Recognizing and Managing Pulmonary Arterial Hypertension in Primary Care

Faculty

- Alexander Duarte, MD
  Professor
  Division of Pulmonary Critical Care & Sleep Medicine
  Department of Internal Medicine
  University of Texas Medical Branch
  Galveston, TX

- Alanna Kavanaugh, FNP-BC, MSN, CCRN
  Nurse Practitioner
  Weill Cornell Medical College
  Pulmonary, Critical Care
  Instructor of Practice for Graduate and Undergraduate Program
  College of Mount Saint Vincent
  New York, NY

- Franck Rahaghi, MD, MHS, FCCP
  Director of Advanced Lung Disease Clinic
  Director: Pulmonary Hypertension Clinic
  Chairman, Dept. of Pulmonary and Critical Care
  Cleveland Clinic Florida
  Weston, FL

- Arunabh Talwar, MD, FCCP
  Director: Pulmonary Hypertension and Advanced Lung Disease Program
  North Shore University Hospital, Manhasset, New York

- Melisa Wilson, ARNP
  Pulmonary Hypertension Nurse Practitioner and Coordinator
  Center for Pulmonary Hypertension and CVD at Florida Hospital
  Orlando, FL

Disclosures

- Dr. Duarte has no financial relationships to disclose.
- Ms. Kavanaugh has no financial relationships to disclose.
- Dr. Rahaghi has served as a Consultant for Actelion, AstraZeneca, Baxter, Boehringer Ingelheim, Gilead, Reata and United Therapeutics. He has served on the Speakers' Bureau for Actelion, Baxter, Boehringer Ingelheim and United Therapeutics and has received Contracted Research support from Actelion, AstraZeneca, Baxter, Bellerophon, Boehringer Ingelheim, Merck, Reata and United Therapeutics.
- Dr. Talwar served on the Speakers' Bureau for Boehringer Ingelheim. He is also on the advisory board for Genentech.
- Ms. Wilson is a speaker for Bayer, Actelion and United Therapeutics. She is also on the advisory board for United Therapeutics.
Learning Objectives

1. Review the risk factors and classification of pulmonary hypertension (PH)
2. Discuss the appropriate diagnostic strategy for pulmonary arterial hypertension (PAH), including the roles of echocardiography, ventilation/perfusion (V/Q) scanning, and right heart catheterization (RHC)
3. Review current and emerging treatments for patients with PAH
4. Describe how to monitor patients with PAH for disease progression

PRE-TEST QUESTIONS

Pre-test ARS Question 1

Please rate your confidence in your ability to recognize features that suggest PAH:

1. Not at all confident
2. Slightly confident
3. Moderately confident
4. Pretty much confident
5. Very confident
Pre-test ARS Question 2

How often do you order an echocardiogram for a patient with unexplained shortness of breath?

1. Never
2. Rarely
3. Sometimes
4. Often
5. Always

What is Pulmonary Arterial Hypertension?

Chronic, progressive, cardiopulmonary condition associated with:
- Progressive exertional shortness of breath
- Decreased endurance related to physical activity
- Syncope, chest pain or fatigue

Hemodynamically defined as:
- Abnormal increase in pulmonary artery pressure
- Near normal to normal pulmonary capillary wedge pressure
- Increased pulmonary vascular resistance

Pulmonary hypertension results in right ventricular pressure/volume overload leading to right heart failure and death.

Fifth World Symposium on Pulmonary Hypertension:

Diagnostic Definition of PAH

<table>
<thead>
<tr>
<th>Pulmonary Arterial Hypertension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean pulmonary artery pressure (mPAP)</td>
</tr>
<tr>
<td>And</td>
</tr>
<tr>
<td>Mean pulmonary artery wedge pressure (PAWP)</td>
</tr>
<tr>
<td>With</td>
</tr>
<tr>
<td>Pulmonary vascular resistance (PVR)</td>
</tr>
</tbody>
</table>

As measured by right-heart catheterization

Pulmonary Vascular Pathology

Normal Pulmonary Artery

Pulmonary Arterial Hypertension

Pathophysiology of PAH Includes:
Vasoconstriction, Vasoproliferation, and Eventual Right Heart Failure


Schematic Progression of PAH

Pre-symptomatic/Compensated
Symptomatic/Decompensating
Declining/Decompensated

Time

PAP

PVR

CO

CO = PAP

PVR

Case Study 1:

