Atrial Fibrillation

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Learning Objectives

• Review the growing incidence and importance of AF in the population
• Discuss the use of anticoagulation in AF for stroke prevention
• Summarize pharmacologic and non-pharmacologic options for AF management
Atrial Fibrillation

Projected Number of Adults With AF in the US

Costs to the Health Care System

Estimated US cost burden 15.7 billion annually

- 35% of arrhythmia hospitalizations
- Average hospital stay = 5 days
- Mean cost of hospitalization = $18,800
- Does not include:
  Costs of outpatient cardioversions
  Costs of drugs/side effects/monitoring
  Costs of AF-induced strokes

Quality of Life with AF

1 Jung et al, JACC. 1999 2 Ware et al, New England Medical Center Health Survey. 1993.

NOTE: Higher numbers indicate higher quality of life.
## Diagnostic Evaluation

### Minimum Evaluation
- History and physical – Sx with AF, CV disease
- Electrocardiogram – LVH, MI, BBB, WPW
- Echocardiogram – LVH, LAE, LVEF, Valves
- Labs – TSH, Renal fxn
- Sleep history

**AHA / ACC / ECS Guidelines 2006**

### Additional Testing
- ETT – CAD, Exercise induced SVT / AF
- Holter / Event Monitor – Confirm AF and Sxs
- TEE – LA clot
- EPS – SVT triggered AF
- Sleep Study

**AHA / ACC / ECS Guidelines 2006**
Incidence of AF Based on Presence or Absence of OSA

Gami et al. JACC 2007:49:565-71

ACCF/AHA/HRS FOCUSED UPDATE

2011 ACCF/AHA/HRS Focused Update on the Management of Patients With Atrial Fibrillation (Updating the 2006 Guideline)

A Report of the American College of Cardiology Foundation/American Heart Association Task Force on Practice Guidelines

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Heart Rhythm 2011; 8: 157-176
Classification of Atrial Fibrillation
ACC/AHA/ESC Guidelines

Paroxysmal (Self-terminating) → Persistent (Not self-terminating) → Permanent

Treatment Options

Rate control
- Pharmacologic
  - Ca\(^{2+}\) blockers
  - β-blockers
  - Digitalis
  - Amiodarone
- Nonpharmacologic
  - Ablate and pace

Maintenance of SR
- Pharmacologic
  - Class IA
  - Class IC
  - Class III
  - β-blocker
- Nonpharmacologic
  - Catheter ablation
  - Surgery (MAZE)

Stroke prevention
- Pharmacologic
  - Warfarin
  - Thrombin inhibitor
  - Aspirin
- Nonpharmacologic
  - Removal / isolation
  - LA appendage

Prevent remodeling
ACE-I
ARB

Adapted from Prystowsky, Am J Cardiol. 2000;85:3D-11D.
Atrial Fibrillation and Stroke

- 5 fold increased risk of CVA
- AF accounts for 1 out of every 6 CVAs
- Paroxysmal same risk as persistent
- Thromboemboli originating from LAA

Stroke Risk Assessment in AF: CHADS$_2$ Score

<table>
<thead>
<tr>
<th>Clinical Parameter</th>
<th>Points</th>
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<tbody>
<tr>
<td>CHF</td>
<td>1</td>
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<tr>
<td>Hypertension</td>
<td>1</td>
</tr>
<tr>
<td>Age &gt; 75yo</td>
<td>1</td>
</tr>
<tr>
<td>Diabetes</td>
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<tr>
<td>Stroke</td>
<td>2</td>
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<table>
<thead>
<tr>
<th>CHADS$_2$ Score</th>
<th>Annual Stroke Risk</th>
<th>NNT</th>
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<tbody>
<tr>
<td>0</td>
<td>1.9</td>
<td>417</td>
</tr>
<tr>
<td>1</td>
<td>2.8</td>
<td>125</td>
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<tr>
<td>2</td>
<td>4.0</td>
<td>81</td>
</tr>
<tr>
<td>3</td>
<td>5.9</td>
<td>33</td>
</tr>
<tr>
<td>4</td>
<td>8.5</td>
<td>27</td>
</tr>
<tr>
<td>5 or 6</td>
<td>12-18</td>
<td>44</td>
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</tbody>
</table>

