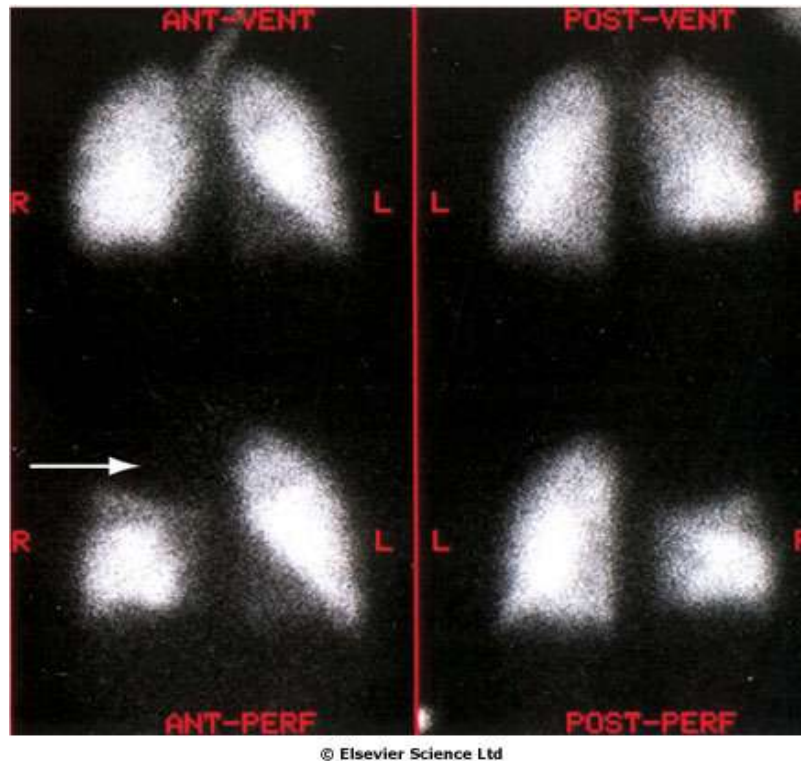


# *Investigations*

## ***Small/medium pulmonary emboli***

- **Chest X-ray** is often normal, but linear atelectasis or blunting of a costophrenic angle (due to a small effusion) is not uncommon. These features develop only after some time. A raised hemidiaphragm is present in some patients. More rarely, a wedge-shaped pulmonary infarct, the abrupt cut-off of a pulmonary artery or a translucency of an underperfused distal zone is seen. Previous infarcts may be seen as opaque linear scars.
- **ECG** is usually normal, except for sinus tachycardia, but sometimes atrial fibrillation or another tachyarrhythmia occurs. There may be evidence of right ventricular strain.
- **Blood tests.** If pulmonary infarction has occurred, there will be a polymorphonuclear leucocytosis, an elevated ESR and increased lactate dehydrogenase levels in the serum.
- **Plasma D-dimer** If this is undetectable, it excludes a diagnosis of pulmonary embolism.
- **Radionuclide ventilation/perfusion scan ([Vdot]/[Qdot] scan)** is a good and widely available diagnostic investigation. The pulmonary <sup>99m</sup>Tc scintigram demonstrates underperfused areas (fig 1) which, if not accompanied by a ventilation defect on a ventilation scintigram performed after inhalation of radioactive xenon gas, is highly suggestive of a pulmonary embolus. There are limitations to the test, however. For example, a matched defect may arise with a pulmonary embolus which causes an infarct or from emphysematous bullae. This test is therefore conventionally reported as a probability of pulmonary embolus and should be interpreted in the context of the history, examination and other investigations.



**Fig1 Ventilation (top) and perfusion (bottom) lung scans** which demonstrate absence of perfusion but normal ventilation in the right upper lobe, i.e. probably pulmonary embolism

- **Ultrasound scanning** can be performed for the detection of clots in pelvic or iliofemoral veins.
- **Spiral CT scans** with intravenous contrast show good sensitivity and specificity for medium-sized pulmonary emboli. They do not exclude pulmonary emboli in small arteries.
- **MR imaging** gives similar results and is used if CT angiography is contraindicated.

### ***Massive pulmonary emboli***

- **Chest X-ray** may show pulmonary oligoemia, sometimes with dilatation of the pulmonary artery in the hila. Often there are no changes.
- **ECG** shows right atrial dilatation with tall peaked T waves in lead II. Right ventricular strain and dilatation give rise to right axis deviation, some degree of right bundle branch block, and T wave inversion in the right precordial leads (fig2). The 'classic' ECG pattern with an S wave in lead I, and a Q wave and inverted T waves in lead III (S<sup>1</sup>, Q<sup>iii</sup>, T<sup>iii</sup>), is rare.

