Device Infection the Nightmare

How to deal with?

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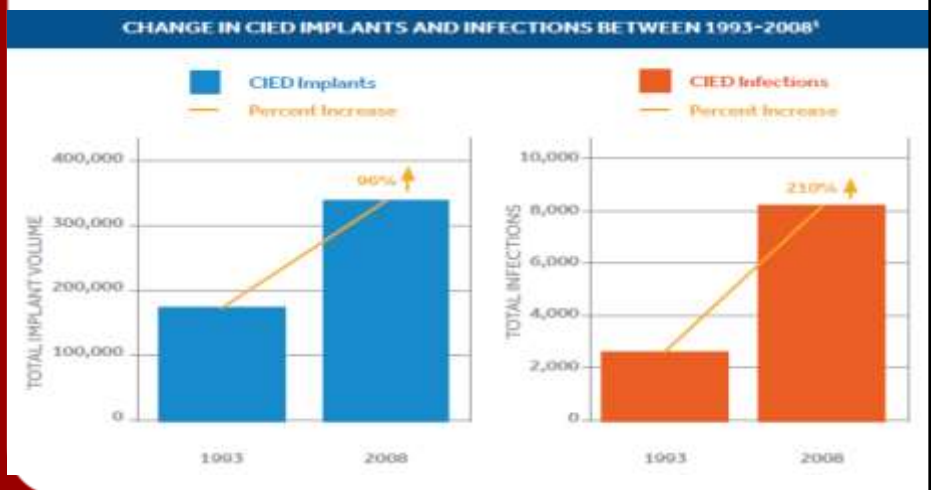
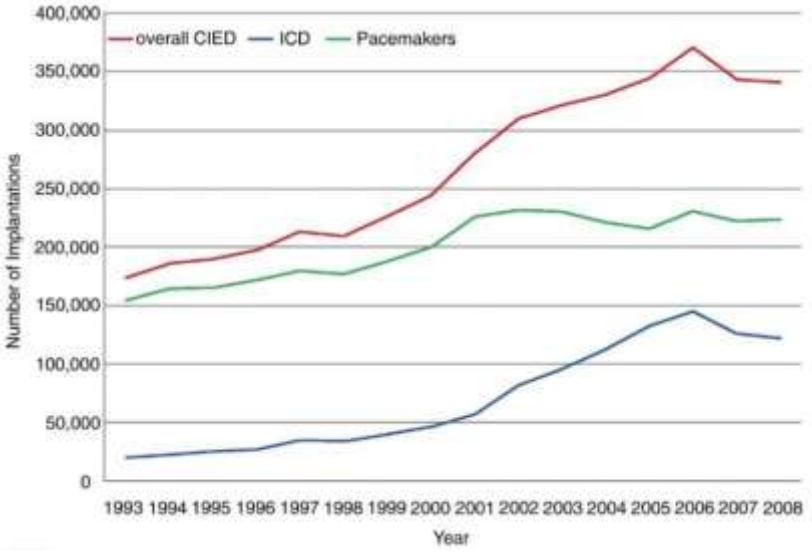
Incidence and mortality

- In the USA, the overall incidence of cardiac implantable electronic device (CIED) infections ranged from 0.5% to 2.2% of patients in 18 studies with follow-up or study periods between 6 weeks and 11 years



Poole JE et al. *Circulation* 2010;122(16):1553–61
Greenspon et al. *JACC* 2011; 58(10): 2011- 2016



