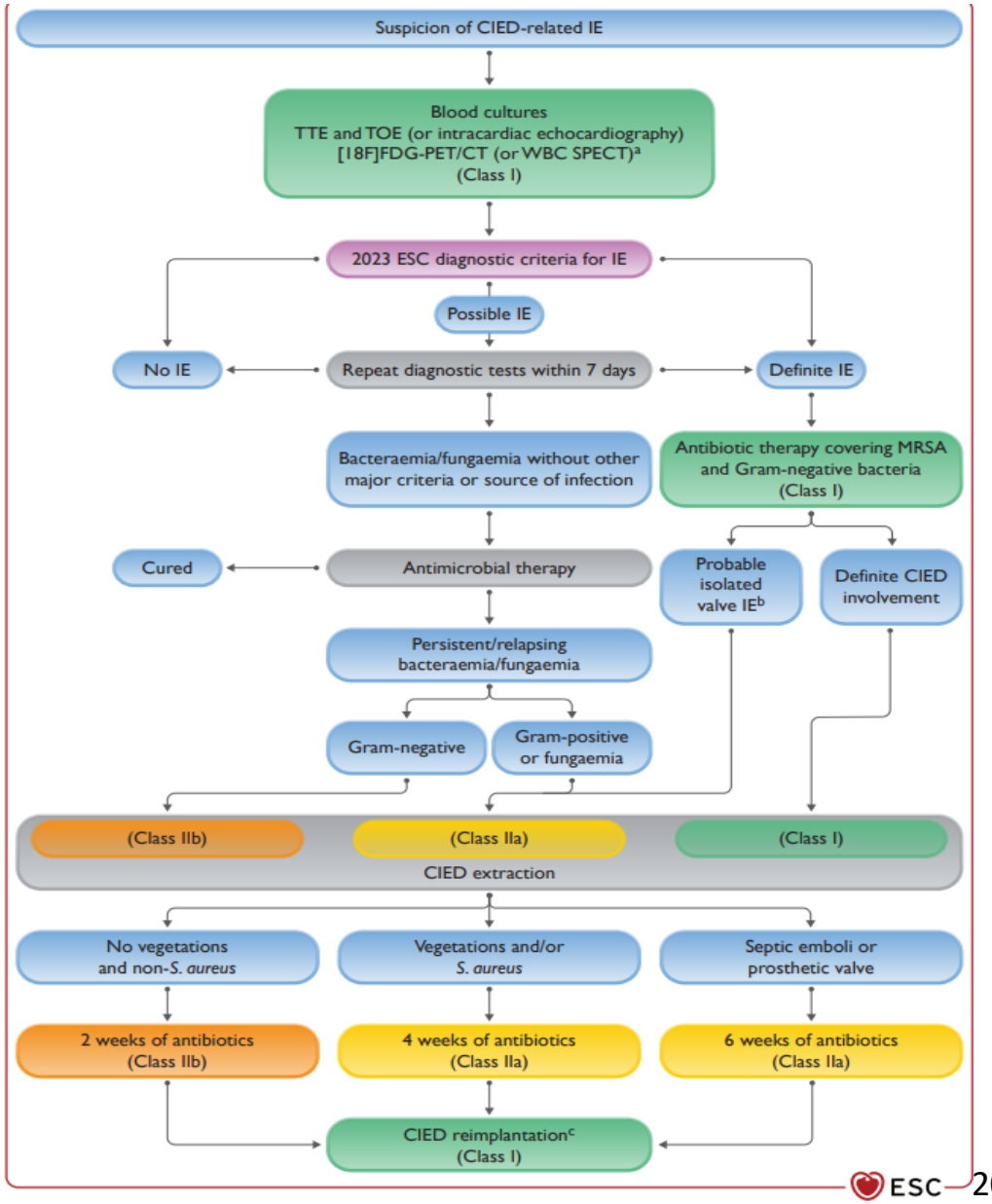


Figure 2. Arbre décisionnel en cas de signes d'infection systémique sans signes d'infection de loge.



ESC 2023

Figure 13 Management of cardiovascular implanted electronic device-related infective endocarditis. [18F]FDG-PET/CT, ^{18}F-fluorodeoxyglucose positron emission tomography/computed tomography; CIED, cardiovascular implanted electronic device; ESC, European Society of Cardiology; IE, infective endocarditis; MRSA, methicillin-resistant *S. aureus*; TOE, transoesophageal echocardiography; TTE, transthoracic echocardiography; WBC SPECT/CT, white blood cell single photon emission tomography/computed tomography. [a]If no signs of pocket infection and negative TOE. [b]Taking into account the identified pathogen, procedural risk, and requirement for valve surgery. [c]At a distant site and postponed as long as possible (until signs and symptoms of infection have resolved and blood cultures are negative for >72 h in the absence of vegetations and /or 'ghosts', or otherwise after >2 weeks of negative blood cultures).

