Annual Internal Medicine Review

CARDIOLOGY

Cardiovascular Arrhythmias
Congestive Heart Failure

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Learning Objectives

1. Describe the basic physiology and pathophysiology of cardiac disorders
2. Review the presenting symptoms, diagnostic imaging, and laboratory test findings associated with cardiac disorders
3. Develop a patient treatment plan based on the current evidence for treating and managing cardiac disorders
Disclosure

• Dr. Singh has no conflicts of interest relevant to this activity.
Arrhythmia – Presentation and Tools for Diagnosis

• Typical Presentations
  • Palpitations
  • Dizziness
  • Pre-Syncope
  • Syncope

• Capture rhythm during the clinical event
  • Resting ECG for all patients
  • Holter, Event Monitors, Mobile Telemetry (MCOT)
  • Apple Watch, Kardia

• Other Testing based on specific situation
  • Exercise induced arrhythmia → exercise stress test
  • Suspected structural heart disease → echocardiogram
A 55-year-old man has had 2 episodes of syncope in the past 12 months. He has no warning and they have occurred while standing and sitting. Vital signs, physical examination and resting ECG and echocardiogram are normal.

Which of the following tests is most appropriate?
A. 24-Hour ambulatory monitor
B. Electrophysiological study
C. Event monitor
D. Implantable loop recorder
E. Mobile Cardiac Telemetry
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Question 1 Key Point

- Diagnostic test of choice for infrequent arrhythmia symptoms, inability to activate a recorder, and structurally normal heart

- Implantable loop recorder
Diagnostic Tools for Symptomatic Arrhythmias

• Ambulatory (24-hour) Monitor – Holter Monitor
  • Records every heartbeat for 24 hours
  • Best for frequent, at least daily arrhythmias

• Event monitor
  • Recorder held to chest and activated by patient
  • Records arrhythmia in real time
  • Good for infrequent arrhythmias lasting 1-2 min
  • Generally poor choice for patients with syncope – no warning
Arrhythmias

• Supraventricular
• Ventricular
Atrial TachyArrhythmias

- Sinus tachycardia
- Inappropriate sinus tachycardia (IST)
- Sinus nodal reentrant tachycardia (SNRT)
- Atrial tachycardia
- Multifocal atrial tachycardia (MAT)
- Atrial flutter
- Atrial fibrillation (AF)
Sinus Tachycardia

• HR > 100

• Physiologic demand or distress
  • Exercise, pain, fever, anemia or anxiety

• Other Medical Conditions
  • Hyperthyroid, Fever, Anemia, Pheo etc

• Inappropriate Sinus Tachycardia
  • Elevated heart rate during day, less during sleep
  • More often women in the 2\textsuperscript{nd} to 4\textsuperscript{th} decade
  • Dx based on exclusion of other causes of sinus tachycardia
  • Remove any aggravating factors, BB, Ca Channel Blockers or Ivabradine (in refractory cases)
26-year-old female with palpitations and fatigue for few months. Symptoms are at rest and aggravated during light activity. No DOE, CP or syncope. Rest of med hx is unremarkable.

- Exam BP 110/65 and HR is 115/min. No orthostasis. Rest unremarkable
- Labs have normal CBC, TSH and urine catechols.
- 12 lead EKG shows sinus tach. Holter shows sinus tach during day time and in 90s at night. Echo is normal.

**Which of the following is the most likely diagnosis:**

A. Generalized anxiety disorder
B. Inappropriate sinus tachycardia
C. Somatic symptom disorder
D. Subclinical hyperthyroidism
Question 2

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- 12 lead EKG shows sinus tach. Holter shows sinus tach during day time and in 90s at night. Echo is normal.

Which of the following is the most likely diagnosis:
A. Generalized anxiety disorder
B. Inappropriate sinus tachycardia
C. Somatic symptom disorder
D. Subclinical hyperthyroidism
Regular Supraventricular Tachycardia

• Narrow complex tachycardia – Many kinds
  • Sinus tachycardia
  • AV nodal reentrant tachycardia (AVNRT)
  • AV reciprocating tachycardia (AVRT)
  • Atrial tachycardia
  • Atrial flutter
AVNRT

- Most common type of SVT
- More in women
- Triggered by PAC or PVC
- Slow pathway
  - Conducts slowly but repolarizes quickly
- Fast pathway
  - Conducts fast but repolarizes slowly
AVNRT Therapy

- Cardioversion if hemodynamically unstable
- Vagal maneuvers
  - Carotid sinus pressure
  - Gagging or coughing
  - Valsalva maneuver
  - Immersing face in ice-cold water
AVNRT Therapy

• Medications
  • Adenosine
  • β-blockers
  • Calcium channel blockers

• Ablation is definitive treatment
  • 95% successful
Mx of AVNRT

• Steps in mx of the ekg
  1. Carotid sinus massage
  2. Next step
     → Adenosine 6 mg
  3. Next step
     → Adenosine 12 mg
AVNRT electrogram recording showing retrograde P wave (arrow) at the end of the QRS complex
AV Reciprocating Tachycardia-WPW

• Bypass tract which can cause pre-excitation

WPW Pattern (ECG diagnosis)
  • Short PR interval
  • Delta wave
  • Borderline or prolonged QRS

WPW Syndrome
  • WPW pattern and symptomatic arrhythmias involving the bypass tract
Wolf-Parkinson-White Syndrome

Sinus Rhythm

Orthodromic Atrioventricular Reentrant Tachycardia

Antidromic Atrioventricular Reentrant Tachycardia

90-95%
WPW (preexcitation) pattern is seen as a short PR interval, slurred onset of the QRS (delta wave), and prolonged QRS complex
WPW Treatment

People with atrial fibrillation and rapid ventricular response are often treated with procainamide or amiodarone (rarely) This is to stabilize their heart rate.

