What’s New/Improved/Exciting in EP

Agenda

1. Review Atrial fibrillation
2. Pulmonary vein isolation ablation (PVI)
3. Atrial Fibrillation and the Left Atrial appendage
   1. New Oral Anticoagulation Agents
   2. Closure devices
4. VT ablation
5. SubQ ICD
6. Obstructive Sleep Apnea
What is the US cost to treat Afib for one year?
- $500 million
- $1.5 million
- $2.6 billion

When compared to other patients, people with Afib are admitted to the hospital:
- Just as much as the others
- Double the rate
- Triple the rate

$26 billion: AFib treatment costs for one year in the United States
When compared to other patients, people with AFib are admitted to the hospital at double the rate.
Afib, So What?

- Symptoms
- Rate control failures
- Developed cardiomyopathy
- Heart failure
- Activity intolerance
- CVA/TIA
- QOL
AF Begets AF

- **Electrophysiologic changes**
  - Shortening of atrial refractory periods
  - Loss of normal adaptation of atrial refractoriness to heart rate

- **Contractile changes**
  - Reduced atrial contractility

- **Structural changes**
  - Left atrium and left atrial appendage enlargement
  - Decrease in cardiac output
  - Histologic changes

- **Prothrombotic changes (increased propensity for clot formation)**
  - Atrial stasis
  - Increases prothrombotic factors
  - Increases in inflammatory mediators

http://www.disability-claims.net/images/atrial-fibrillation-lg.jpg
Who needs anticoagulation?

- Any CHA2DS2VASc > 2
- Medication selection?
  - Age
  - Comorbid conditions
  - Renal status
  - Bleed risk
  - Finance
  - Patient desire
  - Mechanical valves
<table>
<thead>
<tr>
<th>Risk Factors</th>
<th>Score</th>
<th>CHA2DS2-VASc score</th>
<th>Stroke Risk per Year</th>
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<tr>
<td>Congestive Heart Failure/LV dysfunction</td>
<td>1</td>
<td>0</td>
<td>0.7%</td>
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<tr>
<td>Hypertension</td>
<td>1</td>
<td>1</td>
<td>1.3%</td>
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<tr>
<td>Age ≥ 75 years</td>
<td>2</td>
<td>2</td>
<td>2.2%</td>
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<tr>
<td>Diabetes Mellitus</td>
<td>1</td>
<td>4</td>
<td>4.0%</td>
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<tr>
<td>Stroke/TIA/Thromboembolism</td>
<td>2</td>
<td>5</td>
<td>6.7%</td>
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<tr>
<td>Vascular Disease</td>
<td>1</td>
<td>6</td>
<td>9.8%</td>
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<tr>
<td>Age 65 – 74</td>
<td>1</td>
<td>7</td>
<td>9.6%</td>
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<tr>
<td>Female</td>
<td>1</td>
<td>8</td>
<td>6.7%</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>9</strong></td>
<td><strong>9</strong></td>
<td><strong>15.2%</strong></td>
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<table>
<thead>
<tr>
<th>Pradaxa</th>
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<th>Eliquis</th>
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<tbody>
<tr>
<td>Dabigatran</td>
<td>Rivaroxaban</td>
<td>Apixaban</td>
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<tr>
<td>Target</td>
<td>IIa (thrombin)</td>
<td>Xa</td>
</tr>
<tr>
<td>Application</td>
<td>Oral</td>
<td>Oral</td>
</tr>
<tr>
<td>Hours to Cmax</td>
<td>1.25-3</td>
<td>2-4</td>
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<td>Pro-drug</td>
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<td>No</td>
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<td>Food interactions</td>
<td>No</td>
<td>No</td>
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<tr>
<td>Bioavailability (%)</td>
<td>65</td>
<td>80-100</td>
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<tr>
<td>Drug interactions</td>
<td>P gp inhibitors or inductors</td>
<td>CYP3A4 inhibitors or inductors</td>
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<tr>
<td>Median half-life (hours)</td>
<td>12-14</td>
<td>7-11 (11-13 in the elderly)</td>
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<tr>
<td>Renal clearance (%)</td>
<td>85</td>
<td>33</td>
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<tr>
<td>Dose regimen</td>
<td>b.i.d.</td>
<td>q.d.</td>
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</table>