Situations où l'ablation du matériel est indiscutable

- **Infection certaine du site d'implantation** (présence de signes locaux d'inflammation)

  => ceci exclut l'extériorisation « simple » du matériel

  (effraction cutanée avec exposition à la vue du boitier et/ou des sondes, sans signes d'inflammation)

- **Infection de sonde(s) = « ~~endocardite » sur sonde(s)~~**
- **Bactériémie à *S. aureus*, staphylocoque à coagulase négative, *Candida*, *Cutibacterium,*** sans infection de DECI et sans source identifiée,

Tableau. Traitement antibiotique documenté d'infection profonde de la loge, sans bactériémie (traitement oral après ablation du matériel). En cas de bactériémie la durée de traitement proposée est de 14 jours.

Antibiotique	Dosage	Durée
***Staphylococcus* spp.**		
Pristinamycine ou clindamycine	1 g × 3/j 1,8 g/j en 3 prises et jusqu'à 2,4 g/j si poids > 100 kg	
***Streptococcus* spp.**		
Amoxicilline	50 mg/kg/j en 3 prises par jour	
***Streptococcus* spp. et allergie à la pénicilline**		10 j
Pristinamycine	1 g × 3/j	
***Enterococcus* spp.**		
Amoxicilline	50 mg/kg/j en 3 prises par jour	
***Enterococcus* spp. en cas de résistance ou d'allergie à l'amoxicilline**		
Linézolide	600 mg × 2/j	

Situations où l'ablation du matériel est discutable (RCP)

- Bactériémie à streptocoque alpha ou béta-hémolytique ou entérocoque sans signe évident d'infection de DECI, ni autre source identifiée => 2 attitudes:
  - Ablation d'emblée
  - Ablation si bactériémie persistante ou récidivante sous ou après une antibiothérapie adaptée
- Endocardite valvulaire sans atteinte identifiée à l'imagerie (ETO, Pet-Scan, Scinti aux leuco marqués) du matériel.
- Infection « superficielle » du site d'implantation (signes locaux modérés)

Situations où l'ablation du matériel n'est pas indiquée (d'emblée)

- Simple extériorisation du matériel sans signes inflammatoires locaux.
- Premier épisode de bactériémie à BGN ou à pneumocoque

  Mais si, malgré une antibiothérapie adaptée et en l'absence de source identifiée il existe une bactériémie récidivante ou persistante => ablation indiquée

Situation où l'ablation est indiquée mais non réalisable

- Antibiothérapie curative usuelle de 6 semaines, suivie d'une antibiothérapie suppressive de durée non déterminée (> 1 an)
  - Principaux antibiotiques utilisés en suppressif :
    - Céphalosporine de première génération
    - Doxycycline
    - Cotrimoxazole
  - Suivi sous antibiothérapie suppressive : à M2 et M3 puis tous les 6 mois

TABLE 3 Summary of U.S. and European Guideline Recommendations for CIED Device Removal in Patients With Infection

Society, Year	Recommendations: Complete Extraction	Recommendations: Prompt Extraction	Details
AHA, 2010[61]	×	×	• Complete device and lead removal are recommended for all patients with definite CIED-I, CIED pocket infection, valvular endocarditis without definite involvement of the lead(s) and/or device, with occult staphylococcal bacteremia (Class I Indication) • Complete device removal should not be delayed, regardless of timing of imitation of antimicrobial therapy
BHRS, 2015[7]	×	×	• Complete and early (as soon as possible, but not more than 2 wks after diagnosis) removal of an infected CIED system (generator and all leads) combined with appropriate antimicrobial therapy is the most effective, safe, and efficient treatment option for pocket infections, CIED-LI, and CIED-IE
ESC, 2015[60]	×		• Prolonged (ie, before and after extraction) antibiotic therapy and complete hardware (device and leads) removal are recommended in definite CDRIE, as well as in presumably isolated pocket infection (Class I Indication)
HRS, 2017[8]	×	×	• Complete device and lead removal are recommended for all patients with definite CIED system infection, valvular endocarditis without definite involvement of the lead(s) and/or device, persistent or recurrent bacteremia or fungemia (Class I Indication) • Early diagnosis of CIED-I and performing lead extraction within 3 days of diagnosis is associated with lower in-hospital mortality
EHRA, 2020[5]	×	×	• Complete device removal is recommended (including abandoned leads, epicardial leads, and lead fragments) for patients with definite CIED-I (systemic and local), in cases of bacteremia, and infective endocarditis (Class I Indication) • Device removal should occur without unnecessary delay (ideally within 3 d)

AHA = American Heart Association; BHRS = British Heart Rhythm Society; CDRIE = cardiac device-related infective endocarditis; CIED = cardiac implantable electronic device; CIED-I = cardiac implantable electronic device infection; EHRA = European Heart Rhythm Association, ESC = European Society of Cardiology; HRS = Heart Rhythm Society; IE = infective endocarditis; LI = lead infection.