The definitive treatment WPW is a destruction of the abnormal electrical pathway by radiofrequency catheter ablation
Pre-excited Atrial Fib – WPW

**Contraindicated***:  
- Digitalis  
- Verapamil/diltiazem  
- Amiodarone  
- Beta-blockers (more controversial)  
- Adenosine  

*Lengthen refractoriness and slow conduction AV node, but not accessory pathway

**Indicated**:  
- Procainamide  
- Ibutilide  
- Synchronized DCCV
Question 3: Arrhythmias
Question 3: Arrhythmias

44 yo male with lightheadedness to ED. HR 189, BP 110/60. ECG shown. Most appropriate next step?

A. Digitalis 0.5 mg IV
B. Diltiazem 25 mg IV
C. Amiodarone
D. Procainamide
E. Adenosine
Therapy for WPW Syndrome

- Cardioversion if hemodynamically unstable
- Procainamide for narrow-complex WPW
- Ibutilide for irregular, wide-complex WPW
  - Especially if WPW is associated with atrial fibrillation
- Ablation of accessory bypass tract
  - Drug-resistant tachycardia
  - Avoids long-term drug therapy
- Avoid AV nodal blockers
Important Points to Note

• Asymptomatic WPW conduction without arrhythmia does not require investigation or treatment

• Do not select calcium channel blockers, β-blockers, or digoxin for patients who have atrial fibrillation with WPW syndrome because treatment may convert AF to VT or VF
Atrial Tachycardia

- Difficult to differentiate from sinus tachycardia or atrial flutter
- Heart rate typically 120-250/min
- Atrial activity originates from discrete atrial focus outside of sinus node
  - Abnormal appearing P waves
  - Abnormal P wave axis
  - Normal PR interval may be abnormal
- May present with 2:1 AV block
  - Common manifestation of digitalis toxicity
Atrial tachycardia with heart rate around 120/min, unusual P wave morphology (arrows), unusual P wave axis, and short PR interval
Atrial Flutter

• Atrial rates → 250 to 340/min
• Typically 2:1 physiologic conduction block
  • Leads to regular ventricular rate ~150/min
• ECG → saw-tooth pattern in inferior leads and positive deflection in V_1 (most common pattern)
• Common causes
  • Pulmonary disease exacerbation
  • Pericarditis
  • Following open heart surgery
Atrial flutter with “saw-tooth” pattern seen best in inferior leads and rhythm strip
Atrial Flutter Therapy

• Cardioversion if hemodynamically unstable
• Radiofrequency catheter ablation
  • Superior to medical therapy (>90% success rate)
Important Point to Note

- Anticoagulation guidelines for atrial flutter are the same as for atrial fibrillation
Irregular Supraventricular Tachycardia

• Narrow complex irregular tachycardia
  • Atrial fibrillation
  • Atrial flutter with variable conduction
  • Multifocal atrial tachycardia
Atrial Fibrillation

- Irregularly irregular ventricular rhythm
- Absence of P waves in all ECG leads
- Can appear as irregular, wide-complex tachycardia
  - Coexistent bundle branch block
  - WPW pattern
Atrial Fibrillation

**Paroxysmal**: terminates spont/ intervent w/in 7d

**Persistent**: Sustained > 7 days

**Permanent**: ceased efforts to restore sinus rhythm

**Nonvalvular**: absence mod to severe MS or mech valve

"**Lone AF**": "confusing," no longer used!
Atrial Fibrillation

• For most patients with new onset atrial fibrillation obtain:
  • TSH
  • Pulse oximetry
  • Echocardiography
  • Digoxin levels (if appropriate)
An 80-year-old asymptomatic man is diagnosed with atrial fibrillation. Blood pressure is 140/80 mm Hg and heart rate is 88/min. Other than an irregular rhythm, his physical examination is normal. His only medication is hydrochlorothiazide.

Which of the following should be initiated next?
A. Amiodarone
B. Aspirin
C. Heparin followed by warfarin
D. Metoprolol
E. Warfarin
Question 4

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C. Heparin followed by warfarin
D. Metoprolol
E. Warfarin
Question 4 Key Point

• Indication for anticoagulation treatment of atrial fibrillation

• If $\text{CHA}_2\text{DS}_2$–$\text{VASc}$ score $\geq 2$ $\rightarrow$ anticoagulation
CHA₂DS₂–VASc for Estimating Stroke Risk

• 1 point for
  • Chronic heart failure
  • Hypertension
  • Diabetes mellitus
  • Vascular disease (MI, PAD, aortic plaque)
  • Age 65 to 74 years
  • Female

• 2 points for
  ▪ Age >75 years
  ▪ Stroke (or TIA)
Atrial Fibrillation Anticoagulation Therapy

• Use CHA$_2$DS$_2$–VASc to guide need for anticoagulation
  • Score = 0 → no anticoagulation
  • Score = 1 → individualize decision
  • Score ≥ 2 anticoagulate
## Atrial Fibrillation: Oral Anticoagulants