36 year old African American female, mother of two, seen one year ago for hypertension reports she has "a hard time catching her breath":

- Never smoked
- Not on birth control pills or estrogen replacement therapy
- Chart review indicates prior episode of URI
- Treated with HCTZ for mild hypertension (135/90)

What are common conditions to exclude as part of your differential diagnosis?
Approach to Dyspnea

Differential diagnosis of dyspnea includes:
- Diseases of the lungs and chest wall
- Cardiovascular
- Neuromuscular
- Renal
- Endocrine
- Rheumatologic
- Hematologic
- Psychiatric
- **New onset**: pneumonia, pulmonary embolism, congestive heart failure, asthma
- **Chronic dyspnea involves a systematic, physiologically based approach**

Presentations of Dyspnea

**Sudden onset**
- Pulmonary embolism, pneumonia, myocardial infarction

**Slowly progressive conditions**
- COPD, interstitial lung disease, cardiomyopathy, pulmonary vascular disease

**Dyspnea with chronic cough**
- Airway disease, interstitial lung disease, GERD

**Nocturnal symptoms**
- Asthma, COPD, GERD, cardiomyopathy, neuromuscular conditions

Case Study 1:

Further questioning about dyspnea finds:
- **Dyspnea occurs with exercise**
  - She has given up her exercise classes and has trouble doing laundry or carrying groceries
  - Denies wheezing or cough
  - Denies chest pain or discomfort except notes palpitations climbing stairs
- **Dyspnea has “slowly building” for several months**
  - She thinks she is stressed with being a mother of two or worries she might be anemic
- Patient describes Raynaud’s phenomenon
**REVEAL: Most Frequent PAH Presenting Symptoms**

- Dyspnea at rest: 12.6%
- Cough: 13.8%
- Dizzy/lightheaded: 14.6%
- Presyncope/syncope: 14.5%
- Edema: 14.3%
- Chest pain/discomfort: 11.9%
- Fatigue: 14.7%
- Dyspnea on exertion: 26.2%
- Incidence (%)

- 85.4% Diagnosed ≤2 years after symptom onset (n=1,967)
- 26.7% Diagnosed >2 years after symptom onset (n=526)


**Diagnostic Strategy for Progressive Dyspnea**

- Progressive Dyspnea
  - CXR
    - Abnormal Lung Fields
      - Pleural Effusion
      - Diffuse Infiltrate
      - Tumor
      - Thoracentesis
    - Chest CT
      - Bronchoscopy
      - Echocardiogram
      - Spirometry
      - VQ scan
      - EMG
    - LV Failure
      - Pericardial Effusion
      - Airway Disease
      - NM disease
      - Pulm Embolism

**Case Study 1:**

- BP: 110/72 mmHg, P: 92 min, RR: 16 min, SpO2 92% (Room air)
  - 36 y/o thin female
  - Neck: Jugular venous distension, pulsatile 10 cm at 45°
  - Heart: RV heave, regular rate and rhythm with accentuated P2 and 2/6 systolic murmur at right mid-sternal border
  - Lungs: clear to auscultation bilaterally
  - Abdomen: shifting dullness, moderately distended
  - Extremities: 2+ edema, pale nail beds
- Labs normal except ANA 1:640
Examination Findings Suggestive of PH/PAH

- Neck: HJR, JVD
- Lungs: CTA w/o wheeze / crackles
- Heart: Heave, RRR, Increased P2, TR SM
- Skin: Changes c/w CTD
- Abdomen: Ascites
- Joint: Changes c/w CTD
- Liver: Hepatomegaly, Pulsatile liver
- Extremities: Edema
- Digits: Cool, Cyanotic


Pre-test ARS Question 3

Which of the following conditions is associated with risk for PAH?

1. COPD
2. Sarcoidosis
3. Left heart dysfunction
4. Connective tissue disorders

Importance of History in Diagnosing PAH in Primary Care Setting: Who is at Risk?