Staphylococcus bacteremia without evidence of cardiac implantable electronic device infection

Ikutaro Nakajima, MD, PhD, Ryohsuke Narui, MD, PhD, Kenichi Tokutake, MD, PhD, Caleb A. Norton, MD, William G. Stevenson, MD, FHRS, Travis D. Richardson, MD, Christopher R. Ellis, MD, FHRS, George H. Crossley III, MD, FHRS, Jay A. Montgomery, MD

Conclusion: For patients with SB without evidence of CIED infection, relapse is predicted by the duration of bacteremia. Empirical CIED removal appears to be associated with a survival benefit, although there are likely clinical situations in which this could be deferred.

Table 2 Multivariable model to predict death by 1 y in patients without evidence of CIED infection

	1-y mortality	
Clinical feature	Hazard ratio (95% CI)	*P*
Age	1.02 (0.99–1.04)	.094
Charlson Comorbidity Index	1.08 (0.97–1.20)	.170
Presentation with hypotension	2.43 (1.38–4.26)	.002
Age of the oldest lead	1.00 (0.94–1.06)	.856
Source of the infection		
Primary focus unknown	1.06 (0.57–1.98)	.855
Presumed source of the infection	1.0 (reference)	
Empirical CIED removal	0.28 (0.08–0.95)	.041

CI = confidence interval; CIED = cardiac implantable electronic device.

Infection. 2022 May 10. doi: 10.1007/s15010-022-01838-3. Online ahead of print.

Enterococcus faecalis bacteremia, cardiac implantable electronic device, extraction, and the risk of recurrence

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Abstract

Purpose: In all patients with cardiac implantable electronic devices (CIED) and Enterococcus faecalis bacteremia (EfsB), endocarditis (IE) and CIED infection should be suspected. Guidelines recommend extraction of the CIED when CIED infection or IE is diagnosed. Whether extraction of the CIED should be done in other situations with EfsB is not known. We aimed to describe the management and outcome of patients with CIED and monomicrobial EfsB, in relation to extraction and recurrent EfsB.

Methods: A population-based cohort of patients with monomicrobial EfsB from January 2014 to November 2020 was identified through microbiology registers in the Region Skåne, Sweden. Data on CIED and other clinical features were collected from medical records.

Results: Among 1087 episodes of EfsB, 72 patients with CIED and monomicrobial EfsB were identified. Five of these patients were diagnosed with IE (7%), three of whom had echocardiographic changes on the CIED. Four CIED were extracted (6%). Recurrences were found in seven of 68 patients (10%) not subjected to extraction and in none of the extracted. In the group of patients without extraction, community acquisition and predisposition for IE were significantly associated with recurrent infection in univariate analyses. No infections involving the CIED were diagnosed during the recurrences.

Conclusions: In patient with monomicrobial EfsB, it seems safe to omit extraction if no structural changes are found on the CIED.

Echocardiography and FDG-PET/CT scan in Gram-negative bacteremia and cardiovascular infections

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Recent findings

Most evidence focuses on characteristics of diagnosed cardiovascular infections and the proportion caused by GNBSI. These proportions are low (1–5%) when it comes to native and prosthetic valve endocarditis as well as cardiac implantable electronic device (CIED) infections whereas the proportion of vascular graft infections caused by GNBSI seems substantially higher (30–40%). Information on the prevalence of cardiovascular infection in patients with GNBSI is limited to a few studies finding around 3% endocarditis in patients with GNBSI and a prosthetic heart valve and 4–16% device-related infection in patients with CIED and GNBSI.

Summary

Patients with GNBSI and native or prosthetic valves should only undergo work-up for endocarditis (TEE and FDG-PET/CT) if they present GNBSI relapse or signs suggestive of endocarditis. CIED patients with GNBSI with *Pseudomonas* or *Serratia* spp. should undergo TEE and PET/CT because of the high prevalence of device-related infection. In other GNBs without IE suggestive signs, normal BSI treatment is reasonable and only cases with relapse need work-up. GNBSI in patients with vascular grafts should lead to consideration of PET/CT.

Open Forum Infectious Diseases
MAJOR ARTICLE

Risk of Cardiovascular Implantable Electronic Device Infection in Patients Presenting With Gram-Negative Bacteremia

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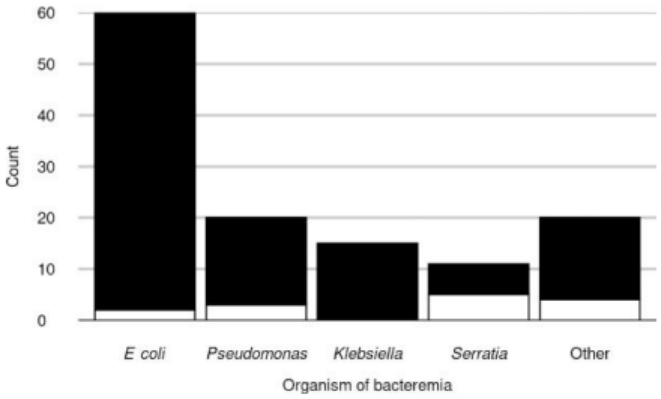


Proportion of cardiovascular implantable electronic device (CIED) infection based on type of gram-negative bacilli. Distribution of *Escherichia coli*, *Pseudomonas* spp, *Klebsiella* spp, *Serratia* spp, and other type of gram-negative bacilli in patients with and without CIED infection.

