Defining the Beat: Getting to the heart of atrial arrhythmias

Carole Moore, RN, MNSc, ACNP-BC
Central Texas Veteran's Health Care System
Carole.Moore@va.gov

Effects of Aging on the Cardiovascular System

- Decreased compliance of blood vessels through arterial stiffening and thickening,
- Mild left ventricular thickening,
- A shift in the balance of early versus late diastolic filling.
- Changes result from:
  - Cardiac cell enlargement
  - Apoptosis of neighboring cells
  - Subsequent fibrofatty infiltration of the myocardium... this leads to conduction disorders

Sinoatrial node

- Aging is associated with:
  - Increased fat and collagen deposits surrounding the sinoatrial node which may result in delayed action potential propagation
  - Complete electrical separation of the node from surrounding tissue
  - Decreased pacemaker cells in SA node by 90%
  - Expected sinus bradycardia is muted by the reduction in parasympathetic activity
Epidemiology

Atrial fibrillation (AF) is the most common sustained dysrhythmia
- Affects between 2.7 - 4.1 million Americans
- 1% total population, 9% for those >80 years
- More common in males than females (1.1 versus 0.8%)
- Expected to double in the next 25 years
- Risk is progressive with age
- Life time risk over the age of 40 y/o is ~25%
- AF is independently associated with a 50-90% increase in the risk of death
- Treating AF adds an estimated $26 billion to healthcare costs in the US annually
- Roughly $8700 per year per person with AF

Stroke risk
- 15-20% of strokes are attributable to AF
- AF related strokes are more severe than non-AF related strokes

Prevalence of atrial fibrillation with age

In a cross-sectional study of almost 1.9 million men and women, the prevalence of atrial fibrillation increases with age, ranging from 0.1 for those <55 years of age to over 9 percent in those ≥85 years of age. At all ages, the prevalence is higher in men than women.


Normal anatomy & physiology
Types of Atrial Arrhythmias

- Atrial fibrillation
- Atrial flutter
- Premature atrial contractions
- Supraventricular tachycardia
- Wolff-Parkinson-White syndrome
- Multifocal atrial tachycardia
- Sinus bradycardia
- Sinus tachycardia
- Sick sinus syndrome

Premature atrial contractions

- Common and benign
- Originates away from the sinus node and sends electrical signals through the upper chamber
- Symptom: may feel skipped beat
- Triggers include: caffeine, tobacco, alcohol, stress
- No treatment

Supraventricular tachycardia

- Rapid heart rate between 100-240 bpm
- Begins and ends suddenly
- Electrical impulse reenters the atrial muscle (commonly due to variation in electrical system)
- Symptoms: low blood pressure, lightheadedness, presyncope, and sometimes syncope
- Triggers include: caffeine, alcohol, exercise
- Treat with ablation
Wolff-Parkinson-White (WPW) Syndrome

- A form of SVT
- Electrical signals fail to pause in the AV node due to extra (accessory) connection between the top and bottom chambers of the heart
- Heart rates approach 240 bpm
- Precursor to atrial fibrillation and dangerous ventricular arrhythmias
- Treat with ablation

Multifocal atrial tachycardia

- Characterized by variability in P wave morphology, with three or more distinct P wave morphologies
- Heart rates over 100 bpm
- Associated with underlying pulmonary disease/COPD (60%), heart disease (coronary, valve, LV diastolic dysfunction)
- Symptoms typically reflective of underlying disease
- Treat the underlying disease, consider CCB (verapamil) or BB (metoprolol); ablation

Sinus tachycardia

- Heart rates over 100 bpm
- Normal response to exercise, fever, dehydration, pain, stress
- May be triggered by adrenaline, caffeine, nicotine, or alcohol
- May reflect an underlying heart disease, lung disease, thyroid disease, or endocrine disease
- Treat underlying physiology
- Consider use of negative chronotropic therapy
**Sinus bradycardia**
- Heart beats less than 60 bpm
- Normal response in sleep and athletes
- Associated with impaired impulse generation in the SA node
- May be triggered by negative chronotropic medications (beta-blockers, nondihydropyridine calcium channel blockers)
- Symptoms may include lightheadedness, dizziness, hypotension, vertigo, syncope

