Update on Cardiac Implanted Electronic Devices (CIEDs)

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Types of CIEDs

• Pacemakers
• ICD
• Biventricular (biV) or Cardiac Resynchronization Therapy (CRT)
• Subcutaneous ICD (S-ICD)
• Implanted loop recorders
• Implanted PA pressure monitor

CIED components

Types of Pacemaker and ICDs

Pacemaker Components

- Connector
- Circuitry
- Battery

Pacemaker Types

- Single Chamber
- Dual Chamber
- Triple Chamber

Pacing systems are generally described by the number of chambers paced by the device.
ICD and risk of sudden death

<table>
<thead>
<tr>
<th>Clinical Factor</th>
<th>Risk Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low EF</td>
<td>~ 45% of all SCA victims have LVEF &lt; 30%</td>
</tr>
<tr>
<td>Heart Failure HF</td>
<td>25% overall death in 2.5 years; 50% die of SCA</td>
</tr>
<tr>
<td>Prior MI and HF</td>
<td>SCD occurs at 4x the rate of the general population</td>
</tr>
<tr>
<td>Prior VT or VF</td>
<td>Risk of arrhythmic death is 18% after 3yrs of prior event</td>
</tr>
</tbody>
</table>


ICD and Cardiac Resynchronized Therapy (CRT) or “biV”

- QRS width of > 120 ms as a marker of dyssynchrony.
- Dyssynchrony can result in
  - cardiac remodeling,
  - LV dilation
  - worsening systolic and diastolic dysfunction
  - progressive HF symptoms
- Current guidelines for CRT include
  - LVEF 50% or less
  - QRS > 120
  - NYHA class II or III despite OMT

ICD and CRT

- ICD after optimization of GDMT (goal directed medical therapy) for at least 3 months for
  - LVEF of 35% or less
  - more than 40 days after MI
- CRT only after above achieved
  - QRS width of > 120 ms as a marker of dyssynchrony.

Biventricular devices (CRT)

Goal is close to 100% biv pacing to avoid RV pacing

Cardiac Resynchronization (biventricular)

- Ventricular Dyssynchrony
- Cardiac Resynchronization

CRT with Atrial Fibrillation

- 20% have AFib
- Difficult to biV pace in AFib with rapid rates
- Meds for rate control
- Reprogramming
- Ablation etc
NBG Code – The Usual Pacing Modes

<table>
<thead>
<tr>
<th>Chamber(s) Paced</th>
<th>Chamber(s) Sensed</th>
<th>Response to Sensing</th>
<th>Rate Modulation</th>
<th>Multiple Pacing</th>
</tr>
</thead>
<tbody>
<tr>
<td>O = None</td>
<td>O = None</td>
<td>O = None</td>
<td>O = None</td>
<td>O = None</td>
</tr>
<tr>
<td>A = Atrium</td>
<td>A = Atrium</td>
<td>T = Triggered</td>
<td>R = Rate mod</td>
<td>A = Atrium</td>
</tr>
<tr>
<td>V = Ventricle</td>
<td>V = Ventricle</td>
<td>I = Inhibited</td>
<td></td>
<td>V = Ventricle</td>
</tr>
<tr>
<td>D = Dual (A + V)</td>
<td>D = Dual (A + V)</td>
<td>D = Dual (T + I)</td>
<td></td>
<td>D = Dual (A + V)</td>
</tr>
<tr>
<td>S = Single (A or V)</td>
<td>S = Single (A or V)</td>
<td>S = Single (A or V)</td>
<td></td>
<td>S = Single (A or V)</td>
</tr>
</tbody>
</table>

Examples of pacing modes which are typically programmed:
- DOOR
- VVIR
- AAIR
- VVR

Implant Complications

- 3.0% overall in hospital adverse event
- Higher in biV devices (4.1%)
- Lower in dual chamber (2.9%) and single chamber (1.9%)
- Pneumothorax
- Hematoma
- Infections
- Upper extremity DVT
- Pericardial effusion

Pneumothorax

- CXR to confirm lead location
- Evaluate for pneumothorax

Hematoma

- 2-5%
- First 24-72 hours postop
- Early intervention critical
- Local pressure, pressure dressing.
- Early reoperation increase infection by 15-fold
- Less anticoagulation bridging
- Harbor for bacteria

Infection

- 1.7%
- Most likely 45 days post implant
- Higher incidence in
  - ESRD
  - previous infection
  - preop fever
  - longer procedure
  - postop hematomata
  - return for lead dislodgement
  - Chlorhexidine “no rinse”
  - Antibiotics preop
  - Ancef, Vancomycin if PCN allergic
  - 60 minutes of incision

Lead extractions

- Infections
- Lead failure/recalls
  - CVOR with immediate surgical backup in case of SVC tear, tamponade
  - CCU postop
What the heck??

- CIEDs now programmed to reduce RV pacing
  - RV pacing more than 40% increase HF and admissions
  - For every 1% increase in unnecessary RV pacing, increase risk of AFib 1%
  - CIEDs now programmed to reduce shocks
    - Longer detection intervals
    - ATP (antitachycardia pacing)

What's with the magnet?

