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UNIQUE EDUCATIONAL EXPERIENCE IN YOUR REGION
Cardiac Implantable Electronic Devices

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Case Study 1

• A 75 year old lady with hypertension and diabetes who underwent a dual chamber pacemaker implant for sinus node disease sends in a remote transmission of her pacemaker interrogation. She is asymptomatic. Relevant traces are shown:
Based in the information provided, what is most important next step?

1. Begin flecainide 100 mg bid
2. Start amiodarone
3. **Begin oral anticoagulation**
4. No immediate intervention is necessary
Device-detected AF

- Confirm true AF and not spurious detections of far field electrograms or noise
- No clear AF burden that defines a risk
- CHA$_2$DS$_2$-VASc score is the probably the best determinant of stroke risk

Chen-Scarabelli C. et al. JACC 2015; 65: 281
Case Study 2

• A 55 year old male with prior inferior myocardial infarction and depressed LV function (LVEF 30%) had a dual chamber ICD implant for primary prevention 5 years ago. Following strenuous exercise, he received multiple ICD shocks (he counts 10). He felt slightly flushed before the shocks.

• In the emergency room, he is placed on telemetry that shows sinus rhythm with heart rate of 90bpm. An ECG shows sinus rhythm with no evidence for acute MI. Troponins are mildly elevated.
Which of the following is most important next step in his management?

1. Begin lidocaine infusion
2. Interrogation of the ICD with a programmer
3. Intravenous esmolol
4. Begin oral amiodarone
Markers
Detect in VF zone

Far Field ECG

Atrial Egm

Ventricular Egm

Contd...

40 J Shock

ATP
Causes of Multiple ICD shocks

- Recurrent VT/VF
- Atrial fibrillation or tachycardia
- ICD lead malfunction with lead conductor coil fracture or insulation break
- Abnormal sensing of intrinsic T waves
- Sinus tachycardia with low ICD rate cut off
Management of Electrical Storm

• Sedation
• Determine rhythm and if inappropriate, apply magnet over device to deactivate
• If VT/VF:
  • Antiarrhythmic including beta blockers
  • Correct electrolytes
  • Rule out myocardial ischemia
  • May need general anesthesia
  • Consider catheter ablation if VT storm or PVC mediated VF
Case Study 3

A 70 year old male with prior CABG and ischemic CM (LVEF 30%) had a single chamber ICD implant for primary prevention 8 years ago. He received one shock two years after implant for rapid VT that was successfully terminated. He was commenced on sotalol with no further shocks. Two weeks ago, he had a generator replacement for battery depletion of the ICD. He returns to the clinic today for wound check:
Wound dehiscence with exposure of Lead
Case Study 1 – contd...

Which of the following should be your recommendation at this stage?

1. Wound culture, begin antibiotics, dress the wound and continue to observe
2. Removal of generator, cap the lead and re-implant new system on the left
3. Reopen the wound, debride, wash with antibiotics and re-suture the wound
4. Remove the ICD generator and lead and re-implant on the left
CIED (Cardiac Implantable Electronic Devices) Implants and Infection between 1996 and 2003 Normalized to 1996

Voigt A. et al. J Am Coll Cardiol 2006; 48: 590
Incidence of CIED infections per 1000 device years of follow up:

Total: 1.9 (95% CI, 1.1-3.1)

Pocket infection: 1.37 (CI, 0.62-3.05)

Blood Stream Infection: 1.14 (CI, 0.47-2.74)
Why Increasing Rate of Infections?

- Use of CIEDs in older patients
- Multiple comorbidities eg. Dialysis
- Complex implant procedures (CRT devices)
- Expanding implant centers with smaller volumes
Risk Factors for CIED Infections

Host Related:

• Renal failure (Odds Ratio: 4.8)
• Congestive heart failure
• Diabetes Mellitus
• Anticoagulation therapy with warfarin
• Long term corticosteroid use (OR: 13.9)
• Malignancy
• Fever within 24 hours prior to procedure (OR: 5.83)
• Male sex and younger age at implant

Risk Factors for CIED Infections

Device Related:

ICDs > pacemakers
Greater complexity (? CRT systems)
Abdominal implants for ICD
Prior device revisions

Procedural:

Non use of antibiotic prophylaxis
Operator experience (Lowest rate of implants versus highest rate OR: 2.47)
Post op hematoma
Early re-intervention (OR: 15)
Use of temporary pacing pre-implant (OR: 2.46)

Uslan D, et al. REPLACE Registry Analysis. PACE 2012; 35:81
Microbiology of CIED Infections

Pathology of CIED Infections

Adherence of bacterial organisms (S. aureus, epidermidis) to PVC, polyethylene, polyurethane, silicon etc. results in a biofilm

Biofilm defined as a surface associated community of 1 or more microbial community attached to surface and encased in extracellular matrix

Resistant to antibiotic and host defenses

Electron Micrograph of a biofilm due to coagulase negative staph. (Mayo Clinic, MN)
## Outcome of CIED Infections

<table>
<thead>
<tr>
<th>Publication</th>
<th>n</th>
<th>Patients</th>
<th>Treatment</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>del Rio, et al 2003</td>
<td>31</td>
<td>PPM or ICD endocarditis</td>
<td>CT – 7</td>
<td>100% relapse, 1 death</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Removal 24</td>
<td>1 relapse; 3 deaths</td>
</tr>
<tr>
<td>Rundstrom et al 2004</td>
<td>38</td>
<td>PPM Endocarditis</td>
<td>CT -16</td>
<td>19% infection free</td>
</tr>
<tr>
<td></td>
<td>(44)</td>
<td></td>
<td>Removal 28</td>
<td>64% infection free</td>
</tr>
<tr>
<td>Sohali et al 2007</td>
<td>189</td>
<td>CIED infection</td>
<td>3 removed after CT</td>
<td>3.7% in-hospital mortality</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Removal 183</td>
<td>95% infection free at 6 mo.</td>
</tr>
<tr>
<td>Sohali et al 2008</td>
<td>44</td>
<td>PPM or ICD endocarditis</td>
<td>Removal in 43</td>
<td>14% in-hospital mortality</td>
</tr>
</tbody>
</table>

CT = conservative therapy, CIED = cardiac implantable electronic device
Prevention of CIED Infection: At Implantation

• Preop control of blood sugar in diabetics
• Pre-operative antibiotics
  Cefazolin 1-2 g 1 hour prior or vancomycin 90-120 min
• Preoperative antiseptic skin preparation
  Chlorhexidine-alcohol superior to povidone iodine*
• Absolute sterile technique; OR environment with required airflow
• Consider retro-pectoral pocket in thin or malnourished patients

Prevention of Infection in CIED Post Implant

Hematoma
- Avoid needle aspiration
- Reopen to drain only if painful or increased tension on skin

Post Operative Antibiotics
- No evidence to support post op antibiotics
- Not recommended to prevent C-Diff, adverse events and drug resistance

No indication for antibiotic prophylaxis for invasive procedure in CIED patients
81 y.o male with CAD and ICD with Failure to Thrive and Low Grade Fevers over 3 months:
(A) Two year Kaplan-Meier mortality rates in the implantable cardioverter-defibrillator (ICD) and conventional (Conv.) therapy groups of the MADIT II study based on the number of risk factors and for patients with severe kidney disease, considered very high risk (VHR); and (B) the corresponding 2 year mortality rate reduction with an ICD, by risk score and in VHR patients. *p<0.05 for the comparison between the conventional therapy and ICD groups.

- **Figure A**: 2-year mortality in conventional and ICD groups by risk group category.
  - % Patients at risk: 29% for 0 risk factors, 28% for 1 risk factor, 24% for 2 risk factors, 14% for 3 risk factors, 5% for VHR.
  - ICD and Conv. bars indicate mortality rates.

- **Figure B**: % 2-year mortality reduction with ICD by risk group.
  - Number of risk factors: 0, 1, 2, 3+.
  - VHR: Significant reduction in mortality rate.
Remote monitoring of implanted devices are increasingly used for diagnosis. In high risk patients, detection of AF should be a consideration for anticoagulation.

Management of Electrical storm with recurrent ICD shocks should include:
- Sedation
- Arrhythmia diagnosis
- Deactivation of ICD (magnet) if inappropriate shocks

CIED Infections:
- Prevention is critical
- Removal of entire infected system is required in most cases