**Sick sinus syndrome**
- Improper firing of electrical impulses caused by disease or scarring of the sinus or sinoatrial node
- Heart rates may fluctuate between bradycardia and tachycardia
- Symptoms may include palpitations, skipped-beats, dizziness, lightheadedness, syncope, fatigue or weakness, confusion, and angina
- Treat with negative chronotropic medications (BB, CCB) to slow the heart rate and pacemaker implant to alleviate symptomatic bradycardia

**Atrial flutter**
- **Typical**
  - Cavotricuspid isthmus dependent
  - Characteristics on ECG
    - Negative sawtooth pattern in leads II, III, aVF
    - Positive P wave in V1
    - Rate 240-300 bpm
    - Ablation highly successful
- **Atypical**
  - Non-cavotricuspid isthmus dependent
  - Characteristics on ECG
    - Positive sawtooth pattern in leads II, III, aVF
    - Negative P wave in V1
    - Rates may exceed 340 bpm
    - Ablation more challenging with less success

9/9/15
A supraventricular tachyarrhythmia with uncoordinated atrial activation and consequently ineffective atrial contraction

Characteristics on an electrocardiogram (ECG)
- irregular R-R intervals (when atrioventricular [AV] conduction is present)
- absence of distinct repeating P waves, and
- irregular atrial activity

Hemodynamic consequences include a variable combination of
- suboptimal ventricular rate control (too rapid or too slow),
- loss of coordinated atrial contraction (kick),
- beat-to-beat variability in ventricular filling, and
- sympathetic activation
Clinical Implications of Atrial Fibrillation

Risk Factors for Chronic Atrial Fibrillation
- Hypertensive heart disease - most common
- Coronary artery disease with MI or HF - atrial ischemia
- Valvular heart disease - increased LA dimension
- Cardiacomyopathy/heart failure - atrial stretching
- Congenital heart disease - anomalies or defects
- Venous thromboembolic disease - atrial strain due to an increase in pulmonary vascular resistance and cardiac afterload
- COPD
- Sleep apnea
- Diabetes mellitus - possible increased left ventricular mass and increased arterial stiffness
- Metabolic syndrome (esp. with BMI>30)
- Obesity - increased LA pressure/volume and shortened effective refractory period in LA and in proximal/distal pulmonary veins
- Chronic kidney disease

Risk factors for Reversible Atrial Fibrillation
- Cardiac surgery (30-60%)
- Cardiac transplantation (10-24%)
- Non-cardiac surgery (1-40%)
- Hyperthyroidism (8-23%)
- Inflammation/infection
- Low magnesium
- Alcohol/caffeine/medications
- Family history/genetic
- Autonomic dysfunction
### Atrial Fibrillation Terminology

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paroxysmal AF</td>
<td>Terminates spontaneously or with intervention within 7 d of onset. Episodes may recur with variable frequency.</td>
</tr>
<tr>
<td>Persistent AF</td>
<td>Continuous AF that is sustained &gt;7 d.</td>
</tr>
<tr>
<td>Long-standing</td>
<td>Persistent AF &gt;30 d in duration.</td>
</tr>
<tr>
<td>Permanent AF</td>
<td>When the patient and clinician make a joint decision to stop further efforts to restore and/or maintain sinus rhythm. Acceptance of AF represents a therapeutic attitude on the part of the patient and clinician rather than an inherent pathophysiological attribute of AF. Acceptance of AF may change as symptoms, efficacy of therapeutic interventions, and patient and clinician preferences evolve.</td>
</tr>
<tr>
<td>Nonvalvular AF</td>
<td>In the absence of rheumatic mitral stenosis, a mechanical or bioprosthetic heart valve, or mitral valve repair.</td>
</tr>
</tbody>
</table>

### Presentation

Atrial arrhythmias are frequently found incidentally during routine examinations. Symptoms may include:
- palpitations
- dyspnea/dyspnea on exertion
- reduced exercise capacity/stamina
- lightheadedness
- chest discomfort
- syncope

Urgent care (cardioversion) is indicated with:
- Active ischemia (symptomatic with angina or electrocardiographic evidence).
- Evidence of organ hypoperfusion (e.g., cold clammy skin, confusion, acute kidney injury).
- Severe manifestations of heart failure (e.g., pulmonary edema).

