Use of echocardiography in diagnosis of pulmonary embolism

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Objectives

- Introduction and epidemiology of PE.
- Definition and classification.
- Diagnostic tools for thromboemboli.
- Role of Echo.
- Prognosis.
INTRODUCTION

- Common and sometimes fatal.
- Variable clinical presentation.
- The evaluation of patients should be efficient so that patients can be diagnosed and therapy administered quickly to reduce the associated morbidity and mortality.
- The overall incidence of PE is approximately 112 cases per 100,000.
- Males > females and incidence increases with age.
- Deaths from PE account for approximately 100,000 deaths per year in the United States.
Pulmonary embolus (PE) refers to obstruction of the pulmonary artery or one of its branches by material (e.g., thrombus, tumor, air, or fat) that originated elsewhere in the body.

PE can be classified according to:
- The presence or absence of hemodynamic stability (hemodynamically unstable or stable).
- The temporal pattern of presentation (acute, subacute, or chronic).
- The anatomic location (saddle, lobar, segmental, subsegmental).
- The presence or absence of symptoms (symptomatic or asymptomatic).
**DIAGNOSIS**

- **CXR:** Classic focal oligemia is seldom seen.
- **ECG:** Abnormal in 80%, but not specific and no diagnostic.
- **Traditional Pulmonary angiography:** Has been the gold standard and it is invasive and expensive.
- **V/Q scans:** It is safe and available, unfortunately 35% of cases are considered non-diagnostic.
- **CTPA:** The most common, available, rapid, cost effective and highly accurate.
- **Transthoracic echocardiography:** ???
Evaluation of the nonpregnant adult with low probability of pulmonary embolism

- Low probability of PE (e.g., Wells score <2)\(\uparrow\)
- Can pulmonary embolism rule out criteria be applied?\(\uparrow\)
  - Yes
  - No

- Are all of the following eight criteria fulfilled?\(\uparrow\)
  - Age <50 years
  - Heart rate <100 beats/minute
  - Oxygen saturation ≥95%\(\uparrow\)
  - No hemoptysis
  - No estrogen use
  - No prior DVT or PE
  - No unilateral leg swelling
  - No surgery/trauma requiring hospitalization within the prior four weeks\(\uparrow\)

- Measure sensitive D-Dimer level\(\uparrow\)
  - D-dimer <500 ng/mL (fibrinogen equivalent units)\(\uparrow\)
    - Pulmonary embolism excluded. No further testing required.
  - D-dimer ≥500 ng/mL (fibrinogen equivalent units)\(\uparrow\)
    - CT pulmonary angiography\(\uparrow\)

Evaluation of the nonpregnant adult with intermediate probability of pulmonary embolism

- Intermediate probability of PE (e.g., Wells score 2 to 6)\(\uparrow\)
  - Measure D-Dimer level (using a "sensitive" assay)\(\uparrow\)
    - D-dimer <500 ng/mL (fibrinogen equivalent units)\(\uparrow\)
      - Pulmonary embolism likely excluded. No further testing generally required.
    - D-dimer ≥500 ng/mL (fibrinogen equivalent units)\(\uparrow\)
      - CT pulmonary angiography (feasible)\(\uparrow\)

Evaluation of the nonpregnant adult with high probability of pulmonary embolism

- High probability of PE (e.g., Wells score >6)\(\uparrow\)
  - CT pulmonary angiography (feasible)\(\uparrow\)

- Positive
- Negative
- Inconclusive\(\uparrow\)
  - Ventilation perfusion scanning feasible?\(\uparrow\)
    - Yes
    - PE diagnosed
    - PE excluded
    - Further testing warranted\(\uparrow\)
  - No
  - Normal\(\uparrow\)
  - Low or intermediate probability
  - High probability
  - PE diagnosed
  - PE excluded
  - Further testing warranted\(\uparrow\)
Echocardiographic findings in acute PE

- Direct visualization of thromboemboli in the right heart and PA.
- RV dilatation.
- RV dysfunction.
- Normal or hyperdynamic LV.
- Septal flattening.
- PA dilatation.
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Echocardiographic findings in acute PE

- Direct visualization of thromboemboli in the RT heart and PA.
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Echocardiographic findings in acute PE

- Direct visualization of thromboemboli in the RV heart and PA.
- RV dilatation.
- RV dysfunction.
- Normal or hyperdynamic LV.
- Septal flattening.
- PA dilatation.
Echocardiographic findings in acute PE

- Unusual degree of TR or PR.
- Increased PA pressure.
- McConnell’s sign.
- The 60/60 sign.
- RVOT midsystolic notching.
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Use the following formula for calculation of RVSP:

$$RVSP = 4 \times V^2 + RA$$
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True sensitivity and specificity of TTE in diagnosing acute PE is difficult to assess. Reported sensitivities range from 60%–90%, and specificities from 80%–95%. (…? Overstated).

Visualizations of an embolus can be considered diagnostic, but negative results must be confirmed with alternative tests such as helical CT.
Role of TEE

- TEE major advantage is visualization of proximal PA, esp the Rt PA.
- Interatrial septum should be evaluated to R/O PFO.
- Examination of IVC and SVC is important in ICU setting.
- Although TEE should not be implemented as first line test, but still considered as an alternative tool for patients with PE in ICU settings.
Other causes of PE seen in Rt Heart

- Vegetations.
- Masses:
  - Malignant or benign.
- Air embolism.
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Several studies have suggested that the degree of RV dysfunction can serve as a predictor of mortality. Some authors suggested that cases with RV dysfunction may benefit from aggressive therapeutic strategies including thrombolysis. Majority of these patients had hypotension.
When to consider thrombolysis?

- Severe or worsening right ventricular dysfunction ("submassive PE")
- Cardiopulmonary arrest due to PE (e.g., BP >90 mmHg after resuscitation)
- Extensive clot burden (e.g., large perfusion defects on ventilation/perfusion scan or extensive embolic burden on computed tomography)
- Free-floating right atrial or ventricular thrombus
In patients with intermediate-risk pulmonary embolism, fibrinolytic therapy prevented hemodynamic decompensation but increased the risk of major hemorrhage and stroke.
Suspected PE with shock or hypotension

CT angiography immediately available

No

Echocardiography

RV overload

No

Search for other causes of haemodynamic instability

Yes

CT angiography available and patient stabilized

CT angiography

No other test available or patient unstable

PE-specific treatment: primary reperfusion

Yes

negative

positive

Search for other causes of haemodynamic instability

CT = computed tomographic; PE = pulmonary embolism; RV = right ventricular.

*Includes the cases in which the patient's condition is so critical that it only allows bedside diagnostic tests.

*Apart from the diagnosis of RV dysfunction, bedside transthoracic echocardiography may, in some cases, directly confirm PE by visualizing mobile thrombi in the right heart chambers. Ancillary bedside imaging tests include transoesophageal echocardiography, which may detect emboli in the pulmonary artery and its main branches, and bilateral compression venous ultrasonography, which may confirm deep vein thrombosis and thus be of help in emergency management decisions.

*Thrombolysis: alternatively, surgical embolectomy or catheter-directed treatment (Section 5).
Potential roles of Echo for evaluation of known or suspected PE

1) Contribute to the diagnosis (indirect).
2) Evaluate the hemodynamic consequences.
3) Assess the cardiopulmonary responses to therapeutic interventions.
4) Determine management.
5) Exclude other entities.
“Thank you"