Patients with:
- Connective tissue disorders
- Congenital heart defects, including corrected shunts
- Exposure to drugs and toxins causing PAH
- HIV disease
- Family history of PAH
- Portal hypertension
- Idiopathic PAH is an extremely rare condition
  - Vast majority of PAH seen in primary care is attributable to causative (secondary) conditions

Classification of Pulmonary Arterial Hypertension by Etiology

Group 1 -- Pulmonary Arterial Hypertension (PAH):
- Idiopathic (IPAH)
- Heritable (HPAH)
- BMPR2
- ALK-1, endoglin, SMAD9, CAV1, KCNK3
- Unknown
- Drugs and toxins induced
- Associated with:
  - Connective Tissue Diseases
  - HIV Infection
  - Portal Hypertension
  - Congenital Heart Diseases
- Schistosomiasis
- Group 1' Pulmonary Venous Occlusive Disease (PVOD) and/or Pulmonary Capillary Hemangiomatosis (PCH)
- Group 1" Persistent pulmonary hypertension of the newborn (PPHN)


Clinical Classification of Other Forms of Pulmonary Hypertension

Group 2 -- Pulmonary Hypertension Due to Left Heart Disease (Most common)
- Left ventricular systolic dysfunction
- Left ventricular diastolic dysfunction
- Valvular disease
- Congenital / acquired left heart inflow / outflow tract obstruction

Clinical Classification of Other Forms of Pulmonary Hypertension

Group 3 -- Pulmonary Hypertension Due to Lung Diseases and/or Hypoxemia (Common)
- Chronic obstructive pulmonary disease
- Interstitial lung disease
- Other pulmonary diseases with mixed restrictive and obstructive pattern
- Sleep-disordered breathing
- Alveolar hypoventilation disorders
- Chronic exposure to high altitude
Clinical Classification of Other Forms of Pulmonary Hypertension

Group 4 -- Chronic Thromboembolic Pulmonary Hypertension (CTEPH)

- **Chronic** qualifies pulmonary hypertension and not thromboembolism
- CTEPH can arise from one embolism that after causing acute pulmonary hypertension persists to cause chronic pulmonary hypertension


Clinical Classification of Other Forms of Pulmonary Hypertension

Group 5 -- Pulmonary Hypertension with Unclear Multifactorial Mechanisms

- **Hematologic disorders**: chronic hemolytic anemias, myeloproliferative disorders, splenectomy
- **Systemic disorders**: sarcoidosis, pulmonary Langerhans cell histiocytosis, lymphangioleiomyomatosis, neurofibromatosis, vasculitis
- **Metabolic disorders**: glycogen storage disease, Gaucher disease, thyroid disorders
- **Others**: tumor obstruction, fibrosing mediastinitis, chronic renal failure


Elevated Pulmonary Artery Pressures are Seen in Wide Range of Conditions

Image courtesy of Jean Elwing, MD
**Prevalence of Pulmonary Hypertension**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Prevalence of PH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reduced EF heart failure</td>
<td>12%-14% of pts with HF</td>
</tr>
<tr>
<td>Preserved EF heart failure</td>
<td>12% of pts with HF</td>
</tr>
<tr>
<td>COPD</td>
<td>20%-50% of pts with advanced lung disease</td>
</tr>
<tr>
<td>Obstructive sleep apnea</td>
<td>20%</td>
</tr>
<tr>
<td>Chronic thromboembolic</td>
<td>0.5%-3.8% pts with acute pulmonary embolism</td>
</tr>
</tbody>
</table>

**Prevalence of PAH in Associated Conditions**

<table>
<thead>
<tr>
<th>Associated condition</th>
<th>Prevalence of PAH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systemic sclerosis</td>
<td>7%-12%</td>
</tr>
<tr>
<td>Portal hypertension</td>
<td>2%-6%</td>
</tr>
<tr>
<td>Congenital heart disease</td>
<td>1%-12% with systemic to pulmonary shunts</td>
</tr>
<tr>
<td>Eisenmenger’s syndrome</td>
<td>25%-50%</td>
</tr>
<tr>
<td>HIV infection</td>
<td>0.5%</td>
</tr>
<tr>
<td>Schistosomiasis</td>
<td>5% with hepatic involvement</td>
</tr>
</tbody>
</table>


**Pre-test ARS Question 4**

A 61 y/o, non-smoking, obese man presents with progressive dyspnea on exertion. He has a history of hypertension and dyslipidemia.  
Workup: BP 140/88 mmHg, lungs CTA, heart RRR, mild edema of LE, and mild hepatomegaly.  
ECG: WNL except for right axis deviation. PFTs: WNL except for reduced DLCO (65%).  
Meds: Fosinopril/hydrochlorothiazide 20/25 mg qd and atorvastatin 80 mg qd.  
What is an appropriate next step for this patient?  
1. Order chest CT  
2. Initiate empiric diltiazem  
3. Order right heart catheterization study  
4. Order echocardiogram with pulmonary pressures
Diagnosing PAH: Assessment of Patients Presenting with Unexplained Dyspnea

