

Pulmonary Artery Pulsatility Index (PAPi)

Rahul Aggarwal

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Abstract

The Pulmonary Artery Pulsatility Index (PAPi) is an invasive hemodynamic measure used to assess right ventricular (RV) function and predict adverse cardiovascular outcomes. PAPi is calculated as pulmonary artery pulse pressure divided by right atrial pressure and reflects RV contractility, RV preload, and RV afterload. Initially developed to identify severe RV dysfunction in acute inferior myocardial infarction, PAPi has since been validated in cardiogenic shock, advanced heart failure, and evaluation for mechanical circulatory support. Lower PAPi values are associated with increased risk of RV failure, need for right ventricular mechanical support, and mortality. PAPi should be interpreted in clinical context, as optimal thresholds may vary across patient populations.

I. HOW TO USE

When to Use

Use PAPi in patients undergoing right heart catheterization to:

- Assess right ventricular function
- Risk stratify for right ventricular failure
- Guide monitoring and response to therapy
- Reflects the interaction between right ventricular contractility, preload (right atrial pressure), and afterload (pulmonary arterial system), providing an index of right heart function.

Requires pulmonary artery systolic and diastolic pressures and right atrial pressure.

Pearls / Pitfalls

- PAPi thresholds vary widely across clinical populations and studies, and higher values may still be associated with adverse outcomes; avoid applying uniform cutoffs.
- PAPi reflects multiple physiologic components, including right ventricular function, right atrial pressure, stroke volume, and pulmonary vascular properties; similar values may arise from different underlying hemodynamic states.
- Most data are derived from adult populations with cardiogenic shock, myocardial infarction, or advanced heart failure; data in pulmonary hypertension and other groups exist but remain limited, and

applicability across age and sex subgroups is not well defined.

- PAPi can be influenced by factors affecting right atrial and pulmonary artery pressures, including volume status, pulmonary hypertension, and positive pressure ventilation.
- Data on serial changes in PAPi and response to therapy remain limited.

Why to Use

- PAPi links invasive hemodynamic measurement to risk stratification and clinical decision-making in a simple, stepwise manner.
- Provides a simple, reproducible hemodynamic assessment of right ventricular function using routinely measured catheterization data.
- Helps identify patients at increased risk of right ventricular failure, cardiogenic shock, and mortality.
- Assists in risk stratification when evaluating patients for escalation of therapies, including mechanical circulatory support.
- May support clinical decision-making in patients with advanced heart failure, acute myocardial infarction, or suspected right ventricular dysfunction.
- Can help monitor response to therapy and recovery of right ventricular function over time.

II. NEXT STEPS

Advice

Interpret PAPi in the context of the overall clinical picture and other measures of right ventricular function. Use caution when applying fixed cutoff values, as thresholds may differ across patient populations and clinical settings. Thresholds should be applied cautiously across different age groups and between sexes, as population-specific differences are not well defined. Consider repeating measurements when clinical status changes or during treatment monitoring.

Management

PAPi thresholds are population- and context-dependent; the following ranges are approximate and should be interpreted cautiously and not as universal. Clinical interpretation and possible actions (requiring clinical context and management):

PAPi <1.0

- Consistently associated with severe right ventricular dysfunction and high risk of adverse outcomes across multiple populations.
- Consider urgent evaluation for escalation of therapy, including inotropes, pulmonary vasodilators, or mechanical circulatory support when clinically appropriate.

PAPi 1.0–2.0

- Suggests possible right ventricular dysfunction, though risk varies by clinical context.
- Consider closer monitoring and optimization of preload, afterload, and right ventricular contractility.

PAPi >2.0

- Generally associated with lower risk of severe right ventricular failure in some populations, but does not exclude increased risk of adverse outcomes.
- Higher PAPi thresholds (e.g., >3–5) have been associated with lower risk in certain cohorts; interpret in the context of the underlying disease state.

Clinical interpretation should be individualized, as optimal thresholds vary across cardiogenic shock, advanced heart failure, pulmonary hypertension, and mechanical circulatory support populations. Where possible, PAPi should be interpreted within population-specific frameworks (e.g., cardiogenic shock, LVAD evaluation, pulmonary hypertension), as risk gradients differ across these groups.

Critical Actions

Assess for clinical and hemodynamic evidence of right ventricular failure and optimize preload, afterload, and contractility as appropriate. Consider early consultation with advanced heart failure or cardiogenic shock teams when PAPi suggests high risk. Reassess hemodynamics and escalate therapies, including mechanical circulatory support, when clinically indicated.

