

PULMONARY HYPERTENSION

Background

- Definition: Pulmonary arterial hypertension (PAH)—mean Pulmonary Artery Pressure (mPAP) of > 25 mm Hg at rest, with wedge pressure < 15 mm Hg, and pulmonary vascular resistance > 3 Wood units, with other causes of pulmonary hypertension (PH) excluded.¹
- Types / Risk factors:¹

Pulmonary arterial hypertension (PAH)	Pulmonary hypertension (PH)
Idiopathic (formerly "Primary Pulmonary Hypertension") Familial Associated with other conditions: Connective tissue disorders Congenital shunts Portal hypertension HIV Drugs (fen-phen) Other (Gaucher's, sickle cell, et al) Pulmonary veno-occlusive disease	Left sided heart disease, including valvular heart disease Lung disease: COPD Interstitial lung disease Sleep disordered breathing Hypoventilation disorders High altitude Chronic thromboembolic disease Miscellaneous: Sarcoidosis, histiocytosis X, et al.

Preoperative evaluation

Testing for pulmonary hypertension

- Routine screening for pulmonary hypertension is not recommended.
- Consider testing based on clinical suspicion and anticipated change in management. Symptoms and signs include dyspnea on exertion, unexplained hypoxia, decreased DLCO on PFTs.
- Echocardiogram is a reasonable initial test in the workup of suspected pulmonary hypertension. However, it relies on the presence of a tricuspid regurgitant jet to estimate the pulmonary artery systolic pressure (PASP). Pulmonary artery catheterization is the gold standard and can measure the hemodynamic variables required for a formal diagnosis (mPAP, wedge pressure, pulmonary vascular resistance), but is invasive.
- Obstructive sleep apnea (OSA) alone is thought to cause at most mild pulmonary hypertension. A patient with OSA who is found to have moderate or severe pulmonary hypertension should receive workup for other etiologies.

Patients with known pulmonary hypertension

- Echo: Routine testing—Every 12 months for functional class I-II, and every 6 months for functional class IV, with discretion allowed for center-specific protocols and for class III (functional class is similar to NYHA class).¹ We recommend an echocardiogram within 12 months of surgery for moderate to severe pulmonary hypertension, with consideration to repeat depending on a patient's interval history.
- Assessment of severity: Do not rely strictly on "mild" "mild-moderate" "moderate" and "severe" classifications by echocardiogram calculation of PASP alone—there are no strict definitions. Useful markers of severity are:
 - Baseline functional capacity (NYHA or WHO functional class, 6 minute walk)
 - RV function
 - Mean and/or systolic PA pressures (mPAP and PASP)
 - Hypoxia
 - Example: A patient with "moderate" pulmonary hypertension by echo, good functional capacity (>4 METS), and normal RV function is less worrisome than a patient with poor functional capacity and/or baseline RV dysfunction.

Pulmonary

Suggested preoperative strategy for patients with pulmonary hypertension:

Category	Characteristics*	Management strategy
Severe	NYHA III/IV mPAP >55 PASP >60	<u>Elective surgery</u> : Defer. Strongly consider pulmonary evaluation if not already being treated or followed. <u>Urgent or emergency surgery</u> : Urgent cardiac anesthesia and pulmonary consultation. If risk is excessive or not within patient's goals of care, consider palliative care or more limited procedure.
Moderate	NYHA II mPAP 41-55 PASP 45-59	<u>Elective surgery</u> : <i>If etiology unknown</i> , consider workup prior to surgery. Goal is to identify etiology and determine whether treatment of pulmonary hypertension and/or underlying disease state is indicated. <i>If etiology is known</i> , consider whether pulmonary hypertension is expected to improve or whether other management will be undertaken prior to surgery. <u>Urgent or emergency surgery</u> : Consider cardiac anesthesia consultation depending on assessment of patient's severity and type of surgery.
Mild	NYHA I mPAP 26-40 PASP < 45	Proceed with surgery in most cases. If etiology is unknown, would still be reasonable to complete workup prior to purely elective surgery.

* There are no strict definitions of mild, moderate, or severe pulmonary hypertension—these characteristics are guidelines only.

Examples:

Patient has severe idiopathic Pulmonary Arterial Hypertension, PASP of 90 on right heart cath, NYHA IV despite therapy with treprostinil and sildenafil, now with severe back pain and spinal stenosis. Patient discusses the overall prognosis and risks of spine surgery and decides against it. Elects epidural steroid injections instead, with temporary cessation of warfarin for the procedure.

Patient without identified risk factors is identified in preop eval as having poor functional capacity. Workup reveals PASP of 55 mm Hg by echocardiogram. Surgery is deferred and patient is referred back to the primary care provider with pulmonary consultation.

