

# Ten years of imaging for pulmonary embolism: too many scans or the tip of an iceberg?



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## ARTICLE INFORMATION

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**AIM:** To examine the number and nature of investigations performed for suspected pulmonary embolism (PE) in a large teaching hospital and the change in incidence and severity of PE over a decade.

**MATERIALS AND METHODS:** In this retrospective study, all patients investigated for suspected PE using computed tomography pulmonary angiography (CTPA) or lung scintigraphy during 10 years to March 2012 were identified and their records reviewed. In the final year, all reportedly positive CTPA cases were reviewed and PE severity calculated, for comparison with similar historical data.

**RESULTS:** From 2002 to 2012, total annual investigations for suspected acute PE increased by 163% (805 to 2121). CTPA increased by 325% (475 to 2019). Detection of PE increased by 121% (193 to 426 per annum), with stable distribution of severity scores. The positive scan rate decreased from 24% to 20%. The mean age of patients being investigated for PE increased from 56 to 63 years.

**CONCLUSIONS:** Increased detection of PE is not due to disproportionate increase in small PEs, but to increased detection of PE of all severities. This finding supports the hypothesis that PE is more common in the general population than previously appreciated, which may represent an iceberg phenomenon of previously undetected disease.

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## Introduction

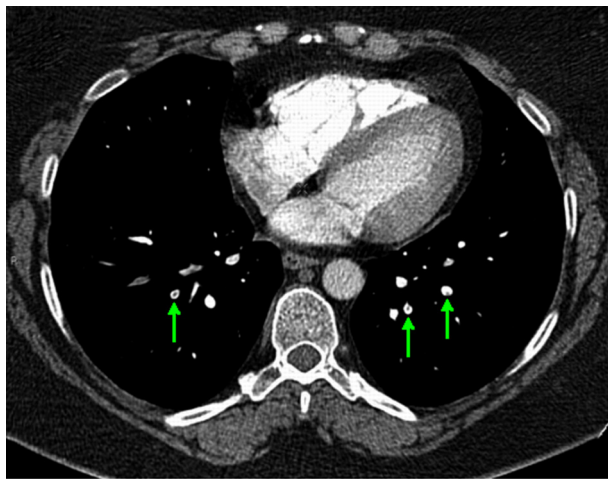
Venous thromboembolism (VTE), including deep vein thrombosis (DVT) and pulmonary embolism (PE), is a frequent and important diagnosis.<sup>1,2</sup> Despite routine prophylaxis, it also remains a leading cause of secondary mortality and morbidity in many common healthcare

scenarios, for example maternity,<sup>3</sup> and lower-limb arthroplasties.<sup>4</sup>

As VTE is prevalent, dangerous, and treatable, it is not surprising to encounter controversy regarding its diagnosis and management.<sup>5,6</sup> A recent article argues that modern computed tomography pulmonary angiography (CTPA) makes increasingly sensitive detection of “small emboli”, and so alters the spectrum of diagnosis.<sup>7</sup> Fig 1 shows some example CTPA images. The authors hypothesised that additional inclusion of small emboli (previously undetectable) effectively causes overdiagnosis and overtreatment. They highlighted an experimental study reported in 2007,<sup>8</sup>

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(a)



(b)

**Figure 1** Axial images from positive CT pulmonary angiograms. Patients are scanned shortly after injection of intravenous contrast medium, timed for greatest opacification in pulmonary arteries. (a) Multiple small emboli are present. Three centriluminal filling defects are shown in cross-section in lower-lobe segmental arteries. (b) Another patient with a “saddle embolus” astride the pulmonary trunk bifurcation and filling defects in the proximal pulmonary arteries. Secondary cor pulmonale causes retrograde opacification in the azygous vein and delayed opacification of the aorta.

in which patients with suspected PE were randomised to either ventilation–perfusion scintigraphy (V/Q) or CTPA. Appropriate patient selection, sufficient numbers, and modern techniques made this a robust comparison. More PEs were detected in the CTPA arm, but no significant differences in outcome were observed. In the CTPA group, 7% of those with PE had isolated, subsegmental emboli, less likely to be detected using V/Q.

In combination, the findings above support the hypothesis: “It is not beneficial to anticoagulate patients with small PEs”. This was the topic of a systematic review,<sup>9,10</sup> which found no includable studies and a multicentre trial in North America is currently recruiting to test it<sup>11</sup>; however, it is

worth considering that treatment of PE is partly secondary prevention. A PE causing presentation might be the forerunner of a preventable secondary event. In addition to dissolution of the embolus causing the presentation, the treatment also targets the thrombotic source of emboli.

PE is a difficult clinical diagnosis with varied and sometimes minimal symptoms and signs. As a result, patients being investigated for suspected PE may have various other serious illnesses. Patients with clinically suspected PE in whom the diagnosis is refuted show a higher mortality than those in whom the diagnosis is confirmed (17% versus 11% at 6 months).<sup>12</sup> In a more recent study, patients with negative CTPA had a 14% 3-month mortality.<sup>13</sup> It is also relevant to consider that subclinical PE is a common incidental finding at CT performed for other reasons,<sup>14</sup> and also at post mortem.<sup>15</sup> In summary, patients being referred with suspected acute PE are a heterogeneous population with many other potential diagnoses and there is a recognised prevalence of subclinical VTE.

The objective of the present study was to assess the impact of a putative increase in detection of small PEs over the decade 2002–2012.

## Materials and methods

This work builds on previous published data from this institution.<sup>16,17</sup> An earlier paper reports a cohort of consecutive positive CTPAs ( $n=504$ ) from 2001 to 2004, with standardised severity scoring. A retrospective analysis of all CTPA and V/Q referrals in the year ending 31/03/12, with comparable severity scoring using the modified Miller score, was performed.<sup>18</sup> For some analyses, the Miller scores have been categorised as mild,<sup>1–5</sup> moderate,<sup>6–10</sup> and severe.<sup>11–16</sup> With specific regard to subsegmental emboli, each bronchopulmonary segment containing an embolus (or emboli) would contribute one point to the score, analogous to “involvement” in the Miller Score,<sup>19</sup> unless superseded by a more proximal embolus. The project was approved by the local research ethics authority.

### Retrospective case reviews

All CTPA and V/Q records in the year ending 31/03/12 were retrieved from the hospital information system, numbering 2138. Referrals and reports were evaluated by two independent physicians. Seventeen cases were excluded because the indication was not suspected acute PE, for instance, the investigation of pulmonary hypertension. CTPA reports detailing new PEs were identified. These cases were reviewed and PE severity quantified with a modified Miller score, under the supervision of a chest radiologist with 20 years of experience. Similar hospital record searches were used to identify the rates of referral for V/Q and CTPA examinations in the years between 2001 and 2012.

In seeking to quantify the incidence of PE, this study is limited to cases where suspected acute PE has been referred to the clinical radiology department for imaging using V/Q

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