Stroke Risk Assessment in AF: CHADS\textsubscript{2} Score

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<td>1</td>
</tr>
<tr>
<td>Stroke</td>
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</table>

<table>
<thead>
<tr>
<th>CHADS\textsubscript{2} Score</th>
<th>Treatment</th>
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<tbody>
<tr>
<td>0</td>
<td>ASA</td>
</tr>
<tr>
<td>1</td>
<td>ASA or Warfarin (INR 2-3)</td>
</tr>
<tr>
<td>2+</td>
<td>Warfarin (INR 2-3)</td>
</tr>
</tbody>
</table>


Anticoagulation

- **Overall**
  - 62% reduction with warfarin
  - 19% with ASA
- **AFFIRM**
  - 80% of CVAs occurred after coumadin was stopped or was subtherapeutic

<table>
<thead>
<tr>
<th>CHADS\textsubscript{2} Score</th>
<th>Events per 100 person-years</th>
<th>NNT</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Warfarin</td>
<td>No Warfarin</td>
</tr>
<tr>
<td>0</td>
<td>0.25</td>
<td>0.49</td>
</tr>
<tr>
<td>1</td>
<td>0.72</td>
<td>1.52</td>
</tr>
<tr>
<td>2</td>
<td>1.27</td>
<td>2.50</td>
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<tr>
<td>3</td>
<td>2.20</td>
<td>5.27</td>
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<tr>
<td>4</td>
<td>2.35</td>
<td>6.02</td>
</tr>
<tr>
<td>5 or 6</td>
<td>4.60</td>
<td>6.88</td>
</tr>
</tbody>
</table>
Atrial Fibrillation-Anticoagulation


Warfarin Limitations

- Slow onset/offset
- Unpredictable dosing
- Drug/diet interactions
- Warfarin resistance (genetic)
- Narrow therapeutic index
- Routine monitoring
- Patient dissatisfaction (“rat poison”)
- Prescriber dissatisfaction
**Dabigatran**

- Direct thrombin inhibitor
  - Reversible binding
  - Free & clot-bound thrombin
- Inhibits platelet aggregation
- Inhibits tissue factor-induced thrombin generation
- Renally cleared
- No antidote

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**FDA-Approved Labeling**

- Who it’s for:
  - Non-valvular AF patients for stroke prevention
- Who it’s **NOT** for:
  - Mechanical heart valves
  - PE
  - DVT
  - Prophylaxis for knee/hip replacements
  - HIT
Management of AF

ANTITHROMBOTIC RX

AND

RHYTHM CONTROL OR RATE CONTROL

Rate Control
**Atrial Fibrillation**

**Rate control – Drug Therapy**

Digoxin – controls resting rate, OK in CHF patients.  
Beta, Calcium channel blockers – controls resting and exercise rates.  
Best therapy – combination of beta blocker and digoxin.  
Primary Goal – Avoid Tachycardia Induced Cardiomyopathy

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**What is optimum rate control?**

- **AFFIRM trial**  
  - Resting heart rate less than 80 bpm  
  - Peak heart rate less than 110 bpm  
- **RACE II**
RACE II

- 614 patients
- Lenient Control (<110 bpm) versus strict control (<80 at rest, <110 at peak).
- Mean follow up 2 years.
- Primary Outcomes of death, CHF, stroke embolism, life threatening arrhythmias


Rate Control

- No significant difference in two groups

## Rhythm Control

### Conversion of AF

Duration of AF is the best predictor of recurrent AF after cardioversion.