- History including risk factors
- Physical examination
- Chest X-ray
- ECG
- PFT including DLCO
- Echocardiogram
- Chest CT
- Serology: HIV, Hepatitis B & C, ANA
- Ventilation-perfusion scan (V/Q)
- Right heart catheterization (RHC)


Case Study 1: 36-year-old Female Presenting with Exertional Dyspnea

Symptoms could be caused by cardiopulmonary disease includingILD, PE, PAH

Clues for possible PAH:
- Mixed connective tissue disease (MCTD)
- Shortness of breath
- Chest pain
- Exertional lightheadedness
- SBP 102 mmHg, O2sat 92% on RA
- RHF signs on examination

Echocardiography: Apical Four Chamber

Echocardiogram Findings:
- LVEF 60%-65%
- Ventricular septum diastolic and systolic flattening
- RA dilation
- RV severely dilated with reduced function
- Estimated PA pressure 87-92 mm Hg
- Pericardial effusion without RV collapse
Echocardiogram: Apical Four Chamber

Normal structure and function
Abnormal structure and function
Image courtesy of Valerie McLaughlin, MD

Echocardiography: Tricuspid Regurgitation

Modified Bernoulli’s Equation:

\[ 4 \times (V)^2 + RAP = RVSP (PASP) \]

RAP is estimated at 5, 10, or 15 based on collapsibility of IVC:
Sometimes arbitrarily set at 10: Must have a good echo lab

V: tricuspid jet velocity (m/s); RAP: right atrial pressure; RVSP: right ventricular systolic pressure; PASP: pulmonary artery systolic pressure

Echocardiogram in Pulmonary Hypertension

Echocardiogram findings in pulmonary hypertension (PH)
- RA/RV
  - Right atrial enlargement (RAE), RV dilation
  - RV dysfunction
  - Decreased tricuspid annular plane excursion (TAPSE)
  - Elevated pulmonary artery pressure (PAP)

Echocardiogram findings in PH associated with left heart disease
- Left atrial enlargement (LAE), LVH, LV dilation
- LV systolic dysfunction
- Grade II/III diastolic dysfunction
- Mitral/aortic valvular disease
Pre-test ARS Question 5
A 70 y/o overweight woman presents with progressive dyspnea on exertion. She has a history of osteoarthritis, hypertension, and dyslipidemia.
Workup: BP 138/82 mmHg, lungs CTA, heart RRR, mild edema of LE.
EGC shows right axis deviation. PFTs show reduced DLCO (56%). Echo: LVEF 65%, moderate tricuspid regurgitation, RVSP 50 mmHg.
Meds: Lisinopril 20 mg qd, hydrochlorothiazide 25 mg qd, rosvastatin 40 mg qd, ibuprofen pm.
What is an appropriate next step for this patient?
1. Order chest CT
2. Initiate empiric diltiazem
3. Order right heart catheterization study
4. Diagnose PAH and initiate PAH-specific therapy

Echocardiographic Estimation of Pulmonary Hypertension in Clinical Practice
- In the echo lab a commonly measured and reported value is systolic pulmonary artery pressure or RVSP
- Normal resting values defined as peak systolic pressure of 35 or 36 mmHg
- ACC/AHA expert consensus recommends further evaluation of patient with dyspnea and an estimated RVSP >40 mm Hg
- Echo-derived reports of PH are not considered diagnostic
- Further work-up is required

PH by Echo ≠ PAH
- Single echo lab/Western Australian community of 165,000
- Echo defined PH (RVSP ≥ 40 mm Hg)
- N=936 of 10,314 patients with echo PASP >40 mm Hg.