III. EVIDENCE

Evidence Appraisal

The original study developing PAPi included 20 patients with acute inferior myocardial infarction and suspected right ventricular dysfunction.¹ 64 control patients (50 non-obstructive coronary disease, 14 acute coronary syndrome without hemodynamic compromise) were included. Inclusion criteria were acute inferior ST-elevation myocardial infarction, angiographically confirmed proximal right coronary artery occlusion, clinical evidence of suspected right ventricular dysfunction, right heart catheterization and echocardiography performed during hospitalization. Exclusion criteria were valvular heart disease, pre-existing nonischemic cardiomyopathy, significant pulmonary hypertension, renal failure, unsuccessful coronary revascularization, mechanical ventilation prior to catheterization. The primary endpoint was a composite of in-hospital mortality or requirement for percutaneous right ventricular support device. Lower PAPi values were strongly associated with severe right ventricular dysfunction and adverse clinical outcomes. A PAPi threshold ≤ 0.9 demonstrated high sensitivity and specificity for predicting severe right ventricular failure. PAPi correlated with echocardiographic measures of right ventricular dysfunction and outperformed several traditional invasive hemodynamic parameters. Strengths of this study included a simple, reproducible hemodynamic index using routinely obtained catheterization data; demonstrated strong correlation with clinical outcomes and echocardiographic RV function; compared PAPi with established hemodynamic markers of RV dysfunction. Limitations included small sample size, particularly in the severe RV dysfunction cohort; single-center retrospective design limits generalizability; study population restricted to acute inferior myocardial infarction; and additional external validation required across broader cardiovascular populations.

Additional validations

In a large retrospective cohort of 8,285 patients undergoing right heart catheterization, lower pulmonary artery pulsatility index (PAPi) values were independently associated with higher risk of all-cause mortality, major adverse cardiovascular events, and heart failure hospitaliza-

tions over a mean follow-up of 6.7 years.² Patients in the lowest PAPi quartile had approximately a 60 % higher risk of death compared with those in the highest quartile, and also showed increased risk of major adverse events and HF admissions. This study supports the prognostic utility of PAPi across a broad spectrum of cardiovascular disease and suggests that even modestly low PAPi values may identify high-risk individuals.

In another retrospective cohort of patients³ undergoing continuous-flow left ventricular assist device (LVAD) implantation, the pulmonary artery pulsatility index (PAPi) was found to be an independent predictor of postoperative right ventricular failure (RVF). Lower preoperative PAPi values were significantly associated with higher rates of RVF and need for right ventricular assist device support, even after adjustment for established hemodynamic predictors. This study demonstrated that PAPi adds prognostic value to traditional risk factors in advanced heart failure patients being considered for durable mechanical circulatory support.

In a post-hoc analysis of the ESCAPE trial⁴ involving patients with advanced decompensated heart failure, the pulmonary artery pulsatility index (PAPi) demonstrated significant prognostic value for adverse clinical outcomes. Lower PAPi values were independently associated with higher risk of death or heart failure hospitalization at 6 months, even after adjustment for conventional invasive hemodynamic parameters. This study suggests that PAPi may provide incremental information about right ventricular dysfunction beyond traditional measures in advanced heart failure populations. These findings support PAPi's broader applicability as a risk stratification tool beyond its original context in acute myocardial infarction and mechanical support settings.

Another study looked at PAPi in patients with pulmonary arterial hypertension enrolled from multiple centers into the NIH-RPPH registry.⁵ Survival at 1 year was significantly worse in patients with the lowest PAPi quartile.

The prognostic value of PAPi in cardiogenic shock was established using the dataset from the Should We Emergently Revascularize Occluded Coronaries for Cardiogenic Shock (SHOCK) trial and registry.⁶ This study found that PAPi was not significantly associated with mortality at 30 days.

In patients undergoing heart transplantation, preoperative right heart hemodynamic parameters, including pulmonary artery pulsatility index (PAPi), were associated with the risk of postoperative acute kidney injury.⁷ This study supports the broader relevance of PAPi as a marker of right heart function beyond traditional cardiovascular outcomes.

A systematic review⁸ included 16 retrospective studies with over 20,000 patients with durable LVADs and evaluated the relationship between the pulmonary artery pulsatility index (PAPi), right heart failure (RHF), and mortality after LVAD implantation. Lower PAPi was consistently associated with increased risk of RHF in the few that reported mortality. Lower PAPi was associated with right heart failure. Reported PAPi cutoffs for RHF varied widely (approximately 0.88–3.3), and the review demonstrated that optimal PAPi thresholds depend on pulmonary vascular resistance, reflecting complex right ventricular–pulmonary interactions. Overall, while PAPi is a useful marker of RV performance in the LVAD setting, a single universal cutoff cannot be defined due to its dependence on hemodynamic context.

Formula

Pulmonary artery pulsatility index = (Pulmonary artery systolic pressure – Pulmonary artery diastolic pressure) / Right atrial pressure

Pressures are typically measured in mmHg. PAPi is a unitless ratio, provided that all pressures are measured in the same unit.

Facts & Figures

- PAPi is an invasive hemodynamic index used to assess right ventricular function.
- It is calculated using pulmonary artery pulse pressure divided by right atrial pressure.
- Lower PAPi values are associated with increased risk of right ventricular failure, cardiogenic shock, and need for mechanical circulatory support.
- PAPi is commonly used in advanced heart failure and in evaluation for left ventricular assist device implantation.

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