Right Heart Catheterization for the Diagnosis of Pulmonary Hypertension

Controversies and Practical Issues

Michele D'Alto, MD, PhD, FESC[a,*,1],
Konstantinos Dimopoulos, MD, MSc, PhD[b],
John Gerard Coghlan, MD, FRCP[c], Gabor Kovacs, MD, PhD[d],
Stephan Rosenkranz, MD, PhD[e], Robert Naeije, MD, PhD[f]

KEYWORDS

• Pulmonary hypertension • Heart catheterization • Hemodynamics

KEY POINTS

- Right heart catheterization (RHC) is the gold standard for the diagnosis and classification of pulmonary hypertension.
- RHC is used to assess the response to therapy specific to pulmonary arterial hypertension and guide clinical decision-making.
- Significant expertise is required for safely performing an RHC and for the acquisition of reliable and reproducible information.

BACKGROUND

Right heart catheterization (RHC) is the gold standard for assessing pulmonary hemodynamics and is mandatory for confirming the diagnosis of pulmonary hypertension (PH), assessing the severity of hemodynamic impairment, and performing vasoreactivity testing in selected patients.[1] Indeed, the definition of PH is based strictly on invasive hemodynamics: mean pulmonary arterial pressure (mPAP) greater than or equal to 25 mm Hg by RHC measured at rest. Considering that the upper limit of normal for mPAP is 20 mmHg, it is still debated the meaning and the clinical

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[a] Department of Cardiology, Second University of Naples, Monaldi Hospital, piazzale E. Ruggieri, Naples 80131, Italy; [b] Department of Cardiology, Adult Congenital Heart Centre, Royal Brompton Hospital, Imperial College, Sidney Street, London SW3 6NP, UK; [c] Department of Cardiology, Royal Free Hospital, Pond Street, London NW3 2QG, UK; [d] Department of Internal Medicine, Medical University of Graz, Ludwig Boltzmann Institute for Lung Vascular Research Graz, Stiftingtalstrasse 24, Graz 8010, Austria; [e] Department of Cardiology and Cologne Cardiovascular Research Center (CCRC), Heart Center, University of Cologne, Kerpener Street. 62, Köln 50937, Germany; [f] Department of Cardiology, Erasme University Hospital, University of Brussels, Route de Lennik 808, Brussels 1070, Belgium
[1] This author takes responsibility for all aspects of the reliability and freedom from bias of the data presented and their discussed interpretation.
* Corresponding author. Via Tino di Camaino, 6, Naples 80128, Italy.
E-mail address: mic.dalto@tin.it

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implication of values between 21 and 24 mmHg. Precapillary PH is defined as a pulmonary artery wedge pressure (PAWP) less than or equal to 15 mm Hg, and postcapillary PH as a PAWP greater than 15 mm Hg. Among postcapillary PH, isolated postcapillary PH (Ipc-PH) is defined as a diastolic pulmonary gradient (DPG) less than 7 mm Hg and/or a pulmonary vascular resistance (PVR) less than or equal to 3 Wood units (WU); combined postcapillary and precapillary PH (Cpc-PH) is defined as a DPG greater than or equal to 7 mm Hg and/or a PVR greater than 3 WU.[1] Nevertheless, the role of DPG remain controversial. Pulmonary arterial hypertension (PAH) is characterized by the presence of precapillary PH and PVR greater than 3 WU, in the absence of other causes of precapillary PH, such as PH due to lung diseases, or chronic thromboembolic PH.[1]

Accurate classification of PH patients is essential for their management and can only be achieved by invasive means. The interpretation of invasive hemodynamics should always take into consideration the clinical picture and imaging findings.[1] RHC can be a challenging procedure in PH patients and requires expertise, attention to detail, and meticulous collection of data. To obtain accurate and reproducible information and minimize the risks related to the procedure, RHC should be limited to specialist centers and operators with training and expertise in this specific procedure and condition.[2]

VASCULAR ACCESS

Although any systemic large vein may be used for venous access when performing RHC,[3–5] the femoral and internal jugular veins are most commonly used in clinical practice. The cephalic or basilic vein is preferred in some centers and is particularly helpful in patients who are dyspneic at rest (eg, those with severe respiratory disease) and do not tolerate the supine position. The femoral access is easily compressible and allows access through a large patent foramen ovale (PFO) to obtain direct pulmonary venous and left atrial measurements. Moreover, left heart catheterization can be performed simultaneously. Disadvantages include the need for fluoroscopy, difficulties in reaching the pulmonary artery, and the need for bedrest postprocedure. Vascular access complications (eg, pseudoaneurysm, arteriovenous fistula, or retroperitoneal bleeding) are more likely when arterial and venous access are both obtained.

The internal jugular vein allows easy access to the pulmonary artery, often not requiring imaging. Crossing PFOs through this access is not easy and alternative access is required for left heart catheterization (eg, for obtaining left ventricular end-diastolic pressure [LVEDP] when PAWP is suboptimal). Complications include hemothorax and pneumothorax, which are less likely with an ultrasound-guided approach.[4] Indeed, although in most subjects the internal jugular vein is located lateral to the carotid artery, there is a high degree of variability. In 22.5% of patients the internal jugular vein may be anterior and in 5.5% it is medial to the carotid artery.[6] An arm approach (cephalic or basilica vein) is often preferred by patients because the procedure is similar to venous cannulation, even though ultrasound guidance is often required to access deeper veins. A (hydrophilic) guidewire may be needed to navigate the cephalic-subclavian junction, which may be tortuous.

CATHETERS USED FOR RIGHT HEART CATHETERIZATION

The gold standard for pressure and pulmonary blood flow measurement is the high-fidelity micromanometer-tipped catheter and the direct Fick method, respectively. Currently, fluid-filled, flow-directed thermodilution catheters are widely used, albeit with some error.[7–13] The Swan-Ganz balloon-tipped floatation catheter is an end-hole catheter, which may have an additional lumen terminating in a proximal side port and a thermistor (temperature monitor) at the tip for calculating cardiac output (CO) by the thermodilution method.[14] The use of the Swan-Ganz catheter expanded rapidly in the 1970s in critically ill and high-risk surgery patients but declined thereafter when randomized controlled trials failed to demonstrate a benefit from its use, showing an increase in complications.[15,16] Current indications include cardiogenic shock and the diagnosis and follow-up of PH (**Box 1**).[17]

In few patients with severe PH, advancing the Swan-Ganz catheter to the pulmonary artery and PAWP position may be challenging because of marked dilatation of right heart chambers and vessels, or the presence of severe tricuspid or pulmonary valve regurgitation. Several tricks can be used to overcome such difficulties (eg, use of standard of hydrophilic guidewires, coiling the catheter in the right atrium). Other catheters can be used to access the pulmonary arteries but are not able to provide a reliable PAWP (**Table 1**). The Berman catheter, a balloon-tipped, blind-end angiographic catheter, has several holes proximal (or distal) to the balloon, and does not allow thermodilution or PAWP measurements. Non–flow-directed catheters, such as the multipurpose or pigtail catheter, may be used to access the pulmonary arteries