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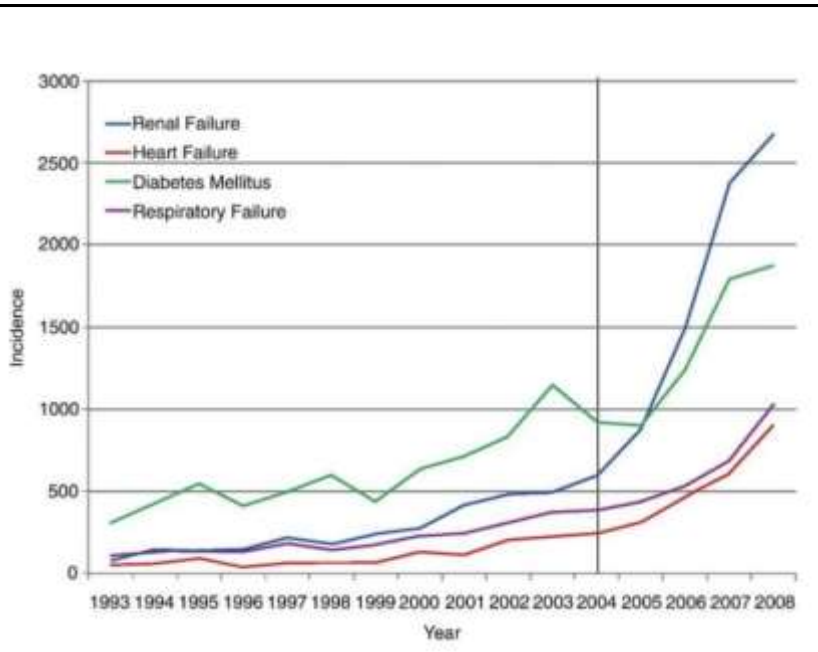

Greenspon et al. *JACC* 2011; 58(10): 2011- 2016.

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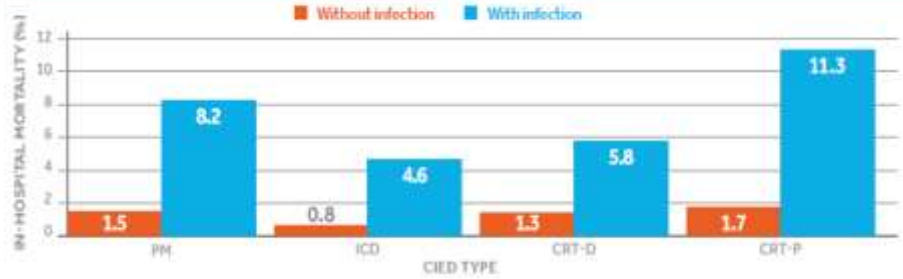
Format: Abstract

Arch Intern Med. 2011 Nov 14;171(20):1821-8. doi: 10.1001/archinternmed.2011.441. Epub 2011 Sep 12.

Mortality and cost associated with cardiovascular implantable electronic device infections.

Sohail MR[1], Henrikson CA, Braid-Forbes MJ, Forbes KF, Lerner DJ

RISK-ADJUSTED MORTALITY RATES[21]

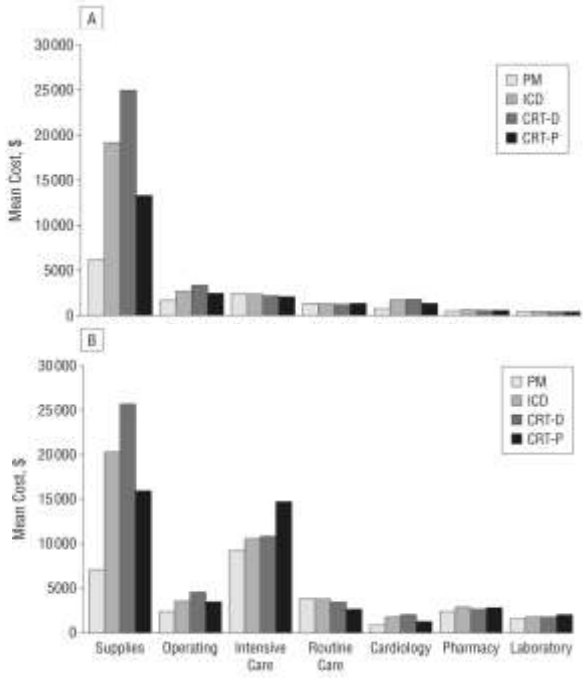


Conclusions Infection associated with CIED procedures resulted in substantial incremental admission mortality and long-term mortality that varied with the CIED type and occurred, in part, after discharge.

