TAKE-HOME MESSAGE

When pretest probability for pulmonary embolism is high, abnormalities in right ventricular function detected on echocardiogram strongly support the diagnosis; however, a normal echocardiogram cannot be used to rule out pulmonary embolism.

Can Echocardiography Be Used to Diagnose Pulmonary Embolism at the Bedside?

EBEM Commentators
Robert R. Ehrman, MD
Mark J. Favot, MD
Department of Emergency Medicine
Wayne State University School of Medicine
Detroit Medical Center/Sinai-Grace Hospital
Detroit, MI

METHODS

DATA SOURCES

EMBASE, CINAHL, and PubMed were searched from January 1980 to November 2016. Reference lists of included studies were also searched.

STUDY SELECTION

Studies of adults with suspected pulmonary embolism who had an echocardiogram as part of the diagnostic pathway were included. The suitability of each study for inclusion was assessed by 2 reviewers. Multiple confirmatory tests were used in the included studies (ie, computed tomography [CT], pulmonary angiogram, high-probability ventilation/perfusion scan, intermediate-probability ventilation/perfusion scan with any other confirmatory study, and surgery or autopsy).

DATA EXTRACTION AND SYNTHESIS

Two authors independently extracted data and assessed study quality with the Quality Assessment of Diagnostic Accuracy Studies Assessment tool; disagreements were resolved by consensus of 4 reviewers. Summary estimates of sensitivity and specificity of ultrasonography were calculated for various signs of right ventricular dysfunction. Pooled test characteristics were also calculated for studies conducted in the emergency department (ED) only

Results

Pooled test characteristics of echocardiographic signs of pulmonary embolism.

Sign	N	Sensitivity (95% CI), %	Specificity (95% CI), %	LR+ (95% CI)	LR– (95% CI)
McConnell's sign	571	22 (16–29)	97 (95–99)	8.5 (4.4–16.5)	0.8 (0.7–0.9)
Paradoxic septal motion	925	26 (22–31)	95 (93–97)	5.1 (3.6–7.6)	0.8 (0.7–0.8)
Elevated RV end-diastolic diameter	473	80 (61–92)	80 (67–89)	4.5 (3.5–5.9)	0.3 (0.2–0.3)
RV hypokinesis	627	38 (31–44)	91 (88–94)	4.2 (3.0–6.0)	0.7 (0.6–0.8)
Abnormal RV:LV ratio	879	55 (49–60)	86 (83–89)	3.9 (3.1–4.8)	0.5 (0.5–0.6)
Right-sided heart strain	1,986	53 (45–61)	83 (74–90)	3.4 (2.9–4.0)	0.6 (0.5–0.6)

CI, Confidence interval; *LR+*, positive likelihood ratio; *LR–*, negative likelihood ratio; *RV*, right ventricle; *LV*, left ventricle.

The search strategy yielded 5,905 potential references, of which 24 full-text articles were included in the final analysis; pulmonary embolism prevalence was 40.8%. Study design was prospective in 17 studies and retrospective in 7. Risk of bias was low in 7 studies, high in 4, and unclear in the remaining 13. Echocardiograms were performed by physicians in 9 studies (3 by emergency physicians, 5 by cardiologists, and 1 unclear) and at the point of care in 7 studies; 7 studies were conducted solely in the ED.

The authors identified 9 unique echocardiographic signs of pulmonary embolism, as well as the undefined finding of "right-sided heart strain." Overall, the signs of pulmonary embolism were moderately specific (range 61% to 99%) but poorly sensitive (range 5% to 80%). Test characteristics were slightly improved when echocardiograms were performed by physicians. In the pooled and subgroup analyses, McConnell's sign, paradoxic septal motion, and presence of a right-sided heart thrombus had specificities greater than or equal to 95%; right ventricular hypokinesis performed well in the subgroup analyses, with a specificity greater than or equal to 98%. Normal right ventricular end-diastolic diameter was the only sign with a sensitivity greater than 80%. McConnell's sign

and when ultrasonographic examinations were performed by physicians.

had the best positive likelihood ratio, at 8.5; the best negative likelihood ratio was normal right ventricular end-diastolic diameter, at 0.3 (Table).

Commentary

In many cases, making the decision to pursue the evaluation for pulmonary embolism can be more challenging than making the diagnosis itself. Clinical decision aids (eg, pulmonary embolism rule-out criteria[1]) can exclude pulmonary embolism in very-low-risk patients. When risk is low to moderate, D-dimer testing is often used, but it is nonspecific, often leading to increased ionizing radiation from CT scans, as well as overdiagnosis.[2] Alternative methods of diagnosis are potentially most useful in unstable patients who transfer to radiology or when there are other delays in treatment because sequential testing (ie, D-dimer before imaging) may be perilous. Although echocardiography is noninvasive and emergency physicians have demonstrated proficiency in its use, this review suggests that it has limited utility in the diagnosis of pulmonary embolism. However, it may be used postdiagnosis for risk-stratification purposes.[2]

None of the reported echocardiographic variables had negative likelihood ratios sufficient to safely rule out the diagnosis of pulmonary embolism. The presence of McConnell's sign (ie, hypokinesis of the basal and mid right ventricular free wall with apical hyperkinesis) strongly suggested the diagnosis of pulmonary embolism, with a positive likelihood ratio of 8.5. Although none of the reported variables performed well enough to definitively diagnose pulmonary embolism in stable patients, in situations in which definitive testing may not be feasible (eg, hemodynamic instability) and pretest probability is very high, it may be reasonable to initiate treatment based on the presence of McConnell's sign. Perhaps future studies will include a combined approach using point-of-care ultrasonography such as echocardiography, deep venous thrombosis scanning, and thoracic ultrasonography.

Systematic reviews are limited by the heterogeneity of the included articles, and this systematic review had a great degree of heterogeneity. Only 6 of 24 included studies specifically evaluated physician-performed point-of-care ultrasonography, and of these 6 studies, 4 enrolled convenience samples. ED patients undergoing point-of-care ultrasonography represent approximately 30% of the patients included in the review. Considering these and other sources of heterogeneity within the studies, and given that sonographer experience was not assessed in this review, echocardiographic-based treatment decisions in the ED should be made by clinicians with significant experience and comfort with their ultrasonographic skills.

Editor's Note: This is a clinical synopsis, a regular feature of the *Annals'* Systematic Review Snapshot (SRS) series. The source for this systematic review snapshot is: **Fields JM, Davis J, Girson L, et al. Transthoracic echocardiography for diagnosing pulmonary embolism: a systematic review and meta-analysis. *J Am Soc Echocardiogr*. 2017;30:714-723.e4.**

1. Kline JA, Courtney DM, Kabrhel C, et al. Prospective multicenter evaluation of the pulmonary embolism rule-out criteria. *J Thromb Haemost*. 2008;6:772-780.
2. Kucher N, Rossi E, De Rosa M, et al. Prognostic role of echocardiography among patients with acute pulmonary embolism and a systolic arterial pressure of 90 mm Hg or higher. *Arch Intern Med*. 2005;165:1777-1781.

Michael Brown, MD, MSc, Jestin N. Carlson, MD, MS, and Alan Jones, MD, serve as editors of the SRS series.