Inpatient Evaluation and Management of Pulmonary Arterial Hypertension (PAH)

**Key Points**
- PAH-specific medication therapies (oral or parenteral) should not be interrupted abruptly.
- On admission, home therapy should be continued. An order should be placed as soon as possible. If dose modification needed, contact pulmonary hypertension (PH) team.
- Avoid bolus administration (or line flush) of continuous infusion parenteral prostacyclins.
- Avoid nitrates for patients on Sildenafil, Tadalafil, and Riociguat.

**Risk Factors**
- Connective tissue disease
- Family history
- HIV
- Weight loss medication
- Cirrhosis
- Thromboembolic Disease
- Congenital Heart Disease
- Sickle Cell Disease

**Suspect PAH if:**
- Unexplained dyspnea
- Syncope
- Chest pain
- Clinical exam – signs/symptoms of right heart failure
- Hypoxia
- Unexplained anxiety

**Hemodynamically Unstable (see below)**
- Hospital admission
- STAT Pulmonary Hypertension (PH) Consult

**Consider Unstable if:**
- Evidence of low cardiac output and a combination of:
  - Right Ventricular Failure
    - Jugular venous distention
    - Ascites
    - Lower extremity edema
    - Hypotension
    - Renal Failure
  - Severe respiratory failure associated with hypoxia
  - Elevated troponins
  - Elevated BNP
  - Metabolic/respiratory acidosis
  - Tachycardia
  - Worsening anxiety

**Known or Suspected PAH**
- Obtain echocardiogram and right heart catheterization

**Right Ventricular Systolic Function NORMAL**
- Right Ventricular Systolic Function NORMAL
- Refer to PH

**Right Ventricular Systolic Function REDUCED**
- Right Ventricular Function REDUCED
- Patient Decompensated

**Euvolemic**
- Inpatient or outpatient evaluation based on clinical judgement
- Consider additional testing to identify etiology of PAH (see table below)

**Outpatient Referral to PH**
- Evidence of low cardiac output and a combination of:

**Tests**

<table>
<thead>
<tr>
<th>Tests</th>
<th>Possible Etiology</th>
</tr>
</thead>
<tbody>
<tr>
<td>VQ scan (perform in all patients)</td>
<td>Chronic PE</td>
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<tr>
<td>Pulmonary angiography</td>
<td>Ventilatory function</td>
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<tr>
<td>Chest CT angiogram</td>
<td>Gas exchange</td>
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<tr>
<td>Coagulopathy profile</td>
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<tr>
<td>PFTs (perform in all patients)</td>
<td>HIV infection</td>
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<tr>
<td>ABGs</td>
<td>Scleroderma</td>
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<tr>
<td>Overnight oximetry</td>
<td>SLE (lupus)</td>
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<tr>
<td>Polysomnography</td>
<td>Rheumatoid arthritis</td>
</tr>
<tr>
<td>HIV tests</td>
<td>Portopulmonary HTN</td>
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<tr>
<td>ANA</td>
<td></td>
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<tr>
<td>CTD serologies</td>
<td></td>
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<tr>
<td>LFTs</td>
<td></td>
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<tr>
<td>Abdominal US/CT</td>
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</tbody>
</table>

**When to Consult Pulmonary Hypertension (PH)**
- If Patient is on parental prostacyclin (IV epoprostenol or IV SubQ treprostinii) and not on cardiology or pulmonary service
- Prostacyclin infusion pump/tubing is not compatible with MRI, if patient needs surgery, procedure involving sedation, or MRI contact PH physician and pharmacy
- RV failure secondary to PAH
- Questions about new drug or dose change of PAH medications

**Guideline Goal**
To direct non-pulmonary hypertension specialists regarding evaluation of PAH, safe management of PAH medications, and indications for pulmonary hypertension (PH) consult.

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In general, PAH-specific medication therapies **should not be interrupted abruptly**, on admission home therapies should be continued while awaiting PH consult. If clinical need for interruption or modification is identified, **contact PH team for recommendation**.