<table>
<thead>
<tr>
<th>Medication</th>
<th>Reversibility</th>
<th>Frequency</th>
<th>Type of AF</th>
<th>Cautions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Warfarin (vitamin K antagonist)</td>
<td>Yes</td>
<td>Dosing adjusted to INR</td>
<td>Valvular or nonvalvular</td>
<td>Avoid in pregnancy. Caution with idiopathic thrombocytopenic purpura, HIT, hepatic disease, protein C or S deficiency. Many drug interactions.</td>
</tr>
<tr>
<td>Dabigatran (direct thrombin inhibitor)</td>
<td>Yes(^a)</td>
<td>Twice daily</td>
<td>Nonvalvular</td>
<td>Decrease dose if CrCl 15-30. Caution with P-glycoprotein inhibition.</td>
</tr>
<tr>
<td>Rivaroxaban (factor Xa inhibitor)</td>
<td>No(^b)</td>
<td>Once daily</td>
<td>Nonvalvular</td>
<td>Avoid with CrCl &lt;30, moderate hepatic disease. Caution with mild hepatic disease.</td>
</tr>
<tr>
<td>Apixaban (factor Xa inhibitor)</td>
<td>No(^b)</td>
<td>Twice daily</td>
<td>Nonvalvular</td>
<td>Avoid with severe hepatic disease, strong dual inhibitors or inducers of CYP3A4 and P-glycoprotein. Caution with moderate hepatic disease.</td>
</tr>
</tbody>
</table>
DOACs and Severe Bleeding

**Rivaroxaban, Apixaban**
- Consider Prothrombin Complex Concentrates
- Andexanet alfa

*Dabigatran*
- Charcoal if within 2 hrs
- Hemodialysis
- Idarucizumab

**J Thromb Thrombolysis** 2015; 39: 395-402
**N Engl J Med** 2015; 373: 511-20
Percutaneous Approaches to Occlude the LAA

<table>
<thead>
<tr>
<th>COR</th>
<th>LOE</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>IIb</td>
<td>B-NR</td>
<td>Percutaneous LAA occlusion may be considered in patients with AF at increased risk of stroke who have contraindications to long-term anticoagulation. <strong>NEW:</strong> Clinical trial data and FDA approval of the Watchman device necessitated this recommendation.</td>
</tr>
</tbody>
</table>
Surgical occlusion of the LAA may be considered in patients with AF undergoing cardiac surgery, as a component of an overall heart team approach to the management of AF. **MODIFIED**: LOE was updated from C to B-NR because of new evidence.
Atrial Fibrillation Cardioversion

• Cardioversion if hemodynamically unstable

• Elective cardioversion
  • If AF ≥48 h or unknown duration → 3 wks of anticoagulation before conversion
  • Alternatively, TEE to rule out a clot, then conversion

• Anticoagulation ≥4 weeks after cardioversion for all patients

• “Pill-in-the-pocket” strategy
  • Flecainide or propafenone with a β-blocker or calcium channel blocker for paroxysmal AF
Rate vs. Rhythm Control

- No mortality benefit of restoring sinus rhythm compared with rate control
- Older patients with chronic AF → rate control
  - Diltiazem, verapamil, atenolol, metoprolol
  - No benefit of strict vs. lenient rate control
  - Target rate (resting) <110/min
Rate vs. Rhythm Control

- Younger patients with symptomatic AF → consider rhythm control
  - Antiarrhythmic drugs
  - Synchronized cardioversion
  - Ablation therapy
Other Therapy

• If rhythm control unsuccessful or not tolerated
  • Catheter-based AF ablation
• Surgical “maze” procedure
  • If undergoing cardiac surgery for other reasons
• Anticoagulation
  • Continue even after successful cardioversion or ablation as guided by CHA$_2$DS$_2$–VASc score
Question 5: Arrhythmias

55 yo M with HTN, DM2, CAD and ESRD in the hospital for 2 wks, recovering PNA develops new, highly symptomatic atrial fibrillation. Elective DCCV is planned <48 hrs. Best recommendation to reduce CVA/TIA?

A. TEE, Aspirin
B. No TEE; give aspirin and clopidogrel
C. TEE, and Rivaroxaban
D. No TEE; give Heparin and warfarin
E. TEE, and enoxaparin and warfarin
Question 5: Arrhythmias

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C. TEE, and Rivaroxaban
D. **No TEE; give Heparin and warfarin**
E. TEE, and enoxaparin and warfarin
Anticoagulation Strategies

No RCTs comparing anticoagulation strategies < 48 hrs AF or Aflutter

• Omit TEE (unless not sure of duration)

\[ \text{CHA}_2\text{DS}_2\text{-VASc} \geq 2 \ (\text{Class I}) \]
• Anticoagulate before and after DCCV

\[ \text{CHA}_2\text{DS}_2\text{-VASc} \ 0-1 \ (\text{Class IIb}) \]
• Optional anticoagulation for DCCV

ACC/AHA Guideline, JACC 2014; 64(21): e1-76
Anticoagulation Strategies

> 48 hours AF or AFib

**Regardless CHA\textsubscript{2}DS\textsubscript{2}-VASc**

- Anticoagulate 3 wks before, 4 wks after \textit{DCCV} or
- Anticoagulate before TEE, and after \textit{DCCV}

ACC/AHA Guideline, JACC 2014; 64(21): e1-76
Atrial Fib with CAD

• BB for rate control
• Avoid Prasugrel
• In ACS or post stent
  • After 4-6 weeks move from triple therapy to P2Y12 inhibitor + DOAC or warfarin
  • Clopidogrel with low dose Rivaroxaban 15mg is an option
Question 6: Arrhythmias

62 yo F with ILD, on home O2, chronic systolic heart failure, EF 35%, symptomatic paroxysmal atrial fibrillation. In addition to anticoagulation, you recommend a rhythm control strategy. Which medication is safest?

