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

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# Clinical Radiology

## 10 years of Imaging for Pulmonary Embolism - Too Many Scans, or the Tip of an Iceberg? --Manuscript Draft--

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<b>Abstract:</b>	<p><b>Aim:</b> This study examines the number and nature of investigations performed for suspected PE in a large teaching hospital and the change in incidence and severity of PE over a decade. With availability of CT pulmonary angiography (CTPA), the number of imaging investigations for suspected acute pulmonary embolism (PE) has been increasing steadily. It has been hypothesised that this leads to increased detection of small emboli and effective over-diagnosis.</p> <p><b>Materials and methods:</b> In this retrospective study, all patients investigated for suspected PE using 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.</p> <p><b>Results:</b> From 2002 to 2012, total annual investigations for suspected acute PE increased by 163% (805 to 2 121). CTPA increased by 325% (475 to 2 019). 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.</p> <p><b>Conclusions:</b> 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.</p>

# 10 years of Imaging for Pulmonary Embolism - Too Many Scans, or the Tip of an Iceberg?

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No competing interests.

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- Pulmonary Embolism
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## Author Contributions

Please list the following phrases and beside each indicate the name(s) of the author(s) to whom they apply:

1 guarantor of integrity of the entire study	NM
2 study concepts and design	JM, EvB, SM, NM
3 literature research	JM, EvB, SM, KM
4 clinical studies	NM, KM
5 experimental studies / data analysis	n/a
6 statistical analysis	NM
7 manuscript preparation	NM, KM
8 manuscript editing	NM, KM, SM, EvB, JM

Reviewer #1: A well written interesting study.

- a. I think it would be useful to give the figures for decreased use of Q scans over the ten years and the percentage now investigated by Q vs CTPA.

Numbers now included in text, line 107.

- b. Was there any difference in diagnosis rate between Q and CT?

Insert at line 115: In the final year 9% of 102 Q scans and 20% of 2 019 CTPAs were positive.

- c. You state the your catchment population increased by only 7% during the study but what happend to patient attendences during the period. They may have increased by more than 7%

There are many different types of hospital attendance and it is difficult to give a useful answer here. We understand that A&E attendances, for instance, are increasing month on month. We feel that the most important observation is the relationship of incidence to the population. All acute admissions for the catchment population were admitted to the hospitals studied and consequently we consider that the catchment population is the most appropriate denominator.

No change made.

- d. In terms of factors that might have driven increased referral for investigation was there any change in care pathway e.g was d-dimer used throughtout period and did institution roll out any care pathway changes which may have contributed to increased investigation?

Alteration beginning line 206:

In a hospital setting, there is easier access to PE diagnostic imaging, and the way in which patients with suspected primary PE are looked after and investigated is changing which could partially explain the increase in radiological referrals. For instance there are new 'ambulatory care' pathways whereby patients can be anticoagulated and return the following day for CTPA.

Reviewer #2:

- a. The paper has looked at a decade of investigations for acute PE (both CTPA and VQ) and compared the numbers of scans performed, the number of positive scans and the 'severity' of the PE with historical data primarily to test the hypothesis that the number of increase in positive scans is due to the increased detection of smaller PEs.
- b. They concluded that there has been an increased incidence of PE but this cannot be attributed to increased detection of smaller PEs with the overall 'severity' score remaining similar to historical data.
- c. The paper discusses well why there may be an increase in the number of PE diagnosis (ultimately presumably because we are doing more investigations) and argues that there the management of 'smaller PEs' remains unclear and perhaps anticoagulation for this group could be withheld - this would be a more powerful argument if there was any outcome data between the periods studied (?)- although it is mentioned in the introduction that a systematic review showed no includable studies in this regard, this may be worth reiterating in the discussion - was outcome worse when we weren't diagnosing all these PEs?

It is difficult to answer this, as we have started with people being scanned. We are not aware of accurate death rates due to TED for our population. This is specifically discussed by Wiener et al. for USA population data.

We highlight this topic cautiously in our introduction to illustrate some of the controversy and ongoing investigation in the field. **No change made.**

- d. I challenge some of the text regarding 'CTPA being better than V/Q at diagnosing subsegmental PE' (eg Intro 22-25 and discussion 158-162) - I believe the literature on this is not entirely as clear cut especially in the current climate with SPECT VQ which has shown good results and is perhaps better than CTPA at smaller PE. While not especially relevant to the study itself I think SPECT VQ should be discussed and referenced more to reflect emerging modern clinical practice.

We agree that SPECT VQ is an important development and we are grateful for your prompt to include this in the discussion.

**Change to line 224:** CTPA is currently the first line...

**Change to line 257:** SPECT V/Q scanning techniques are becoming established elsewhere and we believe that this will play an increasing part in investigation of suspected PE. (28, 29)

Lines 22-25 refer specifically to historic published work, central to the arguments in the Weiner paper. **No change made.**

- e. The Modified Miller Score needs explanation. I maybe wrong but I think this reflects scoring of segmental PE. What happens to the scoring in isolated sub-segmental PEs?

You're correct - the modified Miller score is not explicit regarding this. Referring back to the Miller Score, involvement of a vessel (or segment) was sufficient to incur 1 point.

**Added, line 55:** 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(19), unless superceded by a more proximal embolus.

## Abstract

**Aim:** This study examines the number and nature of investigations performed for suspected PE in a large teaching hospital and the change in incidence and severity of PE over a decade. With availability of CT pulmonary angiography (CTPA), the number of imaging investigations for suspected acute pulmonary embolism (PE) has been increasing steadily. It has been hypothesised that this leads to increased detection of small emboli and effective over-diagnosis.

**Materials and methods:** In this retrospective study, all patients investigated for suspected PE using 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 2 121). CTPA increased by 325% (475 to 2 019). 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.



# 1 10 years of Imaging for Pulmonary Embolism - 2 Too Many Scans, or the Tip of an Iceberg?

## 3 **Introduction**

4 Objective: To assess the impact of a putative increase in detection of  
5 small PEs, we have measured the rate and outcomes of investigation for  
6 suspected acute PE in our institution over the decade 2002-2012.

7 Venous thrombo-embolism (VTE), including Deep Vein Thrombosis  
8 (DVT) and Pulmonary Embolism (PE) is a frequent and important  
9 diagnosis.(1, 2) Despite routine prophylaxis, it also remains a leading  
10 cause of secondary mortality and morbidity in many common healthcare  
11 scenarios, for example maternity,(3) and lower limb arthroplasties.(4)

12 As VTE is prevalent, dangerous and treatable, it