**Reversal agent**
How is Afib cured?
- Flecaïnide - suppressive therapy
- Amiodarone - suppressive therapy
- Beta blockers - suppressive therapy
- Pulmonary vein isolation ablation - maybe!
The ‘Electrifying’ Pulmonary Vein Isolation Ablation

Pre-Proced u re

- Oral anticoagulation
  - Warfarin (preferred 3-4 weeks therapeutic)
  - Less time if paroxysmal AF
- Medication alterations
- Chest CT defines left atrial pulmonary vein anatomy
- TEE (if the left atrial appendage is not clearly seen in CT)
- May be in or out of Afib on the day of ablation: we know the targets
  - Post ablation atypical flutter is a different story
PVI Procedure

- Pre-procedure readiness/ out patient
- Electrophysiology Study: Mapping
- Intracoronary Ultrasound (ICE)
- Ablation
  - Cryoablation
  - Radio Frequency ablation
- Potential Risks
- Post Procedure
How thin is left atrial wall?

average thickness 1.89 ±0.48 mm, range 0.5-3.5 mm.


PVI PROCEDURE
Starts with Mapping
Left Atrial Activation Sequence Mapping 3D
Ablation applications

Right inferior Pulmonary vein

Right superior Pulmonary vein

Left superior Pulmonary vein

Left inferior Pulmonary vein

Ablation application

Mitral Annulus
ICE
Intracoronary Echo
PVI Risks

- Stroke/ischemic events
- Pericardial effusion - tamponade
- Bleeding
- Vascular/valvular injury
- Atrial perforation
- Atrial - esophageal fistula
- Hemidiaphragm paralysis
- Pneumo/hemothorax
- Death
- Sepsis/endocarditis
- Pulmonary vein stenosis
- General anesthesia

LA

ESO
What would YOU do?

Symptoms or complications guide decisions.

Success rates vary due to disease process, time in AF VS NSR, previous ablations, OSA, pulmonary pressures 50-85%

Left Atrial Appendage
Left Atrial Closure Devices

Insert device to occlude LAA to avoid thrombus formation, avoid anticoagulation, i.e. Watchman device example only

The WATCHMAN Device

- indicated to reduce the risk of thromboembolism from the left atrial appendage
  - March 2015
  - patients with non-valvular atrial fibrillation
  - are at increased risk for stroke and systemic embolism based on CHADS₂ or CHA₂DS₂-VASc scores
  - deemed by their physicians to be suitable for warfarin
  - and have an appropriate rationale to seek a non-pharmacologic alternative to warfarin, taking into account the safety and effectiveness of the device compared to warfarin
  - "We know that up to 40 percent of patients who are eligible for oral anticoagulation do not take it for numerous reasons", highlighting the need for additional treatment options.
- Negative TEE prior to implant, on warfarin

Potential Watchman Benefits

- PROTECT AND PREVAIL pivotal studies
  - Reducing thrombus from LAA
  - Ability to stop warfarin long term and reduction in risks when stopping warfarin
  - Only in patients without valvular atrial fibrillation
- PROTECT: 5 years, 707 patients, safety study.
  - Found to be effective as warfarin in reducing risk of stroke, CV death, peripheral thrombus
- PREVAIL: ongoing for 2 years now, 407 patients, looking at stroke, CV death and peripheral thrombus. Results NOT conclude that Watchman outcomes as good as warfarin.