Sohail MR et al. Arch Intern Med. 2011;171(20):1821-1828

Cost for procedure of CIED without infection

Cost for procedure of CIED with infection



Sohail MR et al. Arch Intern Med. 2011;171(20):1821-1828

Risk factors for CIED infection

Europace (2015) 17, 767–777
doi:10.1093/europace/euv053

REVIEW
Pacing and resynchronization therapy

Risk factors for cardiac implantable electronic device infection: a systematic review and meta-analysis

Konstantinos A. Polyzos[1,2], Athanasios A. Konstantelias[1], and Matthew E. Falagas[1,3,4]*

- The aim of this study was to systematically summarize the literature on risk factors for infection after CIED implantation
- Sixty studies (21 prospective, 9 case–control, and 30 retrospective cohort studies) met the inclusion criteria.
- The average device infection rate was 1–1.3%.

Polyzos KA et al. *Europace* 2015 May;17(5):767-77.

Patient related risk factors

- Male gender
- Younger age
- DM
- Chronic Kidney Disease
- Renal Failure
- Haemodialysis
- COPD
- Congestive Heart Failure
- Chronic skin disease
- Anticoagulation
- Corticosteroid treatment
- Fever in 24 hrs pre-implantation
- Early re-intervention (<1 year)
- Number of prior procedures
- Low operator experience

Procedure related risk factors

- Lack of antimicrobial prophylaxis
- Longer procedure duration
- Pocket haematoma
- More complex CIED
- Re-intervention for lead dislodgement
- Temporary pacing
- Device replacement
- Prior CIED infection
- Early infection

Polyzos KA et al. *Europace* 2015 May;17(5):767-77.

Clinical presentation of CIED infection

- Early post-implantation inflammation
  - Erythema affecting the box implantation incision site
  - Without purulent exudate, dehiscence, fluctuance or systemic signs of infection
  - occurring within 30 days of implantation.
  - Includes a small, localised area (<1 cm) of erythema and/or purulence associated with a suture ('stitch abscess')


Harrison JL et al. *Heart* 2015 Feb;101(4):250-2

- Uncomplicated generator pocket infection
  - Any one of:
    1. Spreading cellulitis affecting the generator site
    2. Incision site purulent exudate (excluding simple stitch abscess)
    3. Wound dehiscence
    4. Erosion through skin with exposure of the generator or leads
    5. Fluctuance (abscess) or fistula formation,
       AND no systemic symptoms or signs of infection
       AND negative blood cultures




Harrison JL et al. *Heart* 2015 Feb;101(4):250-2

- Complicated generator pocket infection
  - As for uncomplicated generator pocket infection but with any one of:
    1. Evidence of lead or endocardial involvement
    2. Systemic signs or symptoms of infection
    3. Positive blood cultures

Harrison JL et al. *Heart* 2015 Feb;101(4):250-2

- CIED-lead infection (CIED-LI)
  - Symptoms and signs of systemic infection without signs of generator pocket infection, but with:
  - Definite CIED-LI—either:
    1. Echocardiography consistent with vegetation(s) attached to lead(s) and major modified Duke microbiological criteria or
    2. Culture, histology or molecular evidence of infection on explanted lead
  - Possible CIED-LI—either:
    1. Echocardiography consistent with vegetation(s) attached to lead(s) but no major modified Duke microbiological criteria or
    2. Major modified Duke microbiological criteria but no echocardiographic evidence of lead vegetation(s)

Harrison JL et al. *Heart* 2015 Feb;101(4):250-2

- CIED-associated infective endocarditis (CIED-IE)
  - All of:
    1. CIED in situ
    2. Modified Duke criteria for definite infective endocarditis
    3. Echocardiographic evidence of valve involvement

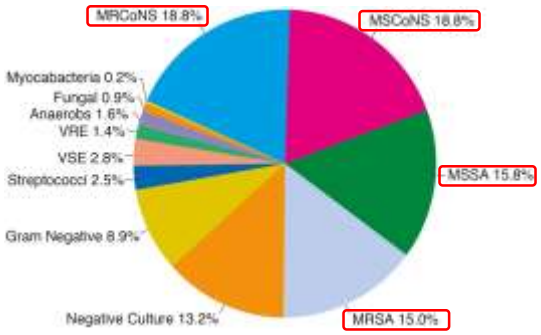
MODIFIED DUKE CRITERIA
MAJOR CRITERIA (2)
BLOOD CULTURE POSITIVE FOR IE
EVIDENCE OF ENDOCARDIAL INVOLVEMENT ON ECHO
MINOR CRITERIA (2)
PREDISPOSING HEART CONDITION OR IVDU
FEVER, TEMP >38
VASCULAR PHENOMENON (MAJOR PULM EMBOLI, SEPTIC INFARCTS, JANEWAY'S LESIONS
IMMUNOLOGIC PHENOMENA
MICROBIOLOGIC EVIDENCE (+VE BLOOD CULTURE BUT DOES NOT MEET MAJOR CRITERION