### Algorithm: Acute Management of Atrial Fibrillation
Management Strategies

Rate Control versus Rhythm control
- The AFFIRM, RACE, and AF-CHF trials demonstrated no mortality benefit between the 2 approaches
- Restoring SR may decrease symptoms and risk of remodeling
- Symptoms may not be recognized until SR restored
- Many will never experience a relapse to AF

Reasons to avoid restoration of sinus rhythm
- Completely asymptomatic in the very elderly (>80 years) or the patient with multiple comorbidities
- Asymptomatic with strong evidence of persistent AF for more than three
- Markedly dilated left atrium (>5.5 cm)
- Review of prior EKGs demonstrate no evidence of sinus

Rate Control

Adequate rate control of the ventricular response
- May decrease symptoms
- Critical in avoiding risk of tachycardia-mediated cardiomyopathy

Beta-blockers (Class II agents)
- IV or oral
- Metoprolol, esmolol
- Preferred after an acute myocardial infarction or exercise-induced angina

Calcium channel blockers (Class IV agents)
- IV or oral
- Diltiazem, verapamil
- Preferred with COPD/asthma

Digoxin
- Generally less effective and preferred in HF etiology
- Helpful when dealing with low normal blood pressures
- Does not convert atrial fibrillation to sinus rhythm

Amiodarone
- May be beneficial when other options fail to control rate

Rhythm Control

Methods:
- Electrical cardioversion
- Chemical cardioversion/maintenance
- EP study with ablation therapy

Timing
- Unless unstable, protect from stroke
- Low stroke risk if arrhythmia began within 48-hours
- Adequate anticoagulation for 3 weeks
- Consider TEE
Electrical Cardioversion

- Preferred for initial onset
- Duration of persistent AF inversely correlates to successful restoration of sinus rhythm
- Most effective in converting arrhythmia to SR
- Consider addition of antiarrhythmic drug (AAD)
- Initial DCCV fails to achieve or maintain SR
- Evidence of prolonged AF (enlarged LA)
- Recommended energy:
  - Atrial fibrillation: 120-200 joules
  - Atrial flutter: 50-100 joules
- Not indicated in paroxysmal AF

Antiarrhythmic Drug Therapy

- Antiarrhythmic drugs work by blocking:
  - Na/K/Ca channels or adrenergic receptors
- Many antiarrhythmic drugs have effects on multiple ion channels and adrenergic receptors with varying cardiac and non-cardiac effects

Antiarrhythmic Drug Therapy

- Vaughan-Williams Classification of Antiarrhythmic Drugs
Pharmacologic Cardioversion

**Class Ia**
- Procainamide, quinidine, disopyramide
- Main side effects: hypotension and QRS and QT prolongation in patients with torsade de pointes
- Quinidine may increase diarrhea and thrombocytopenia
- Disopyramide helpful in hypertrophic cardiomyopathy due to negative inotropic impact
- Not strong players in US

**Class Ic**
- Flecainide, propafenone
- Flecainide is use dependent
- Works best at high heart rates
- Can also become toxic at the higher heart rates
- TST will demonstrate toxicity with QRS widening
- Main side effects: proarrhythmia, QRS/QTc prolongation, dizziness, and visual disturbance
- Requires addition of AV nodal blocking agents such as BB or CCB
- Contraindicated in structural heart disease

**Class III**
- Amiodarone
  - IV amiodarone has minimal effect in atrial tissue.
  - Oral amiodarone prolongs atrial refractoriness
  - May be effective either alone or as an adjunct to DCV to restore NSR
  - Extensive systemic side-effect profile
    - Thyroid toxicity: inhibits conversion of T4 to T3
    - Pulmonary toxicity: increased cough and/or dyspnea
    - Hepatic toxicity: low level transaminase elevation; cirrhosis
    - Significant drug interactions
      - Warfarin: potentiates anticoagulation effect of warfarin
      - Simvastatin (myositis); consider pravastatin
    - FDA has not labelled for use in atrial fibrillation