<table>
<thead>
<tr>
<th>Length of time in AF prior to cardioversion</th>
<th>&lt; 3 Months</th>
<th>3 - 12 Months</th>
<th>&gt; 12 Months</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One month post-CV</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Six months post-CV</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Anticoagulation - Cardioversion

- Atrial stunning
  - Stunning can occur even with one hour of atrial fibrillation
  - If duration < 2 weeks, function may return within 24 hours to one week
  - If duration > 2 weeks, stunning may persist for one month


Cardioversion

- Less than 48 hours duration
  - Cardioversion without TEE
  - Heparin at time of cardioversion
  - Warfarin for a month and re-evaluation as outpatient
Cardioversion

- If greater than 48 hours
  - Option 1: Anticoagulate for 4 weeks and then cardiovert
  - Option 2: TEE and if no thrombus, cardiovert
    - If thrombus, 4 weeks warfarin and recheck
  - Anticoagulate for minimum of one month and re-evaluate

**AFFIRM: Rate vs. Rhythm Control**

**All-Cause Mortality**

![Graph showing mortality rates comparing rate versus rhythm control.](image)

- Rate N: 2027
- Rhythm N: 2033
- p=0.078 unadjusted
- p=0.068 adjusted

4060 patients

Rate vs. Rhythm Control Trials: Implications

- AFFIRM demonstrated that a rate control “strategy” is an acceptable primary therapy in a selected high-risk subgroup of AF patients.

- Continuous anticoagulation seems warranted in all patients with risk factors for stroke
  Asymptomatic recurrences

- AFFIRM did not define whether it is better to be in NSR.

Rhythm Control

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Avoids electrical and anatomical remodeling</td>
<td>• Ventricular proarrhythmia</td>
</tr>
<tr>
<td>• Improves hemodynamics</td>
<td>• Increased mortality?</td>
</tr>
<tr>
<td>• Enhanced exercise capacity</td>
<td>• Drug-induced bradyarrhythmias</td>
</tr>
<tr>
<td>• Symptom relief</td>
<td>• End-organ toxicity</td>
</tr>
<tr>
<td>• Improves QOL</td>
<td>• Adverse effects</td>
</tr>
<tr>
<td>• Restores atrial transport</td>
<td>• Recurrences are likely</td>
</tr>
<tr>
<td>• Reduces thromboembolic events?</td>
<td>• Asymptomatic (silent) AF</td>
</tr>
</tbody>
</table>
CTAF Trial*: Maintenance of SR

- Amiodarone 10 mg/kg/2 wk, 300 mg/4 wk, 200 mg/d (n=201)
- Propafenone 300-450 mg/d (n=101)
- Sotalol 160 mg BID or 80 mg TID (n=101)

* Excluded recurrence in first 21 days.

AF Antiarrhythmic Therapy

- Treatment goals
  - ↓ frequency of recurrences
  - ↓ duration of recurrences
  - ↓ severity of recurrences
  - Not to abolish every episode
- Safety is primary concern
- Minimize risk of proarrhythmia

Drug-Induced Proarrhythmia - Torsades
### Factors Which Influence Ventricular Proarrhythmia Risk

- Hypokalemia, hypomagnesemia
- Long QT at baseline
- CHF / Decreased EF
- Ventricular hypertrophy
- Bradycardia
- Female gender
- Reduced drug metabolism or clearance
- Amiodarone has lowest risk

### Alternatives to Drug Therapy

**“Non-Pharmacologic Therapy”**

- **Coumadin** – LAA closure (Watchman)
- **Rate Control** – AVN RFA + PCMK
- **AARx** – Adjunctive AFL RFA
- **AARX** – Curative Afib RFA
The Rational for the Watchman Device

Clean Left Atrial Appendage  Left Atrial Appendage Clot


Watchman®

• Efficacy of Watchman was non-inferior to warfarin for stroke prophylaxis in patients with non-valvular atrial fibrillation

• Higher rate of adverse events in the intervention group was mainly result of periprocedural complications

• Awaiting FDA approval

Pacemaker + AV Node Ablation

AVN RF Ablation
Objective Benefits of AV Nodal Ablation

- **A** Left ventricular ejection fraction (%)
  - Before: mean 43 + 8
  - After: mean 54 + 7
  - p < 0.001