A. Dofetilide
B. Amiodarone
C. Dronedarone
D. Sotalol
E. Propafenone
AF Ablation:
1-3% develop PV stenosis (SOB)
Question 7: Arrhythmias

75 yo Filipino M perm AF, on apixaban, verapamil, indapamide, digoxin, recent pneumonia admit, completed azithromycin, now confusion, nausea, K 2.9, Mg 1.2, dig level 1, ECG shown. Besides potassium and magnesium, next best step?

A. Digibind  
B. Glucagon  
C. Amiodarone  
D. Activated charcoal  
E. No additional medication
Dig Toxicity- Clinical dx regardless level

• Lethargy, confusion, nausea, anorexia, vomiting
• Yellow-green vision change, scotomas, haloes
• Precipitated: Hypokalemia, Hypomagnesemia, AKI Hypoxia, Amiodarone, Verapamil, Quinidine, Macrolides, Azoles, Cyclosporin
• Arrhythmias (essentially any)
  • Classic: SVT with 3\textsuperscript{rd} degree AVB
  • Classic: Bidirectional VT
• Dig level determines # ampules digibind to give
Multifocal Atrial Tachycardia (MAT)

- At least 3 different P wave morphologies
- Associated with pulmonary/cardiac disease, hypokalemia, hypomagnesemia
- Treat underlying cause, β-blockade, verapamil
A 75-year-old man with chronic stable angina is evaluated for lightheadedness. Vital signs are stable. ECG shows a wide-complex tachycardia with an RBBB pattern at 130/min.

Which of the following is the most likely diagnosis?

A. Atrial fibrillation  
B. Atrial tachycardia  
C. Supraventricular tachycardia with aberrancy  
D. Ventricular tachycardia
Question 8

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Question 8 Key Point

- Wide-complex arrhythmia most commonly associated with structural heart disease, particularly ischemic heart disease

- Ventricular tachycardia
Wide Complex Tachycardia

• Ventricular tachycardia
• Supraventricular tachycardia with aberrancy
• Supraventricular tachycardia with bypass tract
• Ventricular pacemaker
Ventricular Tachycardia

• QRS >0.12 s and AV dissociation
• VT rate → 140 to 250/min
• VT is either sustained or nonsustained
  • Nonsustained VT duration <30 s
• VT is either monomorphic or polymorphic
  • Monomorphic → QRS complexes in the same leads do not vary in contour
  • Polymorphic → QRS complexes in same leads do vary in contour
Don’t be tricked

• In patients with structural heart disease, therapy to suppress PVCs does not affect outcomes
Torsades de Pointes

• A polymorphic VT associated with long QT syndrome
  • Means “twisting of the spikes”
  • Characteristic ECG rotation of depolarization vector around baseline
• May be congenital or acquired
• Episodes typically short-lived and terminate spontaneously
• Multiple successive episodes may result in syncope or VF
Torsade de Pointes:
ECG demonstrates continuously changing electrical axis in same lead characteristic of this polymorphic ventricular tachycardia
VT vs. SVT with Aberrant Conduction

• VT is much more common than SVT with aberrancy
• Any wide QRS tachycardia should be considered to be VT until proven otherwise
• In the presence of known structural heart disease the diagnosis of VT is almost certain
Don’t be tricked

• Do not treat irregular wide-complex tachycardia or polymorphic tachycardia with adenosine.
Precautions with ICDs

• Avoid strenuous upper extremity exercises, including weightlifting → lead fracture
• Avoid arc welding, high voltage machinery etc → risk of shock
• Evaluate prior to surgery which may need cautery
• Consider possibility of device infection in patient with unexplained fever → treatment is device removal
Question 9

71 yr old male with h/o ICD 2 years ago has 10 day of malaise and fatigue. No fever, chills or weight loss. Rest of the h/o unremarkable except HTN, HLPD. On exam, ICD site is erythematous and is warm and tender to palpation. Rest of the exam is fine.

• CBC and ESR is ordered

Which of the following is the most appropriate management?
A. Blood cultures
B. Empiric therapy with cephalexin
C. Pacemaker pocket aspiration
D. PET/CT scanning
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ICD Indications for Sudden Death Prevention

• Survivors of cardiac arrest due to VF or VT
• Structural heart disease and sustained VT
• Ischemic or nonischemic cardiomyopathy and EF <35%
• Post MI
  • EF <30% after 40 days or >3 months after revascularization
• Brugada syndrome
• Inherited LQTS not responding to β-blockers
• High-risk hypertrophic cardiomyopathy
Long QT Syndrome

• QTc > 500 ms on repeated 12 lead ECGs accompanied by unexplained syncope or ventricular arrhythmias

• Treatment
  • BB – first line
  • ICD → if h/o cardiac arrest or recurrent syncope or VT refractory to BB
  • No competitive sports
Bradyarrhythmias
Heart Block

- **1st Degree AV Block**: Prolonged AV conduction with PR interval > 0.2 sec
- **2nd Degree AV Block**: Dropped ventricular beats
  - Mobitz Type I: progressive PR prolongation is observed prior to a dropped beat
  - Mobitz Type II: PR interval is constant prior to non-conducted P waves (dropped beats) – can progress to CHB
- **3rd Degree AV Block (Complete heart block)**: failure of any P waves to conduct to the ventricles, and it is characterized by AV dissociation on the ECG.
Mobitz type 1 second degree heart block:
ECG shows progressive prolongation of P-R interval until dropped beat (arrow)
Mobitz type 2 second-degree AV block: ECG is characterized by a dropped QRS complex with no change in preceding PR intervals
In this electrocardiogram, the P waves (short arrows) and the QRS complexes (long arrows) are not associated with each other, indicating the presence of complete heart block.
A 74-year-old man has fatigue and near syncope. He has atrial fibrillation treated with metoprolol and digoxin. ECG shows atrial fibrillation with a regular ventricular rate of 48/min and occasional PVCs.