Post Watchman Implant

- Discharged on warfarin and ASA
- After 45 days will repeat TEE to check seating of implant and document LAA closure
- After TEE, consideration for stopping warfarin in eligible patients
- If warfarin is stopped, will take Plavix + ASA (may change dose of ASA in some patients) for 6 months
- 12 month TEE to be sure LAA remains closed
- Risk in stopping these medications early
- Approximately 92% able to stop warfarin after 45 days
- Approximately 99% able to stop warfarin at one year
- Overall bleed rates similar
- Bleed risk higher in the first 6 months of Watchman recipients but lower beginning at 6 months post.
The Substrate Mapping and Ablation in Sinus Rhythm to Halt Ventricular Tachycardia (SMASH-VT) study was initiated to examine the hypothesis that prophylactic catheter ablation (ablation after defibrillator implantation to prevent the occurrence of future shocks) can safely decrease the likelihood of subsequent ICD therapy in patients with myocardial infarction who receive an ICD after surviving a life-threatening ventricular arrhythmic event.
VT in Ischemic CM

- Sustained VT occurs in 1-5% of patients with a history of MI
  - ~1% if patient receives appropriate reperfusion during index hospitalization
- Electrical substrate for VT develops in the first 2 weeks post MI and remains indefinitely
- Triggers for arrhythmias include surges in autonomic tone, ischemia, medications, & onset of HF
- The hallmark of long-term therapy is the implantable cardioverter-defibrillator (ICD)
- ICD is superior to antiarrhythmic drug therapy in patients with previously documented ventricular arrhythmias
  - Antiarrhythmics vs. Implantable Defibrillators Trial (AVID)
- ICDs provide treatment, but not arrhythmia prevention

Mechanism of scar-related VT

- MI or other insult (myocarditis, sarcoid, ARVC etc.) results in formation of "scar"
- Scar is a mosaic of viable, electrically conducting myocyte strands interspersed within and surrounding areas of non-conducting tissue
- Strands of conducting tissue surrounded by areas of dense, unexcitable scar create "isthmuses"
- Isthmus typically demonstrate "slow conduction" which creates a substrate for reentry
- Location of scar varies depending upon underlying disease process
  - ICM -> area of infarct(s)
  - NICM -> septal or basal (near annulus)
Mechanism of VT in Structural Heart Disease
• Automaticity from damaged Purkinje fibers has been suggested as a mechanism for some catecholamine-sensitive, focal origin VTs. Whether these VTs are due to abnormal automaticity, originating from partially depolarized myocytes, as has been shown for VTs during the early phase of myocardial infarction is not clear.
• Although automaticity is often associated as a mechanism of VT in the absence of overt structural heart disease, disease processes that diminish cell-to-cell coupling are likely to facilitate automaticity. Automatic VTs can occur in structural heart disease, and automatic premature beats may initiate reentrant VTs.
Many factors effect susceptibility to VT in the setting of fibrosis

Triggers of Arrhythmia
- Beta-adrenergic signaling
- Intracellular calcium handling
- Sympathetic and Vagal Tone
- NGF, GAP 43
- Ankyrin B

Fibrosis & Scar Formation
- Matrix metalloproteinases
- RAAS signaling
- Fibroblast growth factors

Abnormal Conduction
- Connexins
- Gap junctions
- Na & K channels
- Na/Ca exchanger
- L-type calcium channels

Treatments

- Current treatments aim to alter the substrate for VT to prevent arrhythmia initiation/propagation
Antiarrhythmic drugs:

- produce conduction block within scar related isthmuses by altering their electrophysiologic properties
- do not reduce mortality in patients surviving AMI (CAMIAT, EMIAT)
- remain first line therapy to treat recurrent ventricular arrhythmias that precipitate frequent ICD shocks
- some actually increase mortality (CAST, CAST-II)
  - proarrhythmia

The problem:

- Frequent ICD shocks are a clinically significant problem and often require adjunctive antiarrhythmic therapy for suppression of VT/VF
- Of 119 patients with ICDs surveyed
  - 23% “dreaded” receiving shocks
  - 5% would rather be without the ICD
The problem:

- AVID study
  - 34% of patients receiving ICDs required addition of AA drug for VT suppression at 3 years of follow-up
    - 60% of this group experienced further VT episodes c/w drug inefficacy
      - 42% received amiodarone as adjunctive agent

Amiodarone

- Drug of choice in VT that is difficult to control [1]
- Will suppress 40% of VT refractory to other AADs (lidocaine, procainamide) [2]
- Full loading dose for VT is 15 – 18 grams
- IV amiodarone has a “short” half-life due to rapid drug redistribution
  - Studies differ but range is 4.3 – 16.8 hrs [3]
Substrate Mapping and Ablation in Sinus Rhythm to Halt Ventricular Tachycardia (SMASH VT)

- 127 patients
  - Prior MI
  - Hx of cardiac arrest, hemodynamically significant VT or inducible VT on EPS
  - Not on antiarrhythmic drug
  - Scheduled to receive or already have ICD in situ
- Randomized to substrate mapping and RFA vs. conservative management
- 3 participating sites
- SR mapping of exit sites using CARTO
- 3 complications:
  - 1 pericardial effusion
  - 1 HF exacerbation
  - 1 deep venous thrombosis
Freedom from recurrent VT after catheter ablation associated with improved survival in patients with structural heart disease
Heart Rhythm, Vol 12, No 9, Sept 2015

- An International VT Ablation Center Collaborative Group Study
  - Retrospective study
  - Only done in specialized tertiary referral centers with expertise in VT ablation
  - Some patients had refractory VT and previous ablation at other centers
  - A causal relationship between VT recurrence and mortality cannot be concluded because clinical variables not accounted for may influence the propensity of VT recurrence and mortality
  - Largest collection of outcomes after VT ablation so far

### Table 2: End Points

<table>
<thead>
<tr>
<th>Variable</th>
<th>Ablation Group (N=64)</th>
<th>Control Group (N=64)</th>
<th>Hazard Ratio (95% CI)</th>
<th>P Value</th>
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</thead>
<tbody>
<tr>
<td>ICD events*</td>
<td>8 (12)</td>
<td>21 (33)</td>
<td>0.33 (0.15–0.78)</td>
<td>0.007†</td>
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<tr>
<td>ICD shocks</td>
<td>6 (9)</td>
<td>20 (31)</td>
<td>0.27 (0.11–0.67)</td>
<td>0.003†</td>
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<tr>
<td>ICD storms</td>
<td>4 (6)</td>
<td>12 (19)</td>
<td>0.30 (0.09–1.00)</td>
<td>0.06†</td>
</tr>
<tr>
<td>Death</td>
<td>4 (6)</td>
<td>11 (17)</td>
<td>0.39 (0.22–0.69)</td>
<td>0.29†</td>
</tr>
<tr>
<td>Congestive heart failure</td>
<td>3 (3)</td>
<td>6 (9)</td>
<td></td>
<td></td>
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<tr>
<td>Ventricular tachycardia storm</td>
<td>0</td>
<td>1 (2)</td>
<td></td>
<td></td>
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<tr>
<td>Cancer</td>
<td>1 (2)</td>
<td>0</td>
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<tr>
<td>Pulmonary embolism</td>
<td>1 (2)</td>
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<tr>
<td>Unknown</td>
<td>1 (2)</td>
<td>4 (6)</td>
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</table>

* Implantable cardioverter-defibrillator (ICD) events include ICD shocks and anti-tachycardia pacing.
† The P value was calculated by log-rank test.
‡ The P value was calculated by Fisher’s exact test.
Objective: examine the association between VT recurrence after ablation and survival in patients with scar VT

- N=2061 patients with structural heart disease
- 1 year freedom of recurrent VT
  - 72% in ischemic cardiomyopathy
  - 68% in nonischemic cardiomyopathy
- 1 year Cardiac transplantation -> 3% (n=57)
- 1 year Death -> 10% (n=216)
- 1 year estimated death and/or mortality 15% - same for IHD & NIHD
- Highest risk for transplant and/or mortality was recurrent VT

SMASH VT: Results
Endocardial VS Epicardial Ablation: NURSING CARE!!

