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When Is a Computed Tomography Angiogram Necessary to Rule Out Pulmonary Embolus in the Emergency Department?

By Joel Handler, MD

Case Examples
A previously healthy woman, age 25 years, presented in the Emergency Department (ED) with sudden onset of pleuritic chest pain. She said that she had had no cough, fever, or chills; she took birth-control pills. Physical examination showed the patient to be comfortable breathing room air and to have a pulse oximetry saturation of 92%, respiration rate of 18 breaths per minute, blood pressure of 118/62 mm Hg, and a heart rate of 74 beats per minute. There was no chest wall tenderness and no calf or popliteal tenderness or swelling. A telephone advice nurse had recommended that she go to the ED.

A man, age 68 years, who had a left upper lobectomy for cancer four years earlier presented with shortness of breath that began a few hours before his ED presentation. He said that he had no chest discomfort, cough, fever, or chills. Physical examination revealed that although he was not uncomfortable, he had modest tachypnea. His respiration rate while breathing room air was 22 breaths per minute; his blood pressure was 142/84 mm Hg and he had a heart rate of 88 beats per minute. Chest examination revealed reduced breath sounds bilaterally. There was no calf or popliteal tenderness or swelling.

Discussion
As illustrated by these two cases, the most common scenarios in the ED in which pulmonary embolus (PE) must be ruled out are otherwise unexplained pleuritic chest pain and dyspnea. However, the frequency of these complaints combined with the ready availability of expensive computed tomography angiography (CTA) has led to the procedure's being ordered too often. CTA is not innocuous; it exposes patients to significant radiation exposure. A single CTA carries a radiation exposure equivalent to that of 400 chest x-rays. Therefore, several careful clinical investigations have sought to define a low-risk population who do not need CTA. A multidisciplinary task force of Kaiser Permanente Southern California (KPSC) experts, supported by the regional Medical Technology Assessment Team, is promoting the use of an evidence-based diagnostic algorithm to rule out PE (Figure 1).

Identification of a low-risk population for whom CTA does not add utility requires both an assessment of pretest probability and an assay of D-dimer, which is a breakdown product of cross-linked fibrin. Studies have shown that the D-dimer assay is not a good enough stand-alone test because of the risk of false negative assay results with high-probability patients. The generally accepted standard for a noninvasive protocol to rule out PE in the absence of CTA is a sensitivity ≥98%. Of patients with normal findings on invasive pulmonary angiography, 1.6% develop PE within one year. There are also different pretest clinical probability scoring systems and D-dimer assays from which to choose. General estimates of low, medium, and high risk used in some studies work well in the hands of pulmonary and critical care experts who have more experience with PE. Specific probability scoring checkoffs on a numeric scale that are then summed have more general applicability at the front line of EDs. At the KPSC hospital laboratories, a rapid enzyme-linked immunosorbent D-dimer assay with a sensitivity of approximately 90% and a specificity of approximately 50% is used in assessing candidates for acute PE.

The algorithm chosen for KPSC is modeled on the Christopher study, a large multicenter prospective trial. That study was unique because of its prospective validation of a user-friendly pretest probability scale dividing patients into “PE likely” and “PE unlikely” groups, thereby eliminating the difficult middle ground of “moderate-probability” patients. A pretest clinical probability score ≤4 means that PE is unlikely. In the group of 1057 patients with a pretest probability assessment of “PE
unlikely” and negative D-dimer assay findings, nonfatal PE occurred in 0.5% (95% confidence interval, 0.2%–1.1%) at three months, well within the previously defined threshold of acceptability of <2%. No PE mortalities were observed. There probably is an additional measure of safety because the prevalence of deep venous thrombosis in a prospectively examined KPSC population was much lower than that in large multicenter trials using the same pretest probability scoring system. Moreover, in the Christopher study, the combination of “PE unlikely” and negative D-dimer assay findings occurred in 32% of the study population and safely avoided CTA in the diagnostic workup.

Our clinical algorithm demands an emergency chest x-ray before pretest clinical probability scoring to rule out obvious alternative explanations for the chief complaint. Patient quality-of-care considerations with regard to radiation exposure are compromised when CTA reveals pneumonia, pneumothorax, or heart failure because a simple chest x-ray has not been performed.

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Within two days. Pulmonary ventilation ultrasonography (CUS) of the lower extremities can be used to assess the presence of an “unlikely” clinical estimate and a negative D-dimer assay result. Another important issue is the D-dimer false positive rate, which leads to unnecessary performance of CTA. Good clinical judgment, sometimes in short supply, should always be the driver for ordering any test, and when to initiate the PE rule-out algorithm incorporating the D-dimer assay is no exception. These two patients, both of whose symptoms engendered a reasonable suspicion of acute PE, were properly treated, according to the evidence-based expert-consensus rule-out algorithm. Both patients were found to be in a low-probability subgroup for which CTA was unnecessary, and both were safely discharged from the ED.

Disclosuer Statement
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References