Which of the following should be done next?
A. Atropine, intravenously
B. Isoproterenol, intravenously
C. Stop digoxin
D. Temporary pacemaker insertion
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Question 10 Key Point

• First-line intervention for patients with heart block

• Identify and treat underlying conditions that may be responsible for the heart block. In this case digoxin is the underlying cause
Digitalis-induced toxic rhythms can include:

- Atrial tachyarrhythmias with AV block (e.g., regularization of atrial fibrillation)
- Ventricular bigeminy
- Junctional rhythms
- Various degrees of AV nodal blockade
- Ventricular tachycardia and ventricular fibrillation
AV Block Therapy

• Correct reversible causes of impaired conduction
  • Ischemia
  • Increased vagal tone
  • Eliminate drugs that alter electrical conduction
    • β-Blockers, calcium channel blockers, digitalis

• Hemodynamic compromise
  • IV atropine
  • IV dopamine continuous infusion
  • Transcutaneous or transvenous pacing
Question 11

A 68-year-old woman is evaluated in the emergency department for a 1-hour history of chest pain. Has HTN, DM. Medications are metformin, quinapril, and aspirin.

On PE, BP is 95/60 mm Hg, pulse rate is 50/min, and respiration rate is 16/min. The patient is alert and conversant. The precordial cadence is not regular. There is no evidence of pulmonary or peripheral congestion, and the extremities are warm.

Laboratory studies reveal a serum troponin T level of 1.1 ng/mL (1.1 µg/L)

Which of the following is the most appropriate next step in the mx of the arrhythmia

A. Cardiac catheterization
B. Echocardiography
C. Permanent pacemaker implantation
D. Temporary pacing
Question 11

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Bundle Branch Blocks

• LBBB
  • Absent Q waves in leads I, aVL, and V₆
  • Large, wide, and positive R waves in leads I, aVL, V₆
  • QRS >0.12 sec

• RBBB
  • rsR’ pattern in lead V₁ (“rabbit ears”)
  • Wide negative S wave in lead V₆
  • QRS >0.12 sec
Bifascicular Block

• Defined as RBBB with either LAFB or LPFB

• Left anterior fascicular block (LAFB)
  • Positive QRS in lead I and negative in II

• Left posterior fascicular block (LPFB)
  • Negative QRS in lead I and positive in II
  • Less common than LAFB
Bifascicular block:
RBBB and LAFB (positive QRS in I and negative in II)
An 81-year-old man is evaluated before elective hip arthroplasty. Medical history is significant for hypertension and osteoarthritis. He reports no chest pain, palpitations, exertional dyspnea, or other symptoms of cardiovascular disease. His medications are lisinopril and celecoxib.

- On physical examination, vital signs are normal. The cardiopulmonary examination is normal. Range of motion of the right hip is limited by pain without overlying erythema or warmth.
- Laboratory studies reveal normal kidney function and electrolyte levels.
- A 12-lead electrocardiogram is shown. Findings are unchanged from 7 years ago.

Which of the following is the most appropriate management?

A. Dobutamine echocardiography
B. Echocardiography
C. Prophylactic pacemaker insertion
D. No further testing or intervention
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A. Dobutamine echocardiography
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Common Indications for Permanent Pacemaker

• Persistent, advanced Mobitz type 2 second-degree heart block
  • Advanced heart block $\rightarrow$ >1 successive non-conducted P waves
• Transient second-degree heart block with bundle branch block
• Third-degree heart block
• Symptomatic heart block of any type
Congestive Heart Failure
NYHA Heart Failure Classification

I. No limitation with ordinary activity
II. Ordinary activity - symptoms
III. Less than ordinary activity - symptoms
IV. Any or no physical activity - symptoms

2013 ACCF/AHA Guideline, CIRC 2013;128:e240-e327
Stages of Heart Failure

**At Risk for Heart Failure:**

STAGE A  High risk for developing HF

STAGE B  Asymptomatic LV dysfunction

**Heart Failure:**

STAGE C  Past or current symptoms of HF

STAGE D  End-Stage HF
Other biomarkers of injury or fibrosis include soluble ST2 receptor, galectin-3, and high-sensitivity troponin.

