

Invasive Assessment of the Hemodynamic Profile of Critically Ill Patients: When Is Echocardiographic Assessment Alone Sufficient

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Short Editorial related to the article: Correlating Invasive and Echocardiographic Hemodynamic Measures in Patients with Heart Failure with Reduced Ejection Fraction

Assessing systemic and/or pulmonary congestion in patients with heart failure is fundamental to clinical management and prognosis. This congestive state is characterized by fluid accumulation in the body and represents the leading cause of hospitalization and hospital readmission in heart failure, both in patients with reduced or preserved ejection fraction, and directly contributes to increased mortality. Therefore, the early and accurate identification of fluid overload is indispensable for guiding therapeutic management, preventing complications, and optimizing clinical outcomes.¹ However, conventional clinical signs generally have low sensitivity and specificity, limiting their effectiveness when used alone for disease diagnosis and management and making complementary methods necessary to better define the clinical condition.²

Invasive tools to establish hemodynamic parameters are considered the gold standard for accurately determining the degree of congestion, assessing cardiac performance, and evaluating pulmonary and systemic vascular resistance. The use of invasive catheters, particularly right-sided catheters, has increased in recent years and has provided relevant prognostic information to guide appropriate treatment in patients with cardiac dysfunction and other diseases, particularly pulmonary hypertension.

Assessing the invasive hemodynamic profile with right heart catheterization is fundamental to managing heart failure. Although echocardiography can measure several noninvasive hemodynamic parameters, right heart catheterization remains indispensable in patients with symptoms refractory to medical treatment and when symptoms and objective findings are discrepant.

With the current establishment of the four-interface conceptual model proposed by Rola et al.,³ the role of echocardiography and its relationship with reliable hemodynamic parameters, particularly right ventricular-pulmonary arterial (RV/PA) and left ventricular-aortic (LV/Ao) coupling, becomes highly relevant for the assessment of systemic congestion and left cardiac function.

Assessing cardiac function in terms of contractile strength (i.e., cardiac power) and congestive processes, without integrating other interfaces, may lead to incomplete diagnoses and inappropriate clinical management. In this context, echocardiography stands out as an indispensable tool because it enables the combined assessment of LV/Ao coupling (Interface I), RV/PA coupling (Interface IV), and the capillary/venular compartment (Interface III) through the assessment of the inferior vena cava and systemic venous flows (hepatic, portal, and renal).

In the elegant study by Barbato et al.⁴ conducted with patients with systolic dysfunction, the relationship between cardiac power output (obtained by hemodynamic assessment) and echocardiographic parameters showed excellent correlation, particularly with the use of left ventricular outflow tract velocity time integral, which can be rapidly obtained even by non-echocardiography practitioners trained in advanced POCUS. The velocity time integral is directly associated with cardiac output, and values < 18 cm (particularly < 16 cm) are associated with impaired ventricular contractility. This parameter is particularly relevant for assessing patients awaiting heart transplantation and those receiving extracorporeal membrane oxygenation, in whom an increased value indicates recovery of ventricular function.

Although the pulmonary artery pulsatility index (PAPI) is fundamental for predicting right ventricular failure and adverse outcomes, translating it into a noninvasive method is challenging. Despite the positive statistical correlation observed ($r = 0.604$, $p < 0.05$), echocardiographic PAPI was obtained in only 16 of the 34 patients (47% of the sample).

The major limitation of the method is its technical dependence on pulmonary regurgitation. In the absence of a detectable pulmonary regurgitant jet with adequate Doppler quality, measuring pulmonary artery diastolic and mean pressures becomes impossible, precluding PAPI calculation. In these cases, the imaging specialist should rely on alternative right ventricular markers that showed correlations with invasive PAPI in the study, such as tricuspid annular plane systolic excursion ($r = 0.553$, $p < 0.01$) and right ventricular free-wall strain ($r = -0.344$, $p < 0.05$), which are complementary approaches when technical limitations of PAPI preclude its assessment.

Although limited by the small sample size, studies such as that by Barbato et al.⁴ are fundamental for defining the accuracy of echocardiography in hemodynamic assessment and its performance compared with invasive methods considered the gold standard. Future studies involving larger numbers of patients and additional centers may provide further information and establish the true role of echocardiography in comparison with hemodynamic assessment.

Keywords

Echocardiography; Catheterization; Heart Failure

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Table 1 – Summary of invasive and noninvasive findings and their correlations.

Hemodynamic correlation and feasibility matrix			
Parameter	Correlation (r)	Significance (p)	Clinical observation
CPO	0.737	p < 0.001	High reproducibility; excellent in critically ill patients.
PAPi	0.604	p < 0.05	Low feasibility (limited by pulmonary regurgitation).
LVOT-VTI	0.469	p < 0.01	Practical bedside marker of stroke volume.
CO (echo) vs. CPO (invasive)	0.616	p < 0.001	Strong correlation that supports echocardiographic flow estimation.

CPO: cardiac power output; PAPi: pulmonary artery pulsatility index; LVOT-VTI: ventricular outflow tract velocity time integral; DC: cardiac output.

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