**Class III (continued):**
- Dronedarone
  - Mimics benefits of amiodarone with fewer noncardiovascular side effects
  - Contraindicated in:
    - CHF (increased mortality risk)
    - Permanent atrial fibrillation (increased risk for CV death, stroke, increased rate of hospitalization)
  - Major side effects: GI distress
  - Monitor with EKGs at least quarterly and LFTs every 6 months
Class III (continued):

- Sotalol & dofetilide
  - Reverse use dependent
  - Works best on slow heart rates
  - Major side effects:
    - Renal dose
    - Strongly recommend 3 night hospitalization for initiation of drug
  - Ibutilide
    - New IV AAD for acute termination of AF

Recommendation for AAD Use

<table>
<thead>
<tr>
<th>No Structural Heart Disease</th>
<th>Coronary Artery Disease</th>
<th>Heart Failure</th>
<th>Severe Ventricular Hypertrophy</th>
</tr>
</thead>
<tbody>
<tr>
<td>First line</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flecainide</td>
<td>Sotalol</td>
<td>Amiodarone</td>
<td>Amiodarone</td>
</tr>
<tr>
<td>Propafenone</td>
<td>Dronedarone</td>
<td>Dofetilide</td>
<td></td>
</tr>
<tr>
<td>Dronedarone</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Second line</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Amiodarone</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dofetilide</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Avoid</td>
<td>Flecainide, Propafenone</td>
<td>Flecainide,</td>
<td>Flecainide, Propafenone,</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Propafenone,</td>
<td>Dronedarone</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

EP Study with Ablation

- History lesson...
  - James Cox introduced an open heart surgical procedure that consisted of incisions and sutures that isolated compartments of the atria (a.k.a., Maze procedure, 1987)
  - Evolved into cryothermic and radiofrequency ablation
  - Michael Haissaguerre and his team in Bordeaux, France recognized that pulmonary vein foci played a key role in triggering atrial fibrillation (1990s)
  - Specialists in EP cardiology developed the method to accomplish the ablation using catheters through the groin or neck veins thereby avoiding incisions
  - The goal is to create a barrier to the propagation of the atrial arrhythmia
Minimally invasive
Relieves symptoms and improves quality of life
Procedure is two part
Diagnostic:
- Maps electrical activity of the heart
- Identifies foci/ectopy
Interventional
- Pulmonary vein isolation
- AV node ablation (pacemaker dependent)
Success rates:
- UNDER-ATP Trial identified 67-68% of patients (2113) were AF free at 1 year

One of the most important management decisions is whether oral anticoagulation should be prescribed to reduce the risk of stroke and embolization.
The AFFIRM and RACE trials confirmed that stroke risk was similar despite rate versus rhythm control strategies.
Strokes or similar thromboembolic event may be the first indication of an atrial arrhythmia

Consider both embolization risk and bleeding risk (HAS-BLED score)
Discuss with patient and family
Consider bridging with LMWH when initiating heparin
Consider aspirin 81mg + clopidogrel 75mg for those who are unable to tolerate stronger anticoagulation (fall risks, etc.)
Timing after a stroke:
- After mild-moderate infarct: wait 24-48 hours
- After large infarct: wait for 2 weeks
CHA2DS2-VASc ~or~ CHADS2

<table>
<thead>
<tr>
<th>CHA2DS2-VASc</th>
<th>CHADS2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cerebrovascular disease (LV dysfunction)</td>
<td>1</td>
</tr>
<tr>
<td>Hypertension</td>
<td>1</td>
</tr>
<tr>
<td>Age 65+ or 75+</td>
<td>1</td>
</tr>
<tr>
<td>Diabetes mellitus</td>
<td>1</td>
</tr>
<tr>
<td>Stroke or other thromboembolic event</td>
<td>2</td>
</tr>
<tr>
<td>Vascular disease (CAD, MI, PAD, etc.)</td>
<td>1</td>
</tr>
<tr>
<td>Gender</td>
<td></td>
</tr>
</tbody>
</table>

Total possible points: 9

Any score over 1 is suggestive for anticoagulation therapy.