Definite CIED-IE if,
- Two major, or
- One major and three minor or,
- Five minor

Harrison JL et al. *Heart* 2015 Feb;101(4):250-2

Microbiology

- Pathogens were identified in the vast majority of patients (86.8%)
- Staphylococcal species remained the most common pathogens in CIED infections (68.4%)



MRSA = methicillin-resistant *Staphylococcus aureus*; MSSA = methicillin-sensitive *Staphylococcus aureus*; MRCoNS = methicillin-resistant coagulase-negative staphylococcus; MSCoNS = methicillin-sensitive coagulase-negative *Staphylococcus*; VRE = vancomycin-resistant *Enterococcus* species; VSE = vancomycin-sensitive *Enterococcus* species.

Hussein AA et al. *J Am Coll Cardiol EP* 2016;2:498–505

Identifying the pathogens

- Source
  1. lead material cultures (63.9%),
  2. Blood cultures (54.5%),
  3. pocket tissue cultures (52.9%),
  4. pocket swab cultures (44.2%).
  5. No growth --remaining 13.2%

Hussein AA et al. *J Am Coll Cardiol EP* 2016;2:498–505

When should blood cultures be taken?

- Blood cultures should be taken prior starting antimicrobial therapy.
- On clinical suspicion of ICED infection:

  Chronic or subacute presentation

  3 sets of aseptically collected, optimally filled blood taken from peripheral sites with ≥6 h between them

  Severe sepsis or septic shock at the time of presentation

  2 sets of optimally filled blood cultures should taken from peripheral sites with 1 h between them
- Blood cultures should be taken from different peripheral sites
- Blood cultures should be taken 48–72 h after removal of an infected CIED.
- Apply meticulous aseptic technique when taking blood cultures to reduce the risk of contamination with skin commensals

Harrison JL et al. *Heart* 2015 Feb;101(4):250-2

Management of CIED infection

J Antimicrob Chemother 2015; 70: 325 - 359
doi:10.1093/jac/dku383 Advance Access publication 29 October 2014

Journal of Antimicrobial Chemotherapy

Guidelines for the diagnosis, prevention and management of implantable cardiac electronic device infection. Report of a joint Working Party project on behalf of the British Society for Antimicrobial Chemotherapy (BSAC, host organization), British Heart Rhythm Society (BHRS), British Cardiovascular Society (BCS), British Heart Valve Society (BHVS) and British Society for Echocardiography (BSE)

Jonathan A. T. Sandoe[1]*, Gavin Barlow[2], John B. Chambers[3], Michael Gammage[4], Achyut Guleri[5], Philip Howard[1], Ewan Olson[6], John D. Perry[7], Bernard D. Prendergast[8], Michael J. Spry[9], Richard P. Steeds[10], Muzahir H. Tayebjee[1] and Richard Watkin[11]

Sandoe JAT et al. J Antimicrob Chemother 2015; 70: 325–359

Principles of antimicrobial therapy

- The biofilm (the growth of bacteria on solid surfaces) nature of CIED infection makes eradication of infection very unlikely without removal of the device
- **In early post-implantation inflammation**, should be determined on a case-by-case basis—either using a short course of an oral antimicrobial appropriate for soft tissue infection or monitoring closely.
- **In generator pocket infection, CIED-LI, CIED-IE or culture negative CIED infection,** empirical IV antimicrobial therapy should be started until the results of the culture.
- Anti-Gram-positive (Vancomycin or Daptomycin) &anti-Gram-negative agents (Aminoglycosides e.g. gentamicin or Meropenem) should be combined for Empirical IV antimicrobial therapy