<table>
<thead>
<tr>
<th>Condition</th>
<th>Incidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>CTEPH</td>
<td>2.7%</td>
</tr>
<tr>
<td>Lung disease</td>
<td>2.0%</td>
</tr>
<tr>
<td>Sleep-related hypventilation</td>
<td>9.3%</td>
</tr>
<tr>
<td>Unknown</td>
<td>15.4%</td>
</tr>
</tbody>
</table>

Diagnostic Testing Results Often Found with PAH

Pulmonary function testing
- Preserved pulmonary mechanics
- Isolated low DLCO
- Example: FEV1 88%, FVC 86%, DLCO 42%

V/Q
- No evidence of acute or chronic PE

Diagnostic Testing Results Often Found with PAH

CT chest
- Lack of significant parenchymal disease
- Enlarged PA/RA/RV

Overnight pulse oximetry
- Normal or mild hypoxemia

Polysomnogram
- Normal or controlled OSA

Right Heart Catheterization Necessary to Establish Cause of Pulmonary Hypertension

- Normal ranges for various pressures and flows are shown in the diagram.
Low Use of Right Heart Catheterization Prior to Initiation of PAH-specific Medications

Right Heart Catheterizations Performed On Patients Receiving PAH-specific Therapy

- RHC <3 Months of PAH Rx: 42%
- RHC At Any Time During Study Period: 60.2%

N=969 patients receiving PAH-specific medications from national private insurance database. Patients were enrolled continuously for 27 months (12 months prior and 15 months after initial office visit for PH).

Case Study 1: 36 y/o Female Has PAH Associated with Mixed Connective Tissue Disease

PAH confirmed by RHC:
- RAP 15 mm Hg
- PAP 80/42 (55) mm Hg
- PCWP (wedge) 10 mm Hg
- Cardiac output 3.5 L/min

High risk features:
- Functional class III
- Rapidly progressive
- RV dysfunction
- Pericardial effusion
- Elevated RA pressure
- Low cardiac output

This patient has severe, advanced disease
Recommend urgent PAH evaluation
Initiation of aggressive PAH therapy indicated

Questions to Consider
Survival in PAH Phenotypes is Decreased and Similar to Metastatic Breast Cancer

![Graph showing survival in PAH and metastatic breast cancer](image)

McLaughlin VV et al. Chest. 2004;126:78S


2015 ESC/ERS Guidelines: Disease Progression Risk Factors in PAH

<table>
<thead>
<tr>
<th>Prognostic factor (estimated 1 yr mortality)</th>
<th>Low risk &lt;5%</th>
<th>Intermediate risk 5%-10%</th>
<th>High risk &gt;10%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clinical signs of RV failure</td>
<td>Absent</td>
<td>Absent</td>
<td>Present</td>
</tr>
<tr>
<td>Progression of symptoms</td>
<td>No</td>
<td>Slow</td>
<td>Rapid</td>
</tr>
<tr>
<td>Syncope</td>
<td>No</td>
<td>Occasional syncope</td>
<td>Repeated syncope</td>
</tr>
<tr>
<td>WHO functional class</td>
<td>1, II</td>
<td>III</td>
<td>IV</td>
</tr>
<tr>
<td>6MWD</td>
<td>&gt;440 m</td>
<td>165-440 m</td>
<td>&lt;165 m</td>
</tr>
<tr>
<td>Cardiopulmonary exercise testing</td>
<td>Peak VO2 &gt;15 ml/min/kg (&gt;75% pred.) VVO2 slope &gt;26</td>
<td>Peak VO2 11-15 ml/min/kg (&gt;50%-75% pred.) VVO2 slope 26-44.9</td>
<td>Peak VO2 6-11 ml/min/kg (&lt;50% pred.) VVO2 slope 44.9</td>
</tr>
<tr>
<td>NT-proBNP plasma levels</td>
<td>BNP &lt;50 ng/l</td>
<td>NT-proBNP &lt;300 ng/l</td>
<td>NT-proBNP &gt;300 ng/l</td>
</tr>
<tr>
<td>Imaging (echocardiography, CMR imaging)</td>
<td>RA area &lt;16 cm²</td>
<td>No pericardial effusion</td>
<td>RA area &gt;26 cm²</td>
</tr>
<tr>
<td>Hemodynamics</td>
<td>RAP 1-1.5 mmHg</td>
<td>CI 2.0-2.4 L/min/m²</td>
<td>RAP &gt;3.5 mmHg</td>
</tr>
</tbody>
</table>

Pre-test ARS Question 6

For a patient diagnosed with PAH who demonstrated no vasodilator response on RHC, all of the following would be appropriate, EXCEPT:

1. Consider anticoagulant therapy
2. Initiate calcium channel blocker
3. Recommend pulmonary rehabilitation
4. Determine patient’s WHO functional class
General PAH Care

Anticoagulation
- In general, IPAH patients receive anticoagulant therapy
- Anticoagulation therapy should be considered for patients with secondary PAH