Cardiovascular Implantable Electronic Device Infection in Patients With *Pseudomonas aeruginosa* Versus *Serratia marcescens* Versus Other Gram-Negative Bacteremia

Organism	Fraction	Estimate, %	(95% CI)[a]
Overall	14/126	11.1	(6.7–17.8)
Pseudomonas aeruginosa	3/20	15.0	(5.2–36.0)
Serratia marcescens	5/11	45.5	(21.3–72.0)
Other	6/95	6.3	(2.9–13.1)

Abbreviations: CI, confidence interval.

[a]Wilson 95% CIs, $P = .002$ for overall Fisher exact test testing whether there are any differences in infection rate between the 3 subtypes. Pairwise tests: *P aeruginosa* vs *S marcescens*, $P = .095$; *P aeruginosa* vs other, $P = .189$; *S marcescens* vs other, $P = .002$.

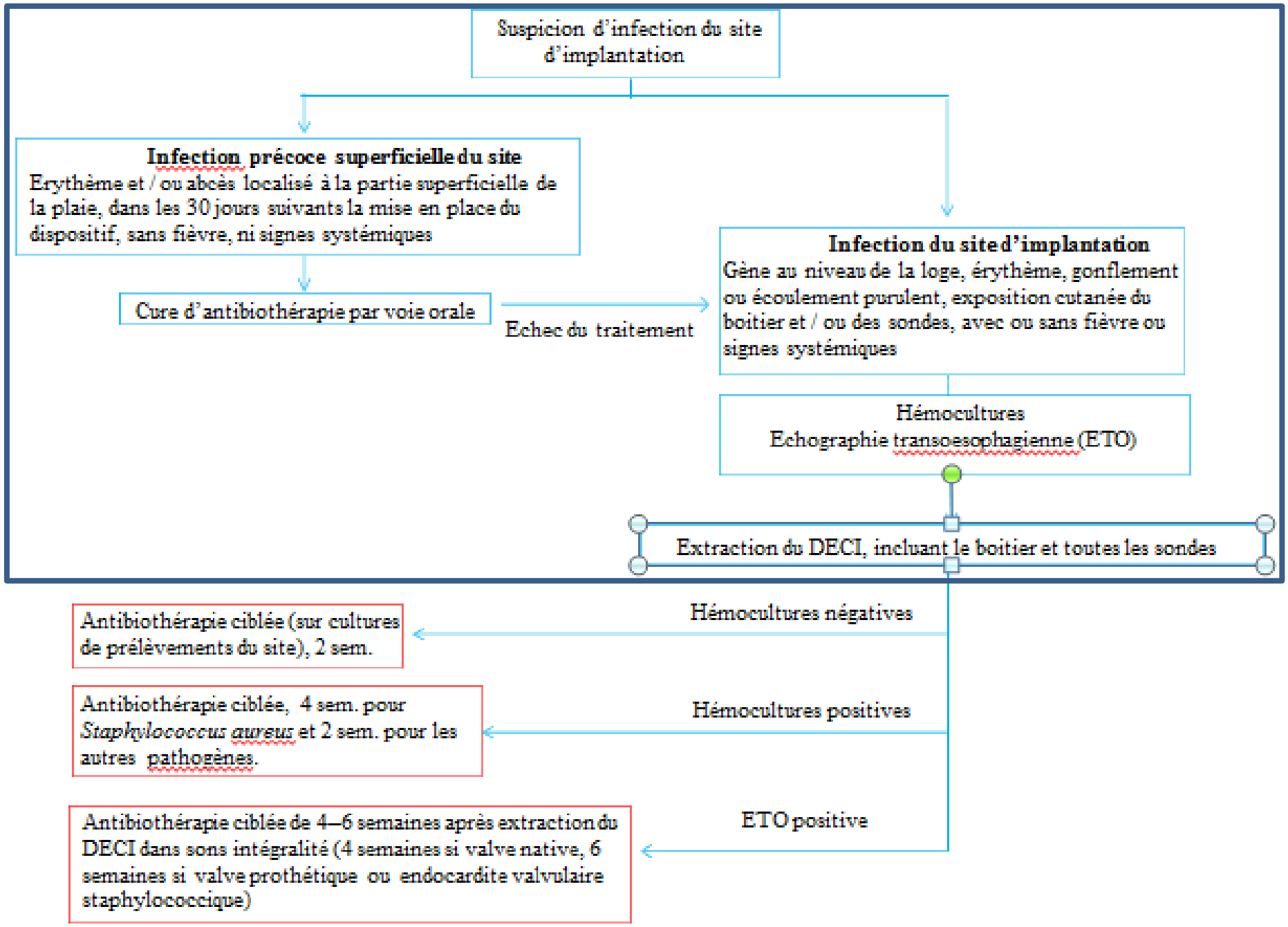
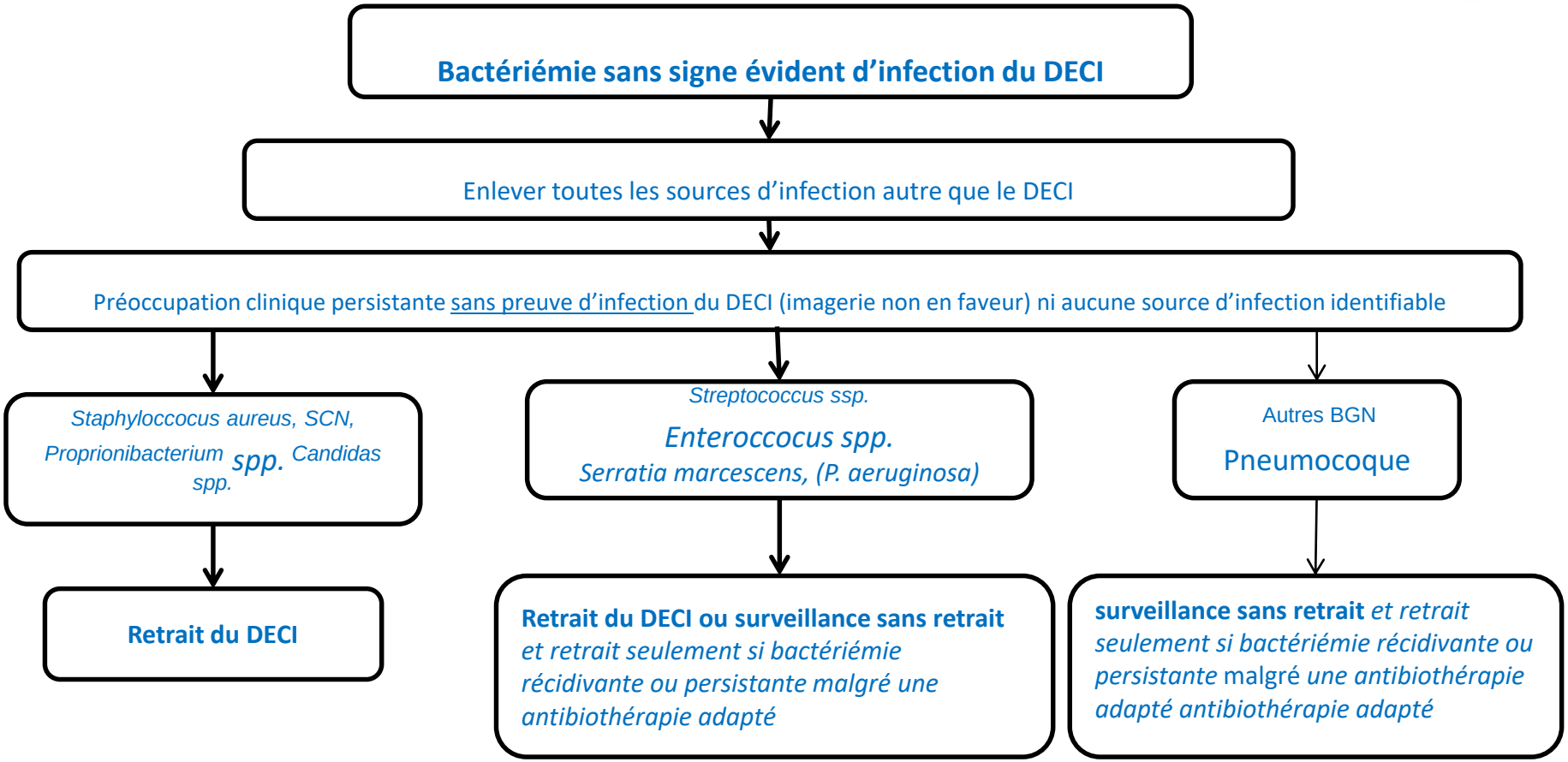
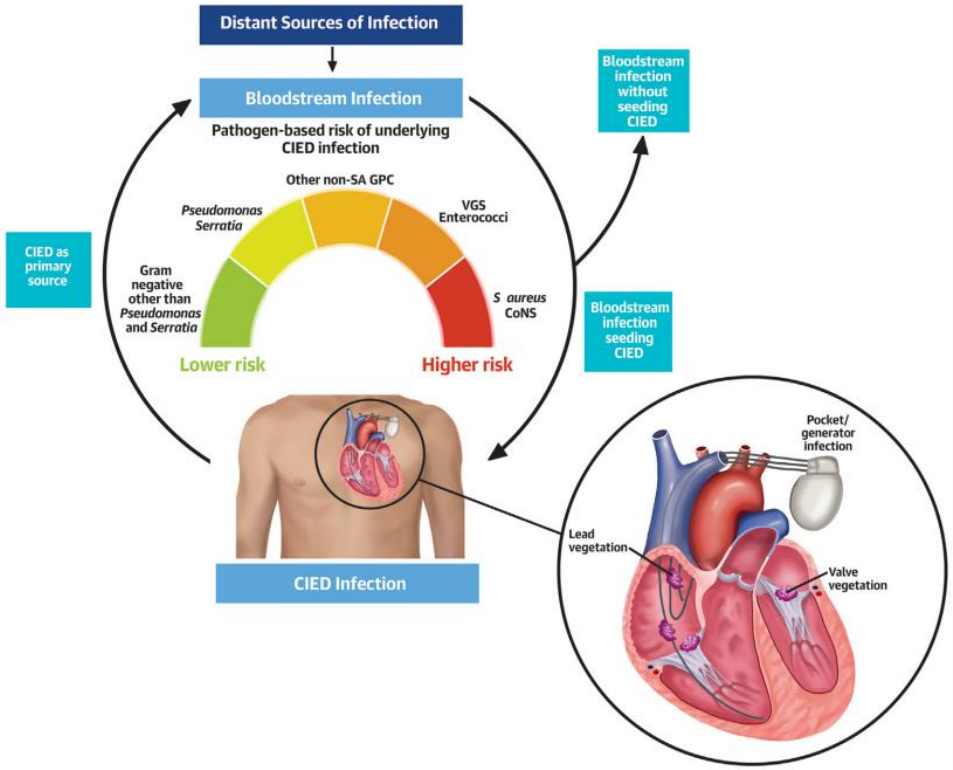