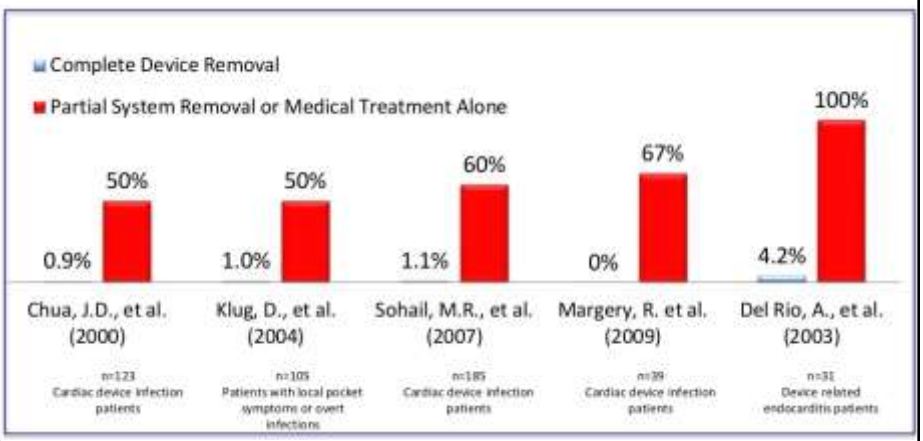
Sandoe JAT et al. J Antimicrob Chemother 2015; 70: 325–359

Diagnosis/scenario	Antimicrobial	Dose/route[a]
1. Early post-implantation inflammation	flucloxacillin	0.5–1 g q6h po
2. Early post-implantation inflammation in penicillin-allergic or MRSA-colonized patient	doxycycline OR linezolid OR clindamycin	100 mg q12h po 600 mg q12h po 450 mg q6h po
3. Uncomplicated generator pocket infection	vancomycin OR daptomycin OR teicoplanin	1 g q12h[b] iv 4 mg/kg q24h iv 6 mg/kg to a maximum of 1 g given at 0, 12 and 24 h and then q24h[183]
4. ICED-LI or ICED-IE or complicated generator pocket infection pending blood cultures, e.g. in severe sepsis	vancomycin AND meropenem OR daptomycin AND meropenem	1 g q12h[b] iv 1 g q8h iv 8–10 mg/kg q24h iv 1 g q8h iv
5. ICED-LI or ICED-IE or generator pocket infection with negative blood cultures	vancomycin AND gentamicin[c] OR daptomycin AND gentamicin[c]	1 g q12h[b] iv 1 mg/kg q12h iv 8–10 mg/kg q24h iv 1 mg/kg q12h iv

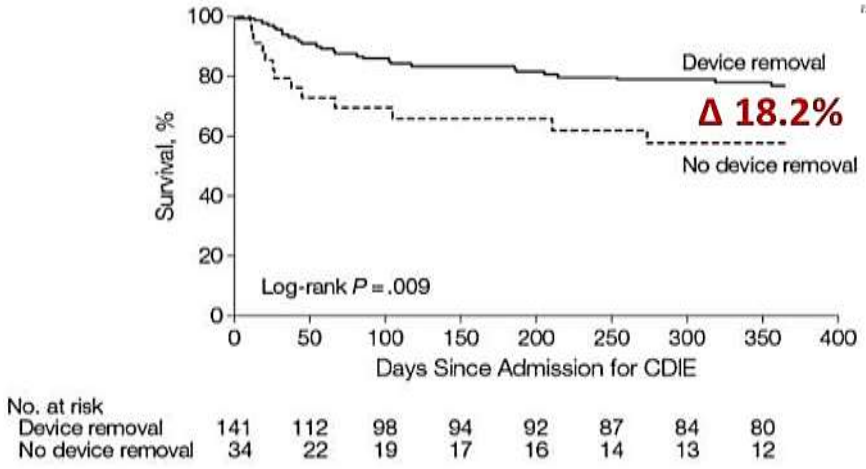
Sandoe JAT et al. J Antimicrob Chemother 2015; 70: 325–359

How should the device be managed?

- Infection relapse occurs in 50% to 100% of cases with partial removal or antibiotic treatment alone, compared to relapse of 0% to 4.2% with complete system removal



- Device removal during the index hospitalization was associated with improved 1-year survival.