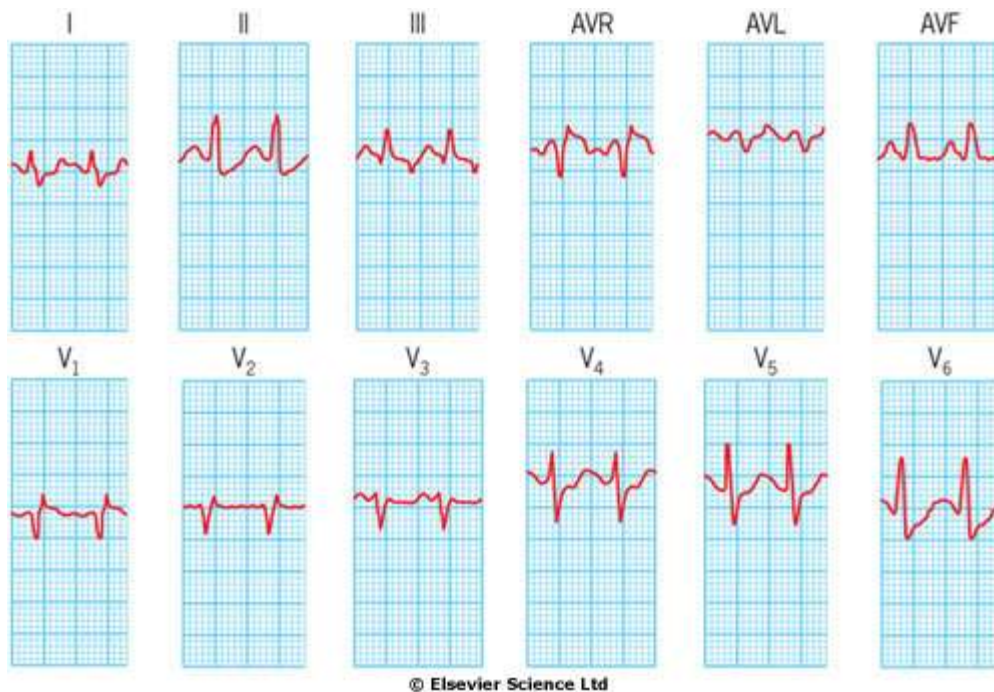
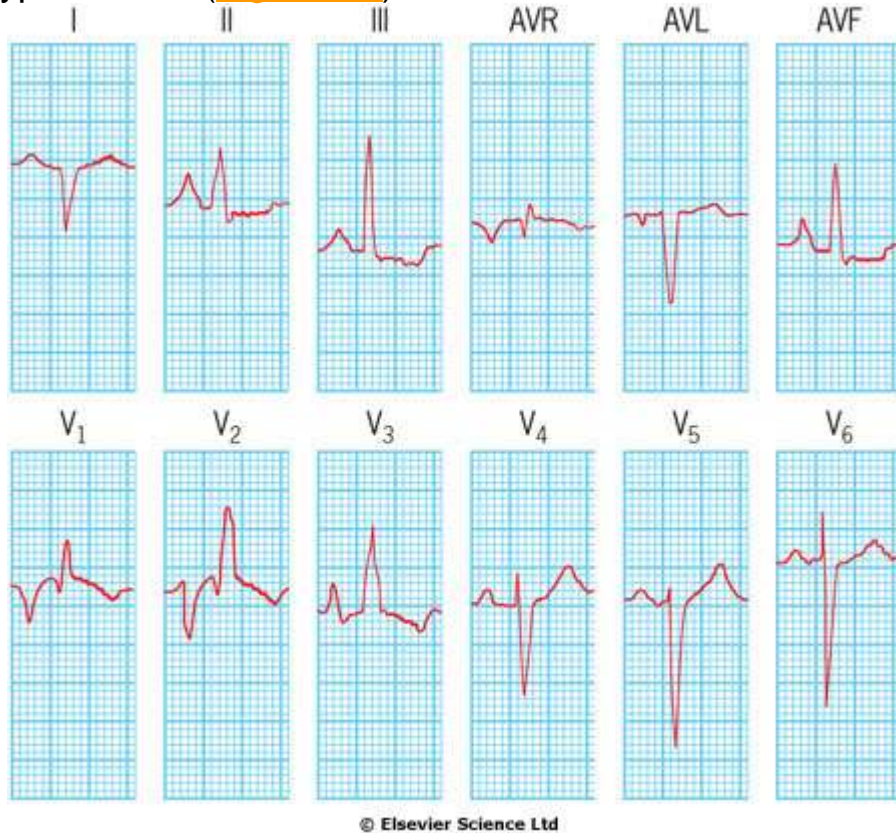


Fig2 **Ventilation** (top) and **perfusion** (bottom) **lung scans** which demonstrate absence of perfusion but normal ventilation in the right upper lobe, i.e. probably pulmonary embolism. **Acute pulmonary embolism** shown by a 12-lead ECG. There is an S wave in lead I, a Q wave in lead III and an inverted T wave in lead III (the S1, Q3, T3 pattern). There is sinus tachycardia (160 b.p.m.) and an incomplete right bundle branch block pattern (an R wave in AVR and V<sub>1</sub> and an S wave in V<sub>6</sub>)

- **Blood gases** show hypoxia and hypocapnia.
- **Echocardiogram** shows a vigorously contracting left ventricle and occasionally a clot in the right ventricular outflow tract.
- **Pulmonary angiography** is sometimes undertaken if surgery is considered in acute massive embolism. The test is performed by injecting contrast material through a catheter inserted into the main pulmonary artery. Filling defects or obstructed vessels can be delineated ([Fig. 13.86](#)). Angiography is hazardous but the risk may be reduced if contrast is injected into each pulmonary artery separately. If the patient is in extremis and the diagnosis is obvious, surgery should proceed without prior angiography.

## Multiple recurrent pulmonary emboli

- **Chest X-ray** may be normal. Enlarged pulmonary arterioles with oligoemic lung fields indicate advanced disease.
- **ECG** can be normal or show signs of pulmonary hypertension ([Fig. 13.87](#)).



13.87 **Pulmonary hypertension** shown by a 12-lead ECG. There is right axis deviation ( $+120^\circ$ ), right ventricular hypertrophy (dominant secondary R wave [R'] in  $V_1$ ) and a combination of left and right atrial conduction

- **Leg imaging** with **ultrasound** and **venography** may show thrombi.
- **[Vdot]/[Qdot] scan** may show evidence of pulmonary infarcts.
- **Further tests** looking for exercise-induced hypoxaemia and catheter studies to estimate pulmonary artery pressures are often required.