Oxygen
- Hypoxia is a potent vasoconstrictor and can elevate PA pressure

Fluid/volume control
- Diuretics
- Fluid restriction
- Low salt diet

Pulmonary Rehabilitation – Encourage participation

PAH-specific FDA-approved Therapies for Use in the US

<table>
<thead>
<tr>
<th>Endothelin Receptor Antagonists</th>
<th>NO-cGMP Pathway</th>
<th>Prostanoids – Prostacyclin Analogs</th>
<th>Prostacyclin Agonists</th>
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</thead>
<tbody>
<tr>
<td>Bosentan (PO) FDA Approved: 2001</td>
<td>Sildenafil (PO) FDA Approved: June 2006</td>
<td>Epoprostenol (IV) FDA Approved: September 1995 FDA Approved: June 2008</td>
<td>Selexipag (PO) FDA Approved: December 2015</td>
</tr>
<tr>
<td>Ambrisentan (PO) FDA Approved: June 2007</td>
<td>Tadalafil (PO) FDA Approved: May 2009</td>
<td>Treprostinil (SC, IV, and inhaled) First (SC formulation) FDA Approved: July 2002</td>
<td></td>
</tr>
<tr>
<td>Macitentan (PO) FDA Approved: October 2013</td>
<td>Riociguat (PO) FDA Approved: October 2013</td>
<td>Epoprostenol (IV) FDA Approved: December 2004</td>
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</tr>
</tbody>
</table>

Calcium Channel Blockers:
- Only for patients with response to vasodilators on RHC
AND NO ONE ELSE!

Initial Therapy with Approved PAH Drugs: Recommendations

INITIAL THERAPY WITH APPROVED PAH DRUGS

<table>
<thead>
<tr>
<th>WHO FC II</th>
<th>WHO FC III</th>
<th>WHO FC IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ambrisentan</td>
<td>Bosentan</td>
<td>Macitentan</td>
</tr>
<tr>
<td>Riociguat</td>
<td>Sildenafil</td>
<td>Tadalafil</td>
</tr>
<tr>
<td>Selexipag**</td>
<td>Epoprostenol (IV)</td>
<td>Treprostinil (SC, IV, inhaled) (oral*)</td>
</tr>
<tr>
<td>Ambrisentan</td>
<td>Bosentan</td>
<td>Macitentan</td>
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<tr>
<td>Riociguat</td>
<td>Sildenafil</td>
<td>Tadalafil</td>
</tr>
<tr>
<td>Treprostinil (IV) (oral*)</td>
<td>Epoprostenol (IV)</td>
<td>Treprostinil (IV) (oral*)</td>
</tr>
</tbody>
</table>

Calcium Channel Blockers:
- Only for patients with response to vasodilators on RHC
AND NO ONE ELSE!

Ambrisentan was approved by the FDA in December 2013 for treatment of PAH in patients with WHO FC III or IV disease.
Bosentan was approved by the FDA in September 2015 for treatment of PAH in patients with WHO FC III or IV disease.
Riociguat was approved by the FDA in December 2015 for treatment of PAH in patients with WHO FC III or IV disease.
**Selexipag was approved by the FDA in November 2015 for treatment of PAH in patients with WHO FC II or III disease.
*Epoprostenol is not currently available in the US.
**Selexipag was approved by the FDA in December 2015 for treatment of PAH in patients with WHO FC II or III disease.

Pre-test ARS Question 7

A study in PAH comparing the combination of ambrisentan/tadalafil to either agent as monotherapy demonstrated which of the following?

1. Similar outcomes in all three treatment groups
2. Significantly higher rate of discontinuations due to adverse events in combination therapy group
3. Reduced risk for disease-related events with combination therapy compared to either agent as monotherapy
4. Reduced risk for disease-related events with combination therapy compared to tadalafil monotherapy but not ambrisentan monotherapy

Combination Therapy Reduces Risk of Events Compared to Ambrisentan or Tadalafil Monotherapy

Combination Therapy Reduces Risk of Events Compared to Ambrisentan or Tadalafil Monotherapy

Managing AEs with Oral Treprostinil: A Delphi Project

Managing AEs with Oral Treprostinil: A Delphi Project

Disclosure, Discussion and Planning on Expected AE Management is Crucial
Pre-test ARS Question 8

What monitoring is appropriate for a patient with PAH who is treated with combination therapy?