Patient with Pulmonary Arterial Hypertension, idiopathic, moderate in severity, being initiated on bosentan, desires hip replacement. It is decided to wait until patient is optimized on therapy and in consultation with pulmonologist and anesthesia, surgery proceeds after a period of 6 months with improved PA pressures and functional status.

Patient has PASP of 50 mm Hg by echo, attributed to longstanding COPD. Patient is undergoing cholecystectomy, has good exercise tolerance. Surgery proceeds without further workup.

- Anticoagulation: Most patients with pulmonary arterial hypertension (PAH) or pulmonary hypertension (PH) due to chronic thromboembolic disease are managed with anticoagulation. In most cases, bridging therapy with heparin is not indicated, but it is best to consult with the patient's pulmonologist.
- Medication management: If a patient is being treated with prostacyclins or vasodilators, it is crucial to work with anesthesia and the patient's pulmonologist. In many cases the patient's baseline therapy is continued and vasoactive medications are used in addition as needed.
- Intraoperative planning: Generally left to the surgery and anesthesia teams. Considerations:
 - Open rather than laparoscopic surgery as the carbon dioxide insufflation causes acidemia and increased pulmonary/systemic hypertension.

- Reduce length of the procedure to keep anesthesia time < 3 hours and/or splitting a high risk procedure into multiple lower risk procedures.
- Cardiac anesthesiology review of patients with moderate to severe pulmonary hypertension (treated or untreated).

Postoperative management

- Severe pulmonary hypertension: Consider ICU and pulmonary consultation.
- Discuss intraoperative course with anesthesia. In one study intraoperative vasopressor use was associated with increased morbidity and mortality.²
- Close attention to volume status, and symptoms and signs of RV failure and respiratory failure (most common complications).²
- If indicated, re-initiate anticoagulation when bleeding risk is acceptable. In most cases patients do not require bridging therapy with heparin, but should have standard DVT prophylaxis until INR is therapeutic or patient is ambulatory.
- If patient is on prostacyclins or vasodilators, in most cases these are continued postop at their baseline doses. Pulmonary should be consulted if there is any question.

Discussion

- Pulmonary hypertension and severe mitral stenosis (which leads to pulmonary hypertension) are two of the most challenging conditions for cardiac anesthesiologists to manage. The primary complication is acute right ventricular failure which results in a downward spiral of intrapulmonary shunting, decreased oxygenation, acidosis, and increased pulmonary pressures. Other complications include persistent postoperative hypoxia, coronary ischemia, and higher mortality rate.
- Right heart failure following cardiac surgery is a well known risk and such patients are screened for pulmonary hypertension. The management of this population is beyond the scope of this handbook.
- Early data—select subsets of patients:
 - Pregnant patients with pulmonary hypertension and Eisenmenger's syndrome undergoing C-section have a mortality of up to 50%.³
 - Liver transplant patients with pulmonary hypertension have up to 35% mortality, with one series showing that 100% of patients with mean pulmonary artery pressures of 50 mmHg or greater died peri-operatively.⁴
- More recent data—general populations, noncardiac surgery:
 - One study (N=62) found that patients with severe PH (RVSP > 70 mmHg on echo) experienced increased mortality (9.7% vs 0%) and major adverse events (24% vs 3%) compared to controls. Major adverse events included heart failure, delayed extubation > 24 hrs, stroke, myocardial ischemia/infarction, or major arrhythmia. Predictors of mortality included emergent surgery, CAD, and higher PASP.⁵
 - A retrospective study (N=145) of patients with PH (mean RVSP 68 mm Hg) who underwent noncardiac surgery, excluding PH secondary to left-sided heart disease, showed:²
 - 30 day mortality was 7%, primarily due to respiratory failure and/or right ventricular failure.
 - Preoperative RVSP/SBP ratio >0.66, right axis deviation on ECG, RVH on echo were associated with increased risk of early mortality.
 - Morbidity was 42%. Predictors: NYHA class II or higher, history of PE, intermediate/high risk surgery, and anesthesia time > 3 hrs. Intermediate/high risk surgery increased the risk of morbidity by 2.5x compared to low risk surgery (62% for thoracic surgery, 48% for orthopedic surgery, 17% for gynecologic/urologic/plastic/dermatologic/breast surgery).
- Guidelines:

Pulmonary

- There are no published guidelines endorsing a pulmonary artery pressure above which surgery is contraindicated.
- There are no recommendations concerning pulmonary hypertension in the ACC/AHA guidelines for perioperative risk assessment for noncardiac surgery.⁶
- A recent consensus statement on pulmonary hypertension discusses only cardiac surgery.¹

References:

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