### Oral Therapies

<table>
<thead>
<tr>
<th>Generic Name</th>
<th>Trade Name</th>
<th>Initial Dose</th>
<th>Maximum Dose</th>
<th>Common Adverse Drug Events</th>
<th>Management if NPO</th>
<th>Special Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Phosphodiesterase Inhibitors</strong></td>
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<tr>
<td>Sildenafil</td>
<td>Revatio</td>
<td>10-20 mg TID</td>
<td>80 mg TID</td>
<td>Flushing, Headache, Visual disturbance</td>
<td>▪ Crush for enteral tube administration</td>
<td>▪ <strong>Avoid</strong> nitrates, riociguat</td>
</tr>
<tr>
<td>Tadalafil</td>
<td>Adcirca</td>
<td>20 mg daily</td>
<td>40 mg daily</td>
<td>Flushing, Headache, Myalgia</td>
<td>▪ Crush for enteral tube administration</td>
<td>▪ <strong>Avoid</strong> nitrates, riociguat</td>
</tr>
<tr>
<td><strong>Soluble Guanylate Cyclase Stimulator</strong></td>
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<tr>
<td>Riociguat</td>
<td>Adempas</td>
<td>0.5-1 mg TID</td>
<td>2.5 mg TID</td>
<td>Headache, Hypotension, Dizziness</td>
<td>▪ Pharmacy to crush for enteral tube administration</td>
<td>▪ REMS Program</td>
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<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>▪ No IV alternative, if strict NPO contact PH team for recommendation</td>
<td>▪ Exposure Precautions</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>▪ <strong>Avoid</strong> nitrates, phosphodiesterase inhibitors</td>
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<tr>
<td><strong>Endothelin Receptor Antagonists</strong></td>
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<tr>
<td>Ambrisentan</td>
<td>Letairis</td>
<td>5 mg daily</td>
<td>10 mg daily</td>
<td>Edema, Headache, Nasal congestion</td>
<td>▪ Pharmacy to crush for enteral tube administration</td>
<td>▪ REMS Program</td>
</tr>
<tr>
<td>Bosentan</td>
<td>Tracleer</td>
<td>62.5 mg BID</td>
<td>125 mg BID</td>
<td>Edema, Headache, Increased LFTs</td>
<td>▪ No IV alternative, if strict NPO contact PH team for recommendation</td>
<td>▪ Exposure Precautions</td>
</tr>
<tr>
<td>Macitentan</td>
<td>Opsumit</td>
<td>10 mg daily</td>
<td>10 mg daily</td>
<td>Headache, Anemia, Nasopharyngitis</td>
<td>▪ Pharmacy to crush for enteral tube administration</td>
<td>▪ REMS Program</td>
</tr>
<tr>
<td><strong>Prostacyclin Analogue</strong></td>
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</tr>
<tr>
<td>Treprostinil</td>
<td>Orenitram</td>
<td>0.125-0.25 mg BID-TID</td>
<td>Patient specific</td>
<td>Flushing, Headache, Diarrhea, Nausea</td>
<td>▪ Do not crush - Contact PH team for recommendation if unable to swallow</td>
<td></td>
</tr>
<tr>
<td><strong>Selective IP Prostacyclin Agonist</strong></td>
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<tr>
<td>Selexipag</td>
<td>Uptravi</td>
<td>200 mcg BID</td>
<td>1600 mcg BID</td>
<td>Headache, Diarrhea, Nausea, Jaw pain</td>
<td>▪ Do not crush - Contact PH team for recommendation if unable to swallow</td>
<td></td>
</tr>
</tbody>
</table>
### Inhaled Therapies

- Patients on inhaled treprostinil or iloprost are restricted to the following units: H2, H6, KMCU, R8E, R8W, C11 A-F (See policy for exceptions)
- A pharmacy consult is required for all patients on inhaled treprostinil or iloprost
- Inhaled epoprostenol may be utilized as an acute therapy for PH, RV failure and/or refractory hypoxemia. Above restrictions do not apply (See separate policy for details).

