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ONE MINUTE CONSULT

BRIEF ANSWERS TO SPECIFIC CLINICAL QUESTIONS

Q: Which patients with pulmonary embolism need echocardiography?

A: Most patients admitted with pulmonary embolism (PE) do not need transthoracic echocardiography (TTE); it should be performed in hemodynamically unstable patients, as well as in hemodynamically stable patients with specific elevated cardiac biomarkers and imaging features.

The decision to perform TTE should be based on clinical presentation, PE burden, and imaging findings (eg, computed tomographic angiography). TTE helps to stratify risk, guide management, monitor response to therapy, and give prognostic information for a subset of patients at increased risk for PE-related adverse events.

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RISK STRATIFICATION IN PULMONARY EMBOLISM

PE has a spectrum of presentations ranging from no symptoms to shock. Based on the clinical presentation, PE can be categorized as high, intermediate, or low risk.

High-risk PE, often referred to as "massive" PE, is defined in current American Heart Association guidelines as acute PE with sustained hypotension (systolic blood pressure < 90 mm Hg for at least 15 minutes or requiring inotropic support), persistent profound bradycardia (heart rate < 40 beats per minute with signs or symptoms of shock), syncope, or cardiac arrest.[1]

Intermediate-risk or "submassive" PE is more challenging to identify because patients are more hemodynamically stable, yet have evidence on electrocardiography, TTE, computed tomography, or cardiac biomarker testing—ie, N-terminal pro-B-type natriuretic peptide (NT-proBNP) or troponin—that indicates myocardial injury or volume overload.[1]

Low-risk PE is acute PE in the absence of clinical markers of adverse prognosis that define massive or submassive PE.[1]

Scoring systems to evaluate PE severity include the PE severity index (PESI)[2,3] and the Bova grading system.[4] The PESI predicts adverse outcomes in acute PE independent of cardiac biomarkers, with risk categorized from lowest to highest as class I to class V (**Table 1**).[4] The Bova score predicts the 30-day risk of PE-related complications in hemodynamically stable patients (**Table 2**). Points are assigned for each variable, for a maximum of 7. From 0 to 2 points is stage I, 3 to 4 points is stage II, and more than 4 points is stage III. The score is based on 4 variables: heart rate, systolic blood pressure, cardiac troponin level, and a marker of right ventricular dysfunction. The higher the stage, the higher the 30-day risk of PE-related complications.[5]

ECHOCARDIOGRAPHIC FEATURES OF HIGH-RISK PULMONARY EMBOLISM

Certain TTE findings suggest increased risk of a poor outcome and may warrant therapy that is more invasive and aggressive. High-risk features include the following:

- Impaired right ventricular function
- Interventricular septum bulging into the left ventricle ("D-shaped" septum)
- Dilated proximal pulmonary arteries
- Increased severity of tricuspid regurgitation
- Elevated right atrial pressure
- Elevated pulmonary artery pressure
- Free-floating right ventricular thrombi, which are associated with a mortality rate

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TABLE 1

Pulmonary Embolism Severity Index (PESI) in risk stratification

Parameter	PESI scoring	Simplified PESI
Age	Age in years	1 point if age > 80
Male sex	10 points	—
Cancer	30 points	1 point
Heart failure	10 points	1 point
Chronic pulmonary disease	10 points	1 point
Pulse ≥ 110 bpm	20 points	1 point
Systolic blood pressure < 100 mm Hg	30 points	1 point
Respiratory rate > 30 per minute	20 points	—
Temperature < 36°C (96.8°F)	20 points	—
Altered mental status	60 points	—
Arterial oxyhemoglobin saturation < 90%	20 points	1 point

Risk stratification	Total points		30-day mortality risk	
PESI	≤ 65	Class I	Very low	(0%–1.6%)
	66–85	Class II	Low	(1.7%–3.5%)
	86–105	Class III	Moderate	(3.2%–7.1%)
	106–125	Class IV	High	(4.0%–11.4%)
	> 125	Class V	Very high	(10.0%–24.5%)
Simplified PESI	0		1.0%	
	≥ 1		10.9%	

Based on information in references 2 and 3.

of up to 45% and can be detected in 7% to 18% of patients[6]

- Tricuspid annular plane systolic excursion, an echocardiographic measure of right ventricular function[1]; a value less than 17 mm suggests impaired right ventricular systolic function[7]
- The McConnell sign, a feature of acute massive PE: akinesia of the mid-free wall of the right ventricle and hypercontractility of the apex.

These TTE findings often lead to treatment with thrombolysis, transfer to the intensive care unit, and activation of the interventional team for catheter-based therapies.[1,8] Free-floating right heart thrombi or thrombus straddling the interatrial septum ("thrombus in transit") through a patent foramen ovale may require surgical embolectomy.[8]

PATIENT SELECTION AND INDICATIONS FOR ECHOCARDIOGRAPHY

TTE is indicated in all patients with high-risk PE who are hemodynamically unstable and present with shock, syncope, cardiac arrest, tachycardia (heart rate > 100 beats per minute), or persistent sinus bradycardia (heart rate < 40 beats per minute) (**Table 3**).[4,9] TTE is also recommended for hemodynamically stable patients with evidence of right ventricular dysfunction or strain on computed tomographic angiography, elevation of troponin or NT-proBNP, or new complete or incomplete right bundle branch block or anteroseptal ST or T-wave changes on electrocardiography.[8] A more objective assessment recently developed for risk stratification uses clinically driven scores: a PESI score of 86 to 105 (class III) or a simplified PESI score of 1 or higher warrants TTE.[2,3]

Certain TTE findings suggest risk of poor outcome and need for aggressive therapy

TABLE 2

Bova scoring system for estimating 30-day risk of complications or death in acute pulmonary embolism

Predictor variable	Points
Systolic blood pressure 90–100 mm Hg	2
Elevated cardiac troponin	2
Right ventricular dysfunction on echocardiography or computed tomography	2
Heart rate ≥ 110/min	1

Points[a]	Stage	30-day risk of complications[a]	30-day risk of death
0–2	I	4.4%	3.1%
3–4	II	18%	6.8%
> 4	III	42%	10%

[a]The Bova score predicts the 30-day risk of complications and death in hemodynamically stable patients. Complications include hemodynamic collapse and recurrent nonfatal pulmonary embolism.

Based on information in reference 4.

TABLE 3

Indications for transthoracic echocardiography in pulmonary embolism

Pulmonary embolism severity index (PESI) class III to V, or simplified PESI score ≥ 1

Right ventricular dysfunction or strain on computed tomographic angiography

Sinus tachycardia (heart rate > 100 beats per minute)

Persistent bradycardia (heart rate < 40 beats per minute)

Elevated cardiac troponin or N-terminal pro-B-type natriuretic peptide

New complete or incomplete right bundle branch block

Changes in anteroseptal ST segment or T wave

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