Risk Factors

<table>
<thead>
<tr>
<th>Risk Factors</th>
<th>Annual Stroke Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHA2DS2-VASc</td>
<td>CHADS2</td>
</tr>
<tr>
<td>0</td>
<td>0.2%</td>
</tr>
<tr>
<td>1</td>
<td>0.6%</td>
</tr>
<tr>
<td>2</td>
<td>2.2%</td>
</tr>
<tr>
<td>3</td>
<td>3.2%</td>
</tr>
<tr>
<td>4</td>
<td>4.8%</td>
</tr>
<tr>
<td>5</td>
<td>7.2%</td>
</tr>
<tr>
<td>6</td>
<td>9.7%</td>
</tr>
<tr>
<td>7</td>
<td>11.2%</td>
</tr>
<tr>
<td>8</td>
<td>10.8%</td>
</tr>
<tr>
<td>9</td>
<td>12.2%</td>
</tr>
</tbody>
</table>

On the CHA2DS2-VASc score:
- 0 points = low risk
- 1 point = low-moderate risk
- 2+ points = moderate high risk

Anticoagulation with Warfarin

- Anticoagulation with warfarin or TSOA/NOAC
  - Decreases stroke risk by up to 70%
  - Associated with increased bleeding risk

Warfarin
- Requires regular lab monitoring of INR
- Therapeutic range: 2.0-3.0
- Numerous dietary restrictions and potential drug interactions
- Preferred with patients
- Comfortable having periodic INR measurements and with relatively easy to control therapeutic range (therapeutic at least 70% of the time).
- Can take warfarin once a day and adjust via laboratory monitoring, and will have time to adjust dose based on INR result.
- Consumer needs to be on isoniazid, or substitute is not available.
- Consumer needs to be on isoniazid, or substitute is not available.
- Consumer needs to be on isoniazid, or substitute is not available.
- Consumer needs to be on isoniazid, or substitute is not available.
- Consumer needs to be on isoniazid, or substitute is not available.
- Consumer needs to be on isoniazid, or substitute is not available.
- Consumer needs to be on isoniazid, or substitute is not available.
- Consumer needs to be on isoniazid, or substitute is not available.
- Consumer needs to be on isoniazid, or substitute is not available.
- Consumer needs to be on isoniazid, or substitute is not available.
Anticoagulation with TSOA/NOACs

- All are now approved for use in PE/DVTs
- Direct thrombin inhibitor
  - Pradaxa (dabigatran)
    - Approved for use in PE/DVTs
    - Dosing: 150mg twice daily
    - Renal dose:
      - SCr 30-50 and on dronedarone or ketoconazole: 75mg bid
      - SCr = 100, contraindicated (not studied)
    - Geriatric (over 75): consider other agents

- Factor Xa Inhibitors
  - Eliquis (apixaban)
    - Dosing: 5mg twice daily
    - Decreased to 2.5mg bid if 2 criteria are met:
      - age > 80 years
      - weight > 90kg
  - Xarelto (rivaroxaban)
    - Dosing: 20mg daily
    - Renal dose:
      - SCr ≥ 15
      - decrease to 10mg daily
      - SCr < 15: Contraindicated

New Findings

- Diagnosis of Atrial Fibrillation after stroke.
- Cryptogenic stroke relation to atrial fibrillation
- Secondhand smoke and atrial fibrillation

Emerging Therapies

- Bridging Anticoagulation in Patients who Require Temporary Interruption of Warfarin Therapy for an Elective Invasive Procedure or Surgery (BRIDGE) trial
- Botulinum toxin injections into epicardial fat pads
You treat a disease, you win, you lose.

You treat a person, I guarantee you, you’ll win, no matter what the outcome.

— Robin Williams in Patch Adams