Athan E et al. JAMA 2012;307(16):1727-1735

AHA Scientific Statement

Update on Cardiovascular Implantable Electronic Device Infections and Their Management

A Scientific Statement From the American Heart Association

Endorsed by the Heart Rhythm Society

Consensus Recommendation for complete hardware removal

Class IIa

- **Systemic**
  - Persistent occult gram-negative bacteremia

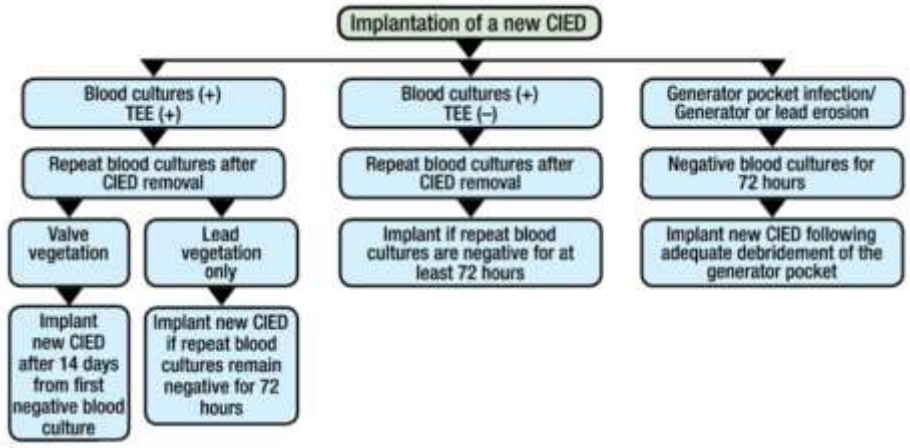
"**Complete removal of all hardware**, regardless of location, is the recommended treatment for patients with established CIED infection"
–*HRS Consensus Document*

Class I

- **Systemic**
  - Occult gram-positive bacteremia
- **Pocket**
  - Pocket abscess, device erosion, skin adherence, chronic draining sinus
- **Endocarditis**
  - Valvular endocarditis, lead endocarditis, sepsis with or without definitive lead involvement

Baddour LM et al. Circulation 2010;121:458-477

Consensus Recommendation for implantation of a new device in patients after removal of an infected CIED



Baddour LM et al. Circulation 2010;121:458-477

Prevention of CIED infection

Pre-implantation

- CIED treatment should be prescribe carefully with a balanced assessment of risks and benefits.
- In high risk group, good pre-operative preparation is warranted including blood sugar level, serum creatinine and acute phase reactants.
- Fever <24 h before implant is associated with higher infection risk. Therefore diagnose and treat ongoing infections before CIED implant.
- Wherever possible, temporary transvenous pacing should be avoided prior to implanting a permanent ICED.
- Central venous catheters and chest tubes should be removed in timely fashion before CIED implantation. Preferably >24 hs .
- Chronic skin conditions are associated with a higher infection risk and should be appropriately treated before implantation

Peri-operatively

- General recommendations for reducing surgical site infection should be applied such as skin preparation … etc.
- Peri-operative systemic antibiotic prophylaxis prior to CIED procedures is mandatory.
- Meticulous surgical technique to prevent tissue damage, assure haemostasis, and ensure secure subcutaneous cover for the device should be standard.
- During device replacement procedures, some authors support capsulectomy. No controlled studies have tested this strategy.
- In anti-coagulated patients, continued warfarin use is preferred to heparin bridging because of a lower risk of haematoma.
- A conservative approach when managing haematoma is often advisable, unless particularly tense or painful. Even large haematomas gradually soften and resorb over a few weeks

Take home messages

- CIED infection rate is increasing with high incidence of mortality .
- Risk factors for CIED infection are related to patient and/or the procedure itself.
- Maintain a high suspicion for early recognition and management of CIED infection.
- Staphylococcal species is the most common pathogens in CIED infections .
- Empirical antimicrobial using anti-gram-negative and anti-gram positive agents.
- Complete removal of all hardware in CIED infection.
- Blood culture should be negative before implantation of a new device in patients after removal of an infected CIED.
- The key challenge in the management of CIED infection is prevention.

Aim for any case of cardiology