<table>
<thead>
<tr>
<th>Generic Name</th>
<th>Trade Name</th>
<th>Initial Dose</th>
<th>Maximum Dose</th>
<th>Common Adverse Drug Events</th>
<th>Special Notes</th>
</tr>
</thead>
</table>
| Iloprost**   | Ventavis   | 2.5 mcg 6-9 times daily (no more frequent than every 2 hours) | 5 mcg 6-9 times daily (no more frequent than every 2 hours) | • Cough  
• Headache  
• Flushing  
• Nausea | • Must self-administer using home inhalation device  
• If unable to self-administer or without home device, contact PAH team for recommendation  
• Not compatible with hospital nebulizer or vent circuits |
| Treprostinil | Tyvaso     | 18 mcg (3 breaths) QID | 54-72 mcg (9-12) breaths QID | • Cough  
• Headache  
• Flushing  
• Throat irritation | |

**Formulary non-stock item: pharmacy may obtain medication, but initially patient will require home supply. Contact PAH team, if patient does not have initial home supply.**

### Parenteral Therapies

- Do not interrupt the continuous infusion of parenteral prostacyclin therapies
- Intravenous access for epoprostenol/treprostinil should never be flushed, this may cause the patient to receive a bolus of medication
- See policy for additional administration considerations

<table>
<thead>
<tr>
<th>Generic Name</th>
<th>Trade Name</th>
<th>Route</th>
<th>Initial Dose</th>
<th>Maximum Dose</th>
<th>Common Adverse Drug Events</th>
<th>Special Notes</th>
</tr>
</thead>
</table>
| Epoprostenol | Flolan     | IV    | 1-2 ng/kg/min| Patient-specific | • Headache  
• Dizziness  
• Flushing  
• Hypotension  
• Nausea/vomiting/diarrhea  
• Jaw pain | • Hospital supply bag change daily at 1400 |
| Epoprostenol | Veletri    | IV    | 1-2 ng/kg/min| Patient-specific | | |
| Treprostinil | Remodulin  | IV    | 1-2 ng/kg/min| Patient-specific | | • Hospital supply bag change every 24-48 hours at 1700  
• Pharmacy may supply medication; patient must self-administer using home subcutaneous infusion pump  
• See policy for details |
| Treprostinil | Remodulin  | Subcutaneous | 1-2 ng/kg/min| Patient-specific | |
PH Resources/Contacts

- Outpatient PH Clinic
- Inpatient PH Consult
- Pharmacists (8PCU, Ross)
- Clinical Nurse Specialists (8PCU/Ross2/Ross 6)

Quality Measures

- Time from admission to ordering of parenteral therapies:
  - Epoprostenol IV (Veletri or Flolan)
  - Treprostinil IV or SubQ (Remodulin)
- Review of medication Patient Safety Event Reports

Resources

P&T Policy and Procedures

- Prostacyclin IV/SQ Infusion Management for Pulmonary Arterial Hypertension Patients in Procedure Areas and Operating Rooms
- Treprostinil (Tyvaso®) Inhalation
- ILOPROST (VENTAVIS®) INHALATION
- Treprostinil (Remodulin®) Intravenous/Subcutaneous Infusion
- Epoprostenol (Veletri®) Intravenous Solution for Inhalation
- Epoprostenol (Flolan®/Veletri®) Intravenous Infusion

IHIS Tip Sheets

- Epoprostenol (Flolan®/Veletri®) IV Order Entry in IHIS
- Treprostinil (Remodulin®) IV Order Entry in IHIS
- Treprostinil (Remodulin®) SQ Order Entry in IHIS

References


Guideline Authors

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Guideline Approved


Disclaimer: Clinical practice guidelines and algorithms at The Ohio State University Wexner Medical Center (OSUWMC) are standards that are intended to provide general guidance to clinicians. Patient choice and clinician judgment must remain central to the selection of diagnostic tests and therapy. OSUWMC’s guidelines and algorithms are reviewed periodically for consistency with new evidence; however, new developments may not be represented.

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