Figure 3 Algorithme décisionnel en cas de suspicion d'infection du site d'implantation du DECI.

HRS


Bactériémie sans signe évident d'infection du DECI
Enlever toutes les sources d'infection autre que le DECI
Préoccupation clinique persistante sans preuve d'infection du DECI (imagerie non en faveur) ni aucune source d'infection identifiable
Staphyloccocus aureus, SCN, Proprionibacterium spp. Candidas spp.
Retrait du DECI
Streptococcus ssp.
Enteroccocus spp.
Serratia marcescens, (P. aeruginosa)
Retrait du DECI ou surveillance sans retrait et retrait seulement si bactériémie récidivante ou persistante malgré une antibiothérapie adapté
Autres BGN
Pneumocoque
surveillance sans retrait et retrait seulement si bactériémie récidivante ou persistante malgré une antibiothérapie adapté antibiothérapie adapté

CENTRAL ILLUSTRATION **Bloodstream Infection and Risk of Cardiac Implantable Electronic Device Infection**



Chesdachai S, et al. J Am Coll Cardiol. 2024;83(14):1326–1337.

When encountering BSI in patients with CIEDs, there are 3 leading possibilities: 1) CIED is the primary source of BSI; 2) BSI is from a distant source with subsequent seeding of the CIED; and 3) BSI is from a distant source without seeding of the CIED. The risk of CIED-related infective endocarditis in this context varies depending on the pathogen causing BSI. BSI = bloodstream infection; CIED = cardiac implantable electronic device; CoNS = coagulase-negative staphylococci; IE = infective endocarditis; non-SA GPC = non-*Staphylococcus aureus* gram-positive cocci; VGS = viridans group streptococci.

Quand et comment extraire le matériel ?

- Quand ?
  - A réaliser le plus précocement possible, une fois l'indication retenue :
    - idéalement dans les 3 jours suivant le diagnostic
    - indépendamment de la durée du traitement antibiotique préalable
- Comment ?
  - Extraction complète (boitier et sondes)
  - Extraction percutanée :
    - si végétations < 2 cm
    - à discuter au cas par cas si végétations > 2 cm (aspiration ? chirurgie ?)
  - Extraction chirurgicale si sondes épicardiques

European Heart Rhythm Association (EHRA) international consensus document on how to prevent, diagnose, and treat cardiac implantable electronic device infections

Table 8 Recommendations for device and lead removal

Consensus statement	Statement class	Scientific evidence coding
In patients with definite CIED infection (systemic and local), complete device removal is recommended (including abandoned leads, epicardial leads, and lead fragments)		O
After diagnosis of CIED infection, the device removal procedure should be performed without unnecessary delay (ideally within 3 days)		O
The recommended technique for device system removal is percutaneous, transvenous extraction technique. Epicardial leads require surgical removal		O
In patients with systemic infection and lead vegetations of approximately >20 mm, percutaneous aspiration of vegetations prior to and during transvenous lead extraction or alternatively surgical extraction may be considered		O
After device removal, meticulous debridement of the generator pocket (complete excision of the fibrotic capsule and complete removal of all non-absorbable suture material) and subsequent wound irrigation with sterile normal saline solution is recommended		E
Cultures of extracted CIED should be performed		E, O