1. Order chest CT annually
2. Perform V/Q scan every 3-6 months
3. Order echocardiogram every 6-12 months
4. Repeat right heart catheterization every 6 months

Suggested Follow-up

<table>
<thead>
<tr>
<th></th>
<th>At baseline</th>
<th>Every 3-6 months</th>
<th>Every 6-12 months</th>
<th>3-6 months after changes in therapy</th>
<th>In case of clinical worsening</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical assessment and determination of functional class</td>
<td>+</td>
<td>+</td>
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<tr>
<td>ECG</td>
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<td>+</td>
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<td>Lung perfusion scan</td>
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<td>CTET</td>
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<td>Extended lab</td>
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<tr>
<td>Brain perfusion</td>
<td>+</td>
<td>+</td>
<td>+</td>
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Collaborative Role of Primary Care Givers in PAH

- Initiate the Workup
- Fluid Diet Co-management
- Rehabs/ Home health
- Anticoagulation Management
- Side effect Co-management
- Comorbidities Management
- Holistic Care
- Completing the Workup
- Diagnostic dilemmas
- Diagnostic costly/ vasoconstrictor trial
- Complex comorbidities
- Failure to achieve Rx goals
- Considering prostanoids
- Considering combination Rx
- Clinical trials
- Clinical trials
- Transplant Referral
Post-test ARS Question 1

After attending this program, how confident are you now in your ability to recognize features that suggest PAH:

1. Not at all confident
2. Slightly confident
3. Moderately confident
4. Pretty much confident
5. Very confident
Post-test ARS Question 2
After attending this program, how often do you intend to order an echocardiogram for a patient with unexplained shortness of breath?
1. Never
2. Rarely
3. Sometimes
4. Often
5. Always

Post-test ARS Question 3
Which of the following conditions is associated with risk for PAH?
1. COPD
2. Sarcoidosis
3. Left heart dysfunction
4. Connective tissue disorders

Post-test ARS Question 4
A 61 y/o, non-smoking, obese man presents with progressive dyspnea on exertion. He has a history of hypertension and dyslipidemia.
Workup: BP 140/88 mmHg, lungs CTA, heart RRR, mild edema of LE, and mild hepatomegaly.
ECG: WNL except for right axis deviation. PFTs: WNL except for reduced DLCO (65%).
Meds: Fosinopril/hydrochlorothiazide 20/25 mg qd and atorvastatin 80 mg qd.
What is an appropriate next step for this patient?
1. Order chest CT
2. Initiate empiric diltiazem
3. Order right heart catheterization study
4. Order echocardiogram with pulmonary pressures
A 70 y/o overweight woman presents with progressive dyspnea on exertion. She has a history of osteoarthritis, hypertension, and dyslipidemia. 

Workup: BP 138/82 mmHg, lungs CTA, heart RRR, mild edema of LE. 
ECG shows right axis deviation. PFTs show reduced DLCO (56%). Echo: LVEF 65%, moderate tricuspid regurgitation, RVSP 50 mmHg. 
Meds: Lisinopril 20 mg qd, hydrochlorothiazide 25 mg qd, rosuvastatin 40 mg qd, ibuprofen pm. 

What is an appropriate next step for this patient? 
1. Order chest CT 
2. Initiate empiric diltiazem 
3. Order right heart catheterization study 
4. Diagnose PAH and initiate PAH-specific therapy

For a patient diagnosed with PAH who demonstrated no vasodilator response on RHC, all of the following would be appropriate, EXCEPT: 
1. Consider anticoagulant therapy 
2. Initiate calcium channel blocker 
3. Recommend pulmonary rehabilitation 
4. Determine patient’s WHO functional class

A study in PAH comparing the combination of ambrisentan/tadalafil to either agent as monotherapy demonstrated which of the following? 
1. Similar outcomes in all three treatment groups 
2. Significantly higher rate of discontinuations due to adverse events in combination therapy group 
3. Reduced risk for disease-related events with combination therapy compared to either agent as monotherapy 
4. Reduced risk for disease-related events with combination therapy compared to tadalafil monotherapy but not ambrisentan monotherapy
Post-test ARS Question 8

What monitoring is appropriate for a patient with PAH who is treated with combination therapy?

1. Order chest CT annually
2. Perform V/Q scan every 3-6 months
3. Order echocardiogram every 6-12 months
4. Repeat right heart catheterization every 6 months