ACC indicates American College of Cardiology; AHA, American Heart Association; ADHF, acute decompensated heart failure; BNP, B-type natriuretic peptide; COR, Class of Recommendation; ED, emergency department; HF, heart failure; NT-proBNP, N-terminal pro-B-type natriuretic peptide; NYHA, New York Heart Association; and pts, patients.
BNP/ ProBNP Measurements 2017 Update of Guidelines

• Prevention: Screening for those at risk of developing HF
• Diagnosis: patients presenting with dyspnea, to support a diagnosis or exclusion of HF
• Prognosis:
  • establishing prognosis or disease severity in chronic HF
  • establish a prognosis in acutely decompensated HF
  • predischarge to establish prognosis
# Causes for Elevated Natriuretic Peptide Levels

<table>
<thead>
<tr>
<th>Cardiac</th>
<th>Noncardiac</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Heart failure, including RV syndromes</td>
<td>• Advancing age</td>
</tr>
<tr>
<td>• Acute coronary syndrome</td>
<td>• Anemia</td>
</tr>
<tr>
<td>• Heart muscle disease, including LVH</td>
<td>• Renal failure</td>
</tr>
<tr>
<td>• Valvular heart disease</td>
<td>• Pulmonary causes: obstructive sleep apnea, severe pneumonia, pulmonary hypertension</td>
</tr>
<tr>
<td>• Pericardial disease</td>
<td>• Critical illness</td>
</tr>
<tr>
<td>• Atrial fibrillation</td>
<td>• Bacterial sepsis</td>
</tr>
<tr>
<td>• Myocarditis</td>
<td>• Severe burns</td>
</tr>
<tr>
<td>• Cardiac surgery</td>
<td>• Toxic-metabolic insults, including cancer chemotherapy</td>
</tr>
<tr>
<td>• Cardioversion</td>
<td></td>
</tr>
</tbody>
</table>
Medical Therapy of HFrEF

- ACEi/ARB or ARNI
- Beta Blockers
- Diuretics
- Aldosterone Antagonists
- Isosorbide Dinitrate-Hydralzine
- Ivabradine
Dosing Loop Diuretics in Heart Failure

Starting dose: 20-40 mg of furosemide equivalent

Double the dose until adequate urine output is seen

If adequate urine output occurs with a dose but the patient is still fluid overloaded, increase the dosing interval to twice daily

Once dry body weight is attained, the minimal dose to maintain dry body weight should be given

Effects of Neprilysin Inhibition in HF

- Sacubitril/valsartan (LCZ696): combined angiotensin receptor neprilysin inhibitor (ARNI)

Endogenous vasoactive peptides
- Natriuretic peptides
- Adrenomedullin
- Bradykinin
- Substance P
- Calcitonin gene-related peptide

Decreases in:
- Neurohormonal activation
- Vascular tone
- Cardiac fibrosis, hypertrophy
- Sodium retention

PARADIGM-HF: Primary Endpoint of CV Death or HF Hospitalization With ARNI

- Randomized trial of patients with NYHA class II-IV HF

Number needed to treat: 21

HR: 0.80 (95% CI: 0.73-0.87; \( P < .001 \))

- Enalapril (n = 4212): 1117 events (26.5%)
- Sacubitril/valsartan (n = 4187): 914 events (21.8%)

20% relative risk reduction over median 27 mos

Slide credit: clinicaloptions.com
ARNI – Important Points – Class III in Guidelines

• ARNI SHOULD NOT BE administered concomitantly with an ACEi or within **36 hours** of the last dose of an ACEi
  • Increased risk of angioedema and morbidity
• ARNI should not be administered to patients with a history of angioedema.
Question 13

A 65 yr old WM with a h/o BPH and HTN undergoes an echo for a heart murmur. EF is 25% with global hypo. He is able to perform his ADLs without difficulty, but does get sob climbing 2 flights of stairs. Physical exam shows heart rate of 50, BP 140/75, 100% on RA. His medications include carvedilol 6.25 milligrams po BID and lisinopril 40 milligrams po daily.

The next most appropriate step in management of this patient is:
A. Switch from lisinopril to sacibutril/valsartan 24/26 milligrams PO BID
B. Increase carvedilol to 12.5 milligram PO BID
C. Initiate spironolactone 25 milligrams PO daily
D. Initiate isosorbide mononitrate/hydralazine 60/25 milligram PO daily
E. Switch from carvedilol to metoprolol succinate 75 milligrams PO daily
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E Switch from carvedilol to metoprolol succinate 75 milligrams PO daily
Systolic CHF Management

Class I: Beta-Blocker:
- Reduce chronic neurohormonal activation
- Reduce mortality by 30%, reduce hospitalization

Takes several months, up-titrte over weeks

Contraindicated in acute HF

Proven:
Metoprolol succinate
Carvedilol – start 3.125 mg BID to 25mg BID
Bisoprolol

2013 ACCF/AHA Guideline JACC 2013; 62: e147-239
A 72-year-old man is evaluated in the hospital for heart failure. In the past month, he has developed progressive dyspnea, such that he cannot walk 50 meters without stopping to catch his breath. He has a history of hypertension and ischemic cardiomyopathy. During the hospitalization, a perfusion imaging study demonstrated no ischemia, and an echocardiogram revealed a left ventricular ejection fraction of 20%. Medications are aspirin, ramipril, isosorbide mononitrate, and furosemide. On physical examination, the patient is afebrile, blood pressure is 120/68 mm Hg, pulse rate is 73/min, and respiration rate is 22/min. The estimated central venous pressure is 9 cm H₂O. A paradoxical split S₂ and an S₃ are present. Lungs are clear to auscultation.

A 12-lead electrocardiogram is shown.

In addition to diuresis, which of the following is the most appropriate treatment before discharge?
A. Add carvedilol
B. Add ivabradine
C. Cardiac resynchronization therapy
D. ICD
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In addition to diuresis, which of the following is the most appropriate treatment before discharge?