- Endocardial ablation approach within heart cavity aimed at ablating endocardium
- Epicardial - requires subxyphoidal pericardial puncture
  - Special care during and post ablation for complications
  - Damage of subdiafragmatic organs
  - Pleural catheterization with guidewire reported in one study population in 1.5% of cases that usually occurs without pneumothorax
  - epicardial bleeding
  - pericarditis
  - epicardial vessels - coronary angiography to clarify the position of the tip of the ablating catheter compared to the vessel
  - position and the course of the phrenic nerve may in some cases be an important obstacle to the delivery of RF energy
Conclusions:

- Catheter ablation is well established as an effective way of treating drug-refractory VT and reducing ICD shocks
- Both hemodynamically stable and hemodynamically unstable VTs can be successfully mapped and ablated by experienced operators
- Catheter ablation for the treatment of an individual patient must be made by the physician and patient with consideration of all the particular co-morbidities and circumstances relevant to that patient
- With the growing population of patients with ICDs, the impact of ICD shocks on quality of life and the inefficacy and side-effects of antiarrhythmic drugs, there is a growing need for more aggressive use of catheter ablation for VT

- Thermocool VT Ablation Trial: using irrigated RF catheter
- Euro-VT Study
- CEASE VT
The S-ICD System is intended to provide:

- **Defibrillation** therapy for the treatment of life threatening ventricular tachyarrhythmias
- For patients who **do not have** symptomatic bradycardia, incessant ventricular tachycardia, or spontaneous, frequently recurring ventricular tachycardia that is reliably terminated with Antitachycardia Pacing

Statistics support safety/efficacy, converted with 80J shock
Annualized mortality comparable to ICD studies (~3.5-8%)
Episode storage

Every patient must be pre-authorized as some medical insurance carriers will not cover this care!
Limitations of Transvenous Leads

- Anatomical limitations
- Implantation risks
- Explantation risks

Benefits over Transvenous Leads

- Defibrillation without transvenous leads
- Prevent pericardial effusion/tamponade
- Prevent vessel valve damage
- Not direct pathway for microorganisms to reach bloodstream
- Not exposed to heart stresses, a factor lead failure
- Confirmed or suspected infections more easily managed often without explant
- Explant rate ~1.3 %
- Rate of inappropriate therapy consistent with current ICD
- ~5 yr longevity
Reduced daytime function and cognition, somnolence

Increased risk of MVA

Cardiovascular morbidity — Patients with OSA, particularly when it is moderate or severe and untreated, are at increased risk for a broad range of cardiovascular morbidities, including systemic hypertension, pulmonary arterial hypertension, coronary artery disease, cardiac arrhythmias, heart failure, and stroke

Increased prevalence of insulin resistance and type 2 diabetes. While this association can be manifested through shared risk factors such as obesity In addition, several longitudinal studies have suggested that OSA is a risk factor for incident diabetes, even after adjusting for potential confounders

Perioperative complications — Patients with OSA may be at greater risk for perioperative complications such as postoperative oxygen desaturation, acute respiratory failure, postoperative cardiac events, and intensive care unit transfers.

Mortality — Patients with untreated severe OSA (ie, AHI ≥30 events per hour) have a two- to threefold increased risk of all-cause mortality compared with individuals without OSA, independent of other risk factors such as obesity and cardiovascular disease

Up To Date 2015
Nursing Care is the Fulcrum of Post EP Care

- You are important
- You are at the bedside 24 hours a day
- You can make real time decisions and change outcomes
- You make a difference
- Whether it’s device implant, extraction or ablation – each patient is unique with history and unique for risk/complication profile.
- Keep up the great work
- Ask questions
- Clinical Pearl: rhythm changes, **ASK FOR 12 LEAD**!
- EP is FUN!