Réimplantation du matériel-HRS 2017
EHRA 2019

- L’évaluation de l'indication de réimplantation est impérative (30 % de non indication)
- Réimplantation possible :
  - au plus tôt 72 heures après la première hémoculture négative = hémocultures quotidiennes en cas de bactériémie
  - plus tardivement si présence d’une autre source d’infection non traitée (abcès du psoas)
  - Réimplantation possible le jour même (dans un autre site) si infection localisée au site d’implantation (hémocultures négatives)

TABLE 2 Summary of Illustrative Cases and Different Clinical Scenarios of Cardiac Implantable Electronic Device Infections

	Signs of Pocket Site Infection	No Sign of Pocket Site Infection				
	Bloodstream Infection Without Lead/Valve Vegetation	Bloodstream Infection Without Lead/Valve Vegetation	Bloodstream Infection With Valve Vegetation	Bloodstream Infection With Lead Vegetation Without Valve Vegetation	Systemic Symptoms With Valve/Lead Vegetation Without Bloodstream Infection	Clinical Scenario for Device Extraction and Reimplantation
Illustrative case	1	2	3	4	5	6
Organism	*Staphylococcus aureus*	*Streptococcus mitis*	*Staphylococcus lugdunensis*	*Streptococcus dysgalactiae*	N/A	*Staphylococcus aureus*
TEE recommended	Yes	Yes	Yes	Yes	Yes	N/A
PET-CT recommended	No	Individualized approach	Individualized approach	Individualized approach	Individualized approach	N/A
Complete device extraction recommended	Yes	Based on the diagnosis	Yes	Based on the diagnosis	Individualized approach	N/A
Timing for reimplantation	72 h after negative blood culture	72 h after negative blood culture	14 d after extraction	72 h after negative blood culture	Individualized approach	N/A
Antimicrobial duration after device extraction	2 wk (4-6 wk with complicated *S aureus* bacteremia)	Based on the diagnosis	4-6 wk	Based on the diagnosis	Individualized approach	N/A

N/A = not applicable; other abbreviations as in Table 1.

Réimplantation du matériel-HRS 2017 EHRA 2019

- Site de réimplantation
  - Choisir un site de réimplantation différent du site initial
    - Controlatéral
    - Veine iliaque (exceptionnelle)
    - Epicardique
    - Sous-cutané
- Alternatives au PM « traditionnel » (permanent)
  - PM semi-permanent
  - PM sans fil
  - Life vest →

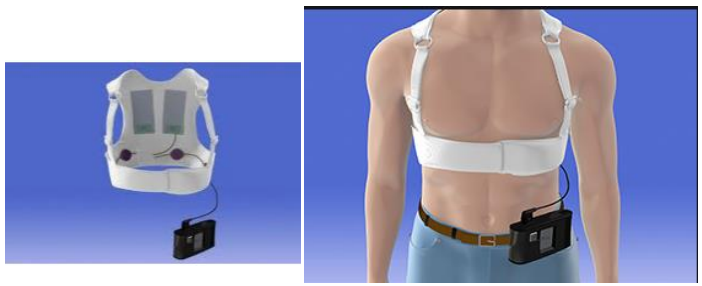


Table 12 Recommendations on minimum volume requirements of cardiac implantable electrical device (CIED) procedures for centres and operators

Consensus statement	Statement class	Scientific evidence coding	References
Operators with less than approximately 100 CIED procedures experience should work under close supervision of more experienced operators		O, E	181–184
An annual minimum operator volume of approximately 50 CIED procedures is recommended for all operators		O, E	185–188

CIED, cardiac implantable electrical device; E, expert opinion; M, meta-analysis; O, observational studies; R, randomized trials.

Recommendation Table 20 — Recommendations for cardiovascular implanted electronic device-related infective endocarditis