A. Add carvedilol
B. Add ivabradine
C. Cardiac resynchronization therapy
D. ICD
Chronic Systolic HF with reduced EF <40%

**Aldosterone-Inhibitors** (NYHA Class II-IV HF) – WHEN TO START
IF Creatinine ≤ 2.5 mg/dL men; ≤ 2.0 mg/dL women (or est. GFR >30 mL/min/1.73 m²)
AND Potassium < 5.0 mEq/L

**POTENTIAL ISSUES WITH SPIRONOLACTONE**
Gynecomastia with spironolactone: 10%
“Careful monitoring of potassium, renal function, and diuretic dosing”
Can switch to Eplerenone

2013 ACCF/AHA Guideline JACC 2013; 62: e147-239
Yancey CW et al. ACC/AHA/HFSA Heart Failure Focused Update. JACC 2017; 70: 776-803
Question 15

62 Hispanic F ischemic cardiomyopathy, EF 30%, chronic dyspnea with 1 city block or 1 flight stairs, on aspirin, lisinopril, carvedilol, bumetanide, atorvastatin.

**Best next medicine?**

A. Hydralazine and isosorbide dinitrate  
B. Digoxin  
C. Cilostazol  
D. Candesartan  
E. Spironolactone
Question 15

62 Hispanic F ischemic cardiomyopathy, EF 30%, chronic dyspnea with 1 city block or 1 flight stairs, on aspirin, lisinopril, carvedilol, bumetanide, atorvastatin.

Best next medicine?

A. Hydralazine and isosorbide dinitrate
B. Digoxin
C. Cilostazol
D. Candesartan
E. Spironolactone
Question 16

49 black M with non-ischemic cardiomyopathy, chronic dyspnea with 1 city block, 1 flight stairs, on lisinopril, carvedilol, furosemide. K 5.1. Cr 2.2.

Best next medicine?
A. Digoxin
B. Spironolactone
C. Candesartan
D. Hydralazine and isosorbide dinitrate
E. Amlodipine
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B. Spironolactone
C. Candesartan
D. Hydralazine and isosorbide dinitrate
E. Amlodipine
HErEF with reduced EF <40% in Black Patients

Yancey CW et al. ACC/AHA/HFSA Heart Failure Focused Update. JACC 2017; 70: 776-803
Ivabradine

- Sino atrial node modulator causing reduction in heart rate
- No negative ionotrophic effects
- Indications
  - Symptomatic heart failure
  - EF < 35%
  - Elevated heart rate > 70/min in sinus despite maximally tolerated doses of β-blocker therapy
- Reduces heart failure–associated hospitalizations and the combined endpoint of mortality and heart failure hospitalization
Cardiac Resynchronization Therapy

• Indications
  • EF <35%
  • Prolonged QRS (>150msec)
    • LBBB most likely to benefit
  • NYHA II to IV despite GDMT
68 F ischemic cardiomyopathy, EF 40%, no symptoms of heart failure, last MI 60 days ago, on aspirin, clopidogrel, lisinopril, metoprolol succ. ECG shown.

Best next step?

A. No additional therapy
B. Implantable CardioDefibrillator
C. Cardiac Resynchronization Therapy (CRT)
D. Implantable CardioDefibrillator + CRT
E. Pacemaker
Question 17

68 F ischemic cardiomyopathy, EF 40%, no symptoms of heart failure, last MI 60 days ago, on aspirin, clopidogrel, lisinopril, metoprolol succ. ECG shown.

Best next step?

A. **No additional therapy**
B. Implantable CardioDefibrillator
C. Cardiac Resynchronization Therapy (CRT)
D. Implantable CardioDefibrillator + CRT
E. Pacemaker
Heart Failure & Device Therapy

NYHA class II–III, LVEF $\leq 35\%$; (caveat: $>1$ y survival, $>40$ d post MI)

NYHA class II–IV, LVEF $\leq 35\%$, NSR & QRS $\geq 150$ ms with LBBB pattern

ICD‡ (COR I)

CRT or CRT-D‡ (COR I)

Yancey CW et al. ACC/AHA/HFSA Heart Failure Focused Update. JACC 2017; 70: 776-803
Advanced HF: Referral Advanced Therapies

- ≥2 hospitalize in last year
- Progressive cardiorenal
- Cardiac cachexia
- Intolerance to ACE-I and/or BB
- Escalating diuretic
- Hyponatremia
- ICD shocks

2013 ACCF/AHA Guideline JACC 2013; 62: e147-239
Yancey CW et al. ACC/AHA/HFSA Heart Failure Focused Update. JACC 2017; 70: 776-803
HFrEF – Address Other Co-Morbidities – 2017 ACC Update

• Anemia
  • IV iron IF iron deficiency (Class IIb) (Ferritin <100 ng/ml OR 100-300 ng/ml if transferrin sat <20%)
    • Erythropoietin stimulating agents should not be used – no therapeutic benefit

• Hypertension (Stage A to C)
  • BP should be <130/80 (Class 1 recommendation)

• Sleep Disorders
  • Consider sleep study in patients with sleep disordered breathing or excessive daytime sleepiness (IIa recommendation)
    • CPAP if OSA (IIb recommendation)

Yancey CW et al. ACC/AHA/HFSA Heart Failure Focused Update. JACC 2017; 70: 776-803
Treatment of HFrEF Stage C and D

[Diagram showing treatment steps for HFrEF Stage C and D]

