

Challenges and Changes to the Management of Pulmonary Embolism in the Emergency Department



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KEYWORDS

- Pulmonary embolism • Venous thromboembolism • Emergency department • Thrombolysis
- Thrombolytics • PE response team

KEY POINTS

- Diagnosis of PE may include the use of age adjusted D-dimer and point-of-care ultrasound.
- Classification of PE is essential for prognosis and treatment and has evolved over the last decade.
- Alternative treatments such as low dose thrombolytics may be most appropriate in some patients.
- Cutting edge therapies for life threatening PEs include nitric oxide ventilation and extracorporeal membrane oxygenation.

 Video content accompanies this article at <http://www.chestmed.theclinics.com>.

EPIDEMIOLOGY AND DIAGNOSIS

The incidence of pulmonary embolism (PE) is slightly more than 1 per 1000 person-years, with estimates ranging as high as 900,000 PEs annually in the United States with 200,000 fatalities per year (Box 1).¹ Between 1 in 400 and 1 in 1500 patients presenting to US emergency departments (EDs) will be diagnosed with PE, an incidence that is highly age-related, and may increase as the population ages further.² With more than 140 million annual ED visits in the United States, this suggests that between 90,000 and 350,000 PEs are diagnosed annually in US EDs.³

In 1998 multidetector computed tomography (CT) pulmonary angiography was introduced and rapidly became the first-line test for PE.⁴ CT is rapid, accurate, and essentially universally available in EDs as a diagnostic option. However, despite a near doubling of diagnostic incidence since CT replaced ventilation perfusion scanning,

the age-adjusted mortality from PE has remained relatively stable, suggesting “overdiagnosis.”⁴

At the same time, it is frequently posited that PE remains missed in the ED setting, and medicolegal concerns are prominent. It has been suggested that PE “should be suspected in all patients who present with worsening dyspnea, chest pain, or sustained hypotension without an alternate obvious cause.”⁵ However, the hallmark symptoms of PE—chest pain and shortness of breath—are among the most common presenting ED complaints. This makes ruling out a PE by objective means in all such patients neither feasible nor desirable. There are several validated clinical decision rules that can aid in deciding whether further diagnostic testing (D-dimer or CT) is needed, including the PE rule-out criteria (PERC), Wells score for PE, and the Geneva score.²

The PERC score defines a population in whom no testing is needed to exclude PE. Patients in

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Box 1**Challenges and changes in ED management of PE**

- Adjusted D-dimer for diagnosis
- Classification of PE for prognosis and therapy
- Thrombolytic therapy for intermediate-risk PE
- Low-dose thrombolysis dosing
- Adjunctive therapies for large PEs
 - Nitric oxide ventilation
 - Extracorporeal membrane oxygenation
- Multidisciplinary PE response teams

whom PE is considered a possible diagnosis but who are “PERC negative” should not have D-dimer performed. An important concept with PERC is that it does not necessarily completely rule out all possibilities of a PE, but it defines a population in whom the likely harm of performing a D-dimer (false-positive results leading to likely unnecessary testing) outweighs the benefit based on defining a threshold level of diagnostic likelihood (~2%). It is also important not to apply the PERC rule indiscriminately—if there is no real concern for PE then it should not be used.

The Wells score for PE is the predominant scoring system and has been well validated in the ED setting.⁶ It can be divided into either a two- or three-level score, with D-dimer testing used to exclude PE in low- or intermediate-risk patients. The Geneva score (including simplified and revised Geneva) is an alternate approach that is more common in Europe and has been shown in some studies to be more consistently reliable.¹ The decision about whether and which clinical prediction rule to use may be guided by the local prevalence of PE.⁷ Although objective clinical prediction rules are recommended by some analyses, others have suggested that gestalt clinician pretest probability may be used and even preferred in some cases.^{8,9}

Challenges and Changes: Adjusted D-dimer

D-dimer is a cornerstone of PE diagnosis. Quantitative enzyme-linked immunoassay D-dimer tests are sensitive enough to essentially rule out a PE in all but high-risk patients. Although sensitive for ruling out PE, the problem is that D-dimer is not specific and can be elevated in the absence of PE. This is the basis of the PERC score—an attempt to ensure D-dimers are not ordered indiscriminately, leading to increased CT scanning without improving diagnostic yield. D-dimer may

be elevated without PE in pregnancy, malignancy, trauma, or simply as people age. Recently several publications have supported the use of an age-adjusted D-dimer, allowing the threshold for CT angiography testing to increase with age. The most commonly used adjustment is to use age times 10 ng/mL, so while a normal threshold for abnormal is typically 500 ng/mL, an 80 year-old patient’s cutoff would be 800 ng/mL. This approach is supported by the literature and expert opinion.¹⁰ In pregnancy, D-dimer level also increases with each trimester, and a pregnancy-adjusted D-dimer along with a modified PERC rule may be considered (heart rate cutoff of 105; D-dimer threshold 50%, 100%, and 125% higher than normal cutoff by trimester).¹¹

Challenges and Changes: Echocardiography and Focused Cardiac Ultrasound

Transthoracic echocardiography (TTE) can be used in both the diagnosis and prognosis of PE and can thus also influence therapy.¹² Although echo is insufficiently sensitive to completely rule out PE, the presence of findings (usually indirect evidence of right ventricular [RV] strain, occasionally actual visualized thrombus) increases the likelihood of the diagnosis and defines a subset that may benefit from more aggressive therapy.¹³ When available, TTE can be performed by a certified sonographer and interpreted by a cardiologist; however, availability of cardiology echo is often limited or delayed in the ED setting.¹⁴ The specificity of echo may be particularly helpful for “rule-in” of patients with hemodynamic instability in the ED setting.¹²

One of the more recent challenges and changes to the ED diagnosis and management of PE has been the potential incorporation of point-of-care ultrasound, or specifically focused cardiac ultrasound (FoCUS), which is an ultrasound performed by the emergency physician at the bedside.^{15,16} Although echo performed by emergency physicians (EPs) has been described for at least 3 decades, evidence for FoCUS evaluation in suspected or confirmed PE has been more recent.¹⁷ The evaluation of the right heart has consistently been included in consensus statements about FoCUS since 2010.^{15,18,19} Available ultrasound technology has become higher in quality and more affordable, but the issue has always been what level of training is required to adequately perform FoCUS.¹⁹

The most prevalent and reliable sign of a significant PE on echo is RV strain, based on RV enlargement or hypokinesis (Figs. 1 and 2). RV enlargement relative to the left ventricle (LV) is

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