A 30-year-old man complains of chest pain, dyspnea, fever, and nonproductive cough that began earlier in the day

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A 30-year-old man complains of chest pain, dyspnea, fever, and nonproductive cough that began earlier in the day. The pain is constant and does not diminish with rest; it worsens somewhat with deep inspiration and has localized to the left chest. The patient has had no nausea, vomiting, or abdominal pain. He has been immobile for several years secondary to spinal cord disease but has no history of cardiopulmonary disease.

Case 1: Chest Pain and Dyspnea in an Immobilized Man
A 30-year-old man complains of chest pain, dyspnea, fever, and nonproductive cough that began earlier in the day. The pain is constant and does not diminish with rest; it worsens somewhat with deep inspiration and has localized to the left chest. The patient has had no nausea, vomiting, or abdominal pain. He has been immobile for several years secondary to spinal cord disease but has no history of cardiopulmonary disease.

Case 1: DISCUSSION
The ECG demonstrates sinus tachycardia (Figure 1). The axis is "vertical": the principal QRS vector in lead I is nearly isoelectric-although slightly more negative than positive- and the principal QRS vector in lead aVF is positive; thus, the axis is downward, or vertical, and slightly greater than +90. The intervals are normal. The R-wave progression across the precordium is slightly delayed, with a transition zone in lead V5. The S wave in lead I (which plays a role in the right axis deviation) is part of an "S1Q3T3" pattern (see Figure 1):

- Prominent S wave in lead I.
- Q wave in lead III.
- Inverted T wave in lead III.

These findings-although not specific for pulmonary embolism (PE), C-are all associated with this entity. PE is an elusive diagnosis. Findings in the history, physical examination, and chest film-as well as the ECG-lack both sensitivity and specificity. Interpretation of more definitive tests (eg, ventilation-perfusion scan, chest CT scan, D-dimer testing) is also frequently difficult and complicated by the need to include pre-test probability of the disease. Nonetheless, the ECG is a quick, noninvasive bedside test that at times can suggest PE. S1Q3T3 and PE. Nearly 70 years ago, McGinn and White [1] described this constellation of ECG findings in 7 patients with acute right cor pulmonale secondary to PE. They suggested specific criteria for the pattern:

- S wave in lead I and Q wave in lead III greater than 1.5 mm in amplitude.
- Inverted T wave in lead III, in association with the above findings.

S1Q3T3 has been closely linked with the diagnosis of PE, although it is neither sensitive nor specific for the disease. Ferrari and colleagues [2] reviewed 4 studies and found that S1Q3T3 was present in only 12% to 52% of patients with PE (including 40 of 80 patients with confirmed PE in their own study). Others have suggested that criteria for the amplitude of the specific waveforms involved in S1Q3T3 have not been definitively established. Indeed, these findings may be transient and may not even occur simultaneously. Reversible S1Q3T3 has been described with pneumothorax. In fact, the ECG shown in Figure 1, with its sinus tachycardia, deep S wave in lead I, and 3-mm R wave in aVR, could suggest tricyclic antidepressant toxicity in the proper setting-even though the QRS complex is not
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Clinical assessment in the diagnosis of pulmonary embolism. Not surprisingly, sinus tachycardia is not widely prevalent on the ECGs of patients with PE. Chan and colleagues reviewed 6 studies and reported that the ECGs of only 8% to 69% of patients with PE showed sinus tachycardia. Thus, although resting tachycardia in the absence of an obvious cause (eg, fever, dehydration, blood loss, hyperthyroidism, drug reaction [as to cocaine or amphetamine], heart failure, pericardial effusion, pain) suggests PE, the absence of tachycardia is not grounds for ruling out this diagnosis. Right atrial strain, or P pulmonale. Defined as a peaked P wave in the inferior leads (usually best seen in lead II, with P-wave amplitude of at least 2.5 mm), this finding has been associated with PE; it is especially suggestive of the diagnosis when it is an acute change (Figure 2). Chan and coworkers reported right atrial strain in 2% to 31% of patients with PE (based on data from 9 case series). However, this finding is often seen on the ECGs of patients with chronic lung disease as well. Right bundle branch block. Both complete and incomplete right bundle branch block have been detected in a wide range of patients with PE (6% to 67% in 8 series of cases). This ECG finding has been linked to more severe PEs; either complete or incomplete right bundle branch block was seen in 16 of 20 patients with autopsy-proven PE of the main arterial trunk. T-wave inversion in leads V4, through V6. In their series of 80 patients with confirmed PE, Ferrari and colleagues found that this anterior ischemic pattern was the most common ECG finding (68%-more common than the S1Q3T3 pattern (50%), sinus tachycardia (26%), complete/incomplete right bundle branch block (22%), or the right atrial strain pattern (5%). Similarly, in the Prospective Investigative Study of Acute Pulmonary Embolism Diagnosis (PISA-PED), the most common ECG change in 202 patients with confirmed PE was precordial T-wave inversion (23%); the S1Q3T3 pattern was slightly less common (19%). Right precordial Twave inversion pattern was also found to be more common in massive PE. Role of the ECG in the diagnosis of PE. PE cannot be ruled in or out solely on the basis of ECG findings. These must be interpreted in conjunction with other test results. For example, this patient's ventilation-perfusion scan results corroborated the conclusion drawn from the ECG and indicated that PE was highly probable. In patients with chest pain and/or dyspnea, the ECG is chiefly used to suggest diagnoses other than PE. ECG findings (classically, ST-segment elevation) are the cornerstone of diagnosis in myocardial infarction. The early stages of pericarditis usually feature ST-segment elevation as well; however, in pericarditis, these findings are classically diffuse and feature concave (“cupped”) rather than convex (“domed”) morphology. ECG findings in pneumothorax are varied and nonspecific; as with pneumonia, the diagnosis is made on the basis of physical examination results and chest radiographs. The ECG is not helpful in the diagnosis of either gastroesophageal reflux disease or musculoskeletal causes of chest pain. Outcome of this case. Based on the results of the patient's ventilation-perfusion lung scan, therapy with intravenous heparin and oral warfarin was initiated.

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Links: