# Interpretation of Echocardiographic Parameters in the Diagnosis and Follow up of Pulmonary Hypertension

A/Prof. Susanna Proudman, Royal Adelaide Hospital and Dr. Nathan Dwyer, Royal Hobart Hospital

Pulmonary hypertension refers to increased pressure in the pulmonary circulation. There are a broad range of causes.[1] It includes pulmonary arterial hypertension (PAH) due to vascular changes on the pre-capillary side (e.g., idiopathic PAH or systemic sclerosis related PAH) and pulmonary venous hypertension (post-capillary), typically due to left heart disease (80% of pulmonary hypertension).

Echocardiography (ECHO) can provide an indication of pulmonary hypertension but **right heart catheterisation (RHC)** is the gold standard for confirming pulmonary hypertension and distinguishing between the various causes. The definition of PAH is based on the RHC findings of mean pulmonary artery pressure (PAP) ≥ 25 mmHg, pulmonary arterial wedge pressure ≤ 15 mmHg and pulmonary vascular resistance > 3 Wood Units.

Not all ECHO parameters can be measured in all patients especially in those without a tricuspid regurgitant (TR) jet (absent in up to 40% of healthy people). Absence of markers of pulmonary hypertension on ECHO does not exclude a diagnosis of PAH in a patient with unexplained symptoms.

ECHO can be used to monitor people at increased risk of pulmonary hypertension, e.g., those with connective tissue disease such as systemic sclerosis, but must be used in conjunction with other modalities such as pulmonary function tests.

## Signs of pulmonary hypertension:

### Estimated pulmonary artery systolic pressure (PASP)

= 4 x tricuspid regurgitant velocity (TRV)$^2$ + right atrial pressure (RAP)*.

* commonly estimated from IVC size and distensibility, e.g., IVC diameter ≤ 21 mm and collapse of ≥ 50% suggests RAP ≤ 5 mmHg.

TRV > 2.8m/s and RA ≥ 5 mmHg suggests RVSP > 36 mmHg or mean PAP > 25 mmHg

### PASP may be underestimated if:

1. Incomplete spectral Doppler profile
2. Very severe TR (RA pressure underestimated)
3. Reduced stroke volume due to RV dysfunction (cannot generate pressure).

### Presence of any of the following markers of raised PAP should raise the suspicion of PH, especially if there is incomplete TR jet:

1. Pulmonary artery acceleration time < 100 ms
2. Mid and late systolic notching in the RVOT Doppler signal
3. Estimation of PVR from 10 x TRV/VTI(RVOT)
4. Flattening of interventricular septum (D-shaped LV in systole)
5. RV hypertrophy (> 5mm)
6. Significant pulmonary regurgitation (early velocity > 2.2 m/s)
7. Pericardial effusion
8. Right atrium > 18 cm$^2$
9. RV impairment and dilatation (> 42 mm base, > 35 mm midlevel)
10. Pulmonary artery diameter > 25 mm

PASP, pulmonary artery systolic pressure; TRV, tricuspid regurgitant velocity; PAP, pulmonary atrial pressure; RAP, right atrial pressure; IVC, inferior vena cava; TR, tricuspid regurgitation; RA, right atrium; RV, right ventricle/ventricular; RVOT, right ventricular outflow tract; PVR, pulmonary vascular resistance; VTI, velocity time integral

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## Probability of pulmonary hypertension can be estimated from TRV and presence of secondary markers of raised PAP:

| Peak tricuspid regurgitation velocity (m/s) | Presence of other echo 'PH signs' | Echocardiographic probability of pulmonary hypertension |
|---|---|---|
| ≤2.8 or not measurable | No | Low |
| ≤2.8 or not measurable | Yes | Intermediate |
| 2.9 – 3.4 | No | |
| 2.9 – 3.4 | Yes | High |
| > 3.4 | Not required | |

Galiè *et al. European Heart Journal.* 2016. 37(1): 67-119.

Good ECHO laboratories will perform RV focussed windows to assess RV dimensions and estimate RV performance (RV function is the major determinant of outcome in PH):

1. RV Fractional Area Change (abnormal if < 35%)
2. Tricuspid annular plane systolic excursion (abnormal < 16 mm)
3. RV myocardial systolic velocity (abnormal < 10 cm/s)

A right heart catheter is always required for diagnosis and haemodynamic assessment of pulmonary hypertension and should be considered if TRV > 2.8 m/s or < 2.8 m/s plus ancillary ECHO signs or patient symptoms.

Look for evidence of Left Heart Disease:
LV systolic dysfunction (LVEF < 40%), diastolic dysfunction and for left sided valvular heart disease.

Suspect LV diastolic dysfunction if two or more risk factors are present:

1. Age > 65 years
2. BMI ≥ 30 kg/m$^2$
3. Systemic hypertension
4. Diabetes mellitus
5. History of atrial fibrillation

TRV, tricuspid regurgitant velocity; PASP, pulmonary artery systolic pressure; RV, right ventricle/ventricular; PH, pulmonary hypertension; LV, left ventricle; LVEF, left ventricle ejection fraction; BMI, body mass index

**Reference: 1.** Galiè N, *et al. European Heart Journal.* 2016. 37(1): 67-119.

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ACN 000 129 975, 1-5 Khartoum Rd Macquarie Park NSW 2113, Australia. Telephone: 1800 226 334 www.janssen.com/australia
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