Exercise Right Heart Catheterization Protocol for Heart Failure Hemodynamic Assessment[1,2]

Right Heart Catheterization Protocol:

Patients should be studied in the fasting state while on current medications, anticoagulation management is at the preference of the procedure operator. Right internal jugular access is the preferred method for catheter placement.

Measurements of the right atrial (RA), pulmonary artery (PAP) and pulmonary capillary wedge pressure (PCWP) should be made at end expiration and represent the mean of at least 3 beats.

During exercise, intrathoracic pressure swings are enhanced with the increased work of breathing and are reported as the mean of inspiration and expiration. PCWP should be verified based on characteristic wave form, fluoroscopy and O2 saturation. Baseline cardiac output is measured using the thermodilution and FICK methods. Exercise cardiac output is measured using FICK.

Blood pressure is measured by arm cuff during the procedure.

Exercise protocol:

After assessing resting hemodynamics, patients will commence exercise:

- Supine cycle ergometry
    - 60 RPM starting at 20W workload and increase by 10W every 3 minutes to maximally tolerated levels. Aim for exercise duration of ~ 10 minutes.
- Arm exercise:
    - 4lb weights, increase repetition until subjective fatigue

Hemodynamic Measurements performed, measuring PA and PCWP, CO/CI at the following intervals:

- Baseline (supine), check zero.
- Before exercise with passive leg elevation (ie: on the bike), if applicable. Check zero again.
- Low level exercise (20 W) after 1.5 minutes
- Peak exercise
- During 1 minute of recovery, legs still elevated for ergometry.
- CO/CI obtained via Fick method.

Definitions:

- Normal – PCWP 20-23 mmHg
- Heart failure with preserved EF PCWP ≥25 mmHg
- Exercise induced pulmonary hypertension, mean PAP >30 mmHg, with a resting mean PAP of <25 mmHg and total PVR of >3 Woods Units.

Phase	Mean PA	PCWP	CO/CI	TPR (mPAP/CO)	PVR (mPAP-PCWP/CO)
Resting, supine					
Before exercise, Leg elevated					
Low workload (20W), 1.5 min elapsed					
Peak Exercise					
Recovery, 1 min					

References:

1. Borlaug, et al. Exercise hemodynamics Enhance Diagnosis of Early Heart Failure with Preserved Ejection Fraction. Circulation: Heart Failure. 2010;3:588–595
2. Kovacs G, Herve P, Barbera JA, Chaouat A, Chemla D, Condliffe R, Garcia G, Grünig E, Howard L, Humbert M, Lau E, Laveneziana P, Lewis GD, Naeije R, Peacock A, Rosenkranz S, Saggar R, Ulrich S, Vizza D, Vonk Noordegraaf A, Olschewski H. An official European Respiratory Society statement: pulmonary haemodynamics during exercise. Eur Respir J. 2017 Nov 22;50(5):1700578. doi: 10.1183/13993003.00578-2017. Erratum in: Eur Respir J. 2018 Jan 18;51(1): PMID: 29167297.