- **B** Left ventricular end systolic diameter (mm)
  - Before: mean 40 + 5
  - After: mean 34 + 3
  - p < 0.003


AVA N Ablation

**Advantages:**
- 100% efficacy
- 85% symptomatic improvement
- Improved EF (LV remodeling)
- Eliminates need for rate control drugs

**Disadvantages:**
- Pacemaker dependant

**Good Candidates:**
- Tachy / Brady Syndrome
- PPM present – CHF with BiV device
- Medication refractory / intolerant
- Elderly
IC Antiarrhythmic Induced Atrial Flutter
1:1 Conduction

Atrial Flutter Circuit

Termination of Atrial Flutter
Atrial Flutter Ablation

Approximately 15% of AF patients treated with an AARx will develop AFL

Advantages:
95% efficacy
≈ 80% arrhythmia control if AARx continued
As primary Tx RFA more effective than AARx

Disadvantages: Invasive

Good Candidates:
Typical AFL (IVC / TV isthmus)
Primary or AARx related Atrial Flutter

Focal Origin of Atrial Fibrillation

Hassaiguerre M, NEJM, 1998

• 94% of AF triggers from Pulmonary Veins

• “90-95% of all AF is initiated by PV ectopy”
Comparison of Antiarrhythmic Drug Therapy and Radiofrequency Catheter Ablation in Patients with Paroxysmal Atrial Fibrillation: A Randomized Controlled Trial

Major Adverse Events: Ablation 4.9% vs. AARx 8.8%
Repeat Ablation in 12.6% of patients

Conclusion Among patients with paroxysmal AF who had not responded to at least 1 antiarrhythmic drug, the use of catheter ablation compared with ADT resulted in a longer time to treatment failure during the 9-month follow-up period.

JAMA 2010
### Current State of Curative Catheter-Based RFA

#### Who is a good candidate?

<table>
<thead>
<tr>
<th>Symptomatic / Frequent AF</th>
</tr>
</thead>
<tbody>
<tr>
<td>Limited Heart Dz</td>
</tr>
<tr>
<td>EF &gt; 35%</td>
</tr>
<tr>
<td>LA &lt; 5.5cm</td>
</tr>
<tr>
<td>No MS / Rheumatic Dz</td>
</tr>
<tr>
<td>Younger Patients</td>
</tr>
<tr>
<td>No LA thrombus or Hx of CVA</td>
</tr>
<tr>
<td>Medically Refractory / Intolerant</td>
</tr>
<tr>
<td>(Ablation now second line therapy)</td>
</tr>
</tbody>
</table>

#### New Technology

**Multielectrode Ablation Catheters**

Catheter Positioning in Antrum of Left PVs

[Image of catheter positioning in left PVs]
Balloon Technology

<table>
<thead>
<tr>
<th>RSPV</th>
<th>LSPV</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Image" /></td>
<td><img src="image2.png" alt="Image" /></td>
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<tr>
<td><img src="image3.png" alt="Image" /></td>
<td><img src="image4.png" alt="Image" /></td>
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</table>

Stereotaxis
Remote Magnetic Control

![Image](image5.png)
**Atrial Fibrillation**  
**New Technology / Studies at Ohio State University**

<table>
<thead>
<tr>
<th>Stereotaxis – Magnetic Catheter Navigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Catheter Design / Energy Sources</td>
</tr>
<tr>
<td>High Intensity Focused Ultrasound (HIFU)</td>
</tr>
<tr>
<td>Ablation Frontiers – Circular Catheters</td>
</tr>
<tr>
<td>Cryoablation</td>
</tr>
<tr>
<td>Laser Ablation</td>
</tr>
<tr>
<td>Cabana trial – Drug vs Ablation (including primary therapy)</td>
</tr>
<tr>
<td>Watchman – Left Atrial Appendage Closure</td>
</tr>
<tr>
<td>Surgical vs Catheter Ablation</td>
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