Recommendations	Class[a]	Level[b]
Antibiotic prophylaxis covering *S. aureus* is recommended for CIED implantation.[118]	I	A
TTE and TOE are both recommended in case of suspected CIED-related IE to identify vegetations.[692–694]	I	B
Complete system extraction without delay is recommended in patients with definite CIED-related IE under initial empirical antibiotic therapy.[698,699]	I	B
Obtaining at least three sets of blood cultures is recommended before prompt initiation of empirical antibiotic therapy for CIED infection,[710] covering methicillin-resistant staphylococci and Gram-negative bacteria.	I	C
If CIED reimplantation is indicated after extraction for CIED-related IE, it is recommended to be performed at a site distant from the previous generator, as late as possible, once signs and symptoms of infection have abated and until blood cultures are negative for at least 72 h in the absence of vegetations, and negative for at least 2 weeks if vegetations were visualized.[701,711]	I	C
Complete CIED extraction should be considered in case of valvular IE, even without definite lead involvement, taking into account the identified pathogen and requirement for valve surgery.	IIa	C
In cases of possible CIED-related IE with occult Gram-positive bacteraemia or fungaemia, complete system removal should be considered in case bacteraemia/fungaemia persists after a course of antimicrobial therapy.[673–676]	IIa	C
Extension of antibiotic treatment of CIED-related endocarditis to (4–6) weeks following device extraction should be considered in the presence of septic emboli or prosthetic valves.[702]	IIa	C
Use of an antibiotic envelope may be considered in select high-risk patients undergoing CIED reimplantation to reduce risk of infection.[688,689]	IIb	B
In cases of possible CIED-related IE with occult Gram-negative bacteraemia, complete system removal may be considered in case of persistent/relapsing bacteraemia after a course of antimicrobial therapy.[680,690,691]	IIb	C
In non-*S. aureus* CIED-related endocarditis without valve involvement or lead vegetations, and if follow-up blood cultures are negative without septic emboli, 2 weeks of antibiotic treatment may be considered following device extraction.	IIb	C
Removal of CIED after a single positive blood culture, with no other clinical evidence of infection, is not recommended.[675]	III	C

ESC 2023

CIED, cardiovascular implanted electronic device; IE, infective endocarditis; TOE, transoesophageal echocardiography; TTE, transthoracic echocardiography.
[a]Class of recommendation.
[b]Level of evidence.

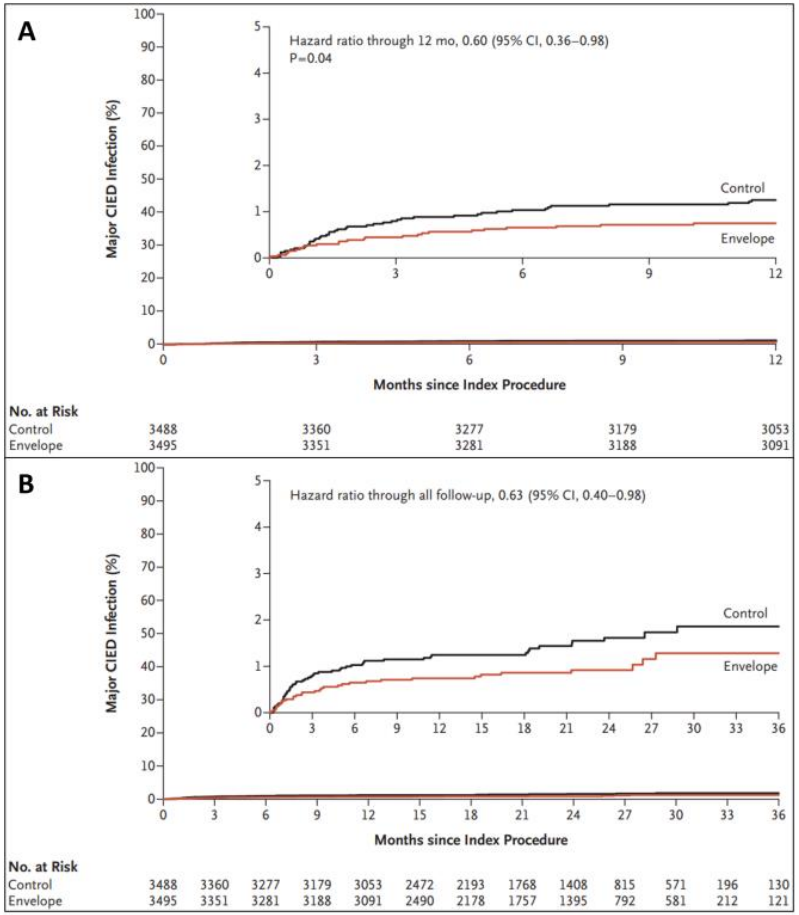


Fig. 4. Kaplan–Meier Curves for first major CIED infection. Results are for the overall randomized cohort through 12 months (A) and all follow-up (B), they were not adjusted for multiple comparisons. HR is derived from Cox regressions, with stratification according to device class, and indicates the relative (envelope *vs.* control) risk of CIED infection. Reprinted from the NEJM article, by Tarakji *et al*. [65]. Antibacterial Envelope to Prevent Cardiac Implantable Device Infection, The WRAP-IT trial, with permission from the NEJM. Abbreviations: CIED, cardiac implantable electronic devices; CI, confidence interval; No. at Risk, number at risk; HR, hazard ratio.

Conclusion

- Beaucoup de situations où les données sont ténues => attitude variable selon les centres, mais, dans tous les cas, prise en charge pluridisciplinaire, si possible par une équipe expérimentée.