- Step 1: Establish Dx of HFrEF; assess volume; initiate GDMT
- Step 2: Consider the following patient scenarios
  - NYHA class II-IV: provided syst. BP <100, HFrEF LVEF <40%
  - NYHA class III-IV: in black patients
  - NYHA class I-III, LVEF <30%; (ensure >1 y survival >40%)
  - NYHA class II-IV, NSR & QRS ≥150 ms with LVNC pattern
  - NYHA class II-III, NSR, heart rate ≥72 bpm on maximally tolerated dose beta blocker
- Step 3: Implement indicated GDMT
  - Assess symptoms
  - NYHA class II-IV: providing syst. BP >100, HFrEF LVEF <40%
  - NYHA class III-IV: in black patients
  - NYHA class I-III, LVEF <30%; (ensure >1 y survival >40%)
  - NYHA class II-IV, NSR & QRS ≥150 ms with LVNC pattern
  - NYHA class II-III, NSR, heart rate ≥72 bpm on maximally tolerated dose beta blocker
- Step 4: Reassess symptoms
- Step 5: Consider additional therapy
  - Palliative care (COR I)
  - Transplant (COR I)
  - LVADS (COR II)
  - Investigational studies (COR II)

Continue GDMT with serial reassessment & optimized dosing/ adherence
Aspects of Palliative Care

- Manage cardiac and noncardiac symptoms
- Support caregivers/loved ones
- Advanced care planning
- Goals of care discussions
- Determine need for a palliative care specialist*

Follow up of Patients with HFrEF

- Education
- Monitor lytes and renal function
- Evaluate for sleep apnea
- ROUTINE surveillance echo in the absence of a change in clinical status or planned interventions is NOT recommended
- Serial BNPs should not be used to guide the care of pts with HFrEF
## Options in Stage D Heart Failure

<table>
<thead>
<tr>
<th>Stage D or NYHA IV</th>
<th>1 year survival</th>
</tr>
</thead>
<tbody>
<tr>
<td>Best medical therapy +/- ionotrope</td>
<td>20%</td>
</tr>
<tr>
<td>LVAD</td>
<td>Original pulsatile: 50%</td>
</tr>
<tr>
<td></td>
<td>Continuous: &gt;85% Bridge</td>
</tr>
<tr>
<td></td>
<td>Destination: 77%</td>
</tr>
<tr>
<td>Heart Transplant</td>
<td>&gt;85%</td>
</tr>
</tbody>
</table>
Takotsubo Cardiomyopathy

• Stress cardiomyopathy
• Typically, in older women
• Classic EKG changes
  • ST elevation (<1mm)
  • QT prolongation (at 48 hrs)
  • Deep symmetric TWI (at 48 hrs)
  • ECG changes resolve
• Non obstructive CAD on coronary angiography
• LV dysfunction NOT in coronary distribution
  • Apical ballooning
  • Mid-ventricular ballooning
  • Basal ballooning
• Treatment similar to other forms of HFrEF
• Most patients will recover over the course of few weeks to months
Takotsubo Cardiomyopathy

Normal heart

Left ventricle
The normal shape of the left ventricle after it contracts (squeezes)

Takotsubo cardiomyopathy

Enlarged left ventricle
The left ventricle swells and forms a shape like an octopus pot

Japanese Octopus Pot (Tako-Tsubo)
Chronic HF preserved EF – BP, Diuretics

Diastolic Heart Failure = Heart Failure with Preserved Ejection Fraction 
HFpEF; EF ≥ 40-50%
-Candesartan reduced hospitalization

<table>
<thead>
<tr>
<th>COR</th>
<th>LOE</th>
<th>RECOMMENDATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>B</td>
<td>Systolic and diastolic blood pressure should be controlled in patients with HFpEF in accordance with published clinical practice guidelines to prevent morbidity (164,165) &lt;130/80</td>
</tr>
<tr>
<td>I</td>
<td>C</td>
<td>Diuretics should be used for relief of symptoms due to volume overload in patients with HFpEF.</td>
</tr>
</tbody>
</table>

Yancey CW et al. ACC/AHA/HFSA Heart Failure Focused Update. JACC 2017; 70: 776-803
CHARM-Preserved Lancet 2003; 362: 777-81
CHARM Trial in HpEF – Candesartan Reduced Hospitalizations
Chronic HFpEF – Aldosterone Receptor Antagonists

In appropriately selected patients with HFpEF (with EF ≥45%, elevated BNP levels or HF admission within 1 year, estimated glomerular filtration rate >30 mL/min, creatinine <2.5 mg/dL, potassium <5.0 mEq/L), aldosterone receptor antagonists might be considered to decrease hospitalizations (83,166,167).

Yancey CW et al. ACC/AHA/HFSA Heart Failure Focused Update. JACC 2017; 70: 776-803

CHARM-Preserved Lancet 2003; 362: 777-81
Question 18

• 76-year-old woman presents with complaints of progressive shortness of breath for the past 2 months. Her past medical history is significant for hypertension. Lungs revealed bibasilar crackles, S1 and S2 is heard, no murmurs. There is one plus pitting edema bilaterally.

• Echo reveals LVH and an ejection fraction of 65%.

In addition to diuretics, what is the best management for this patient?

A. Start digoxin
B. Start candesartan
C. Start calcium channel blocker
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B. Start candesartan

C. Start calcium channel blocker
Thank You!

Cardiology Continues

- Wednesday, July 7
- Wednesday, July 14

Next up in the series – Gastroenterology
Stay tuned for dates