- Suspends ICD detection and therapy
  - Surgery
  - Inappropriate shocks with lead fracture
  - Inappropriate shock with AFib

- Changes pacemakers to asynchronous/fixed rate pacing
- Does NOT affect pacing in ICD

Other CIEDS

- Implanted Holter monitor
- Implanted Swan

Morphology Discriminators

- EGM morphologies during normal sinus rhythm and VT vary significantly
- These differences can be used to distinguish an arrhythmia originating in the ventricles from one originating in the atrium (SVTs)

Normal Sinus Rhythm  Ventricular Tachycardia
Cryptogenic Stroke

Types of Ischemic Stroke:
- Atherothrombotic (25-30%)
- Cardioembolic (20%)
- Other/Uncommon (5-10%)
- Cryptogenic (25-40%)
- Unknown cause

Detection of AFib in cryptogenic stroke

- 30% of ischemic strokes are of unknown mechanism
- AF = anticoagulation instead of antiplatelet therapy
- AF may be paroxysmal and silent
- Detection with routine methods difficult

Crystal AF - cryptogenic stroke and AFib

- Local anesthetic and no leads or fluoroscopy
- 15 minute procedure
- MRI conditional
- 3 year device longevity

Crystal AF Conclusions

- AF detection of 90% vs 3% at 36 months
- AF duration > 6 min > 94% of patients
- 89% of patients prescribed OAC
- 75% of first AF episodes were asymptomatic

Cardiomems PA pressure monitor

Remote monitoring for home

- Less office checks
- Alert events - shocks, VT, AFib not on AC, lead malfunction
- Higher survival rate due to early notification
- 75% reduction in time to notification
- Reduced ED visits
- Decrease unscheduled office visits
- Inappropriate shock reduction
- New cell phone apps
Inpatient procedures with PM and ICD

- MRI/MRA/MRCP
- Surgery
- EGD/Colonoscopy/ERCP

HRS/ASA Consensus on Periop Management of CIEDS


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HRS/ASA general principles

- Inactivation of ICD detection is not a universal requirement
- Asynchronous pacing in pacemaker-dependent patients is not a universal requirement
- Individual the plan to the situation
- Team approach

Surgical location

Grounding pad

Handoffs

- Errors in handoffs regarding reactivation
- Errors in monitoring during transport and holding
- Miscommunication during handoffs involve 80% of preventable events
Handoffs for One Surgical Patient

- Pre-Admission Testing RN
- Cardiology Device rep
- Same Day Surgery RN
- Surgery Charge RN
- Anesthesiologist Device rep
- Recovery Room RN
- Cardiology Device rep
- Same Day Surgery RN or Hospital RN

ICD-ON Protocol

<table>
<thead>
<tr>
<th>Abnormalities</th>
<th>Treatment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atrial Fibrillation</td>
<td>No treatment</td>
</tr>
<tr>
<td>Atrial Flutter</td>
<td>No treatment</td>
</tr>
<tr>
<td>Ventricular Tachycardia</td>
<td>No treatment</td>
</tr>
<tr>
<td>Premature Ventricular Beats</td>
<td>No treatment</td>
</tr>
<tr>
<td>Ventricular Tachycardia</td>
<td>No treatment</td>
</tr>
<tr>
<td>Atrial Tachycardia</td>
<td>No treatment</td>
</tr>
<tr>
<td>Atrial Natriuretic Fibrillation</td>
<td>No treatment</td>
</tr>
</tbody>
</table>

Final thoughts on periop management

- EMI is rare, so reprogramming life saving therapies OFF should be rare ....

End of life considerations – 2010 HRS Consensus statement on end of life

- Discussions about deactivation should begin before and after implant
- Patient has the right to refuse or request withdrawal of device therapy
- Deactivation is not physician assisted suicide or euthanasia
- Clinicians should promote advanced directives
- Involve Palliative Care

Documentation on deactivation

- Confirmation that patient/family have requested deactivation
- Capable of decision making (patient or surrogate)
- Alternative therapies have been discussed
- Consequences of deactivation have been discussed
- Specific reprogramming done
- Family notification

Practically speaking

- We often forget
- Patient/family decisions vary
- Trying to avoid painful shock
- It’s ok
- Magnet will suspend therapy if needed urgently
- End of life acidosis, hypoxemia will lead to loss of PM capture
- Pacing spikes will continue
What’s next?

- Using CIEDs in disease management – stroke, CHF
- Mobile technology
- "Download app from iTunes"
- Leadless devices

Rhythm strips

- If time allows

Undersensing . . . Overpacing

- Pacemaker does not "see" the intrinsic beat, and therefore does not respond appropriately.

Paced Fusion Beat

The artificial pacemaker and the patient’s own cardiac rhythm occur simultaneously producing a combination of a paced beat and a normal beat.

Atrial Flutter

Atrial Rate: commonly 250-350bpm
Ventricular Rate will vary with conduction
P-P Regularity: Regular
R-R Regularity: Usually regular, but may be variable
P wave: "Saw-tooth" p-wave morphology
P-QRS Ratio: Varies, can be 1:1, 2:1, 3:1, etc.
PR Interval: Varies
QRS Width: Normal
VF to asystole – ICDs all have back up pacing as low at 40 bpm

When to shock?
- VT may be below programmed detection rate
- Position paddles away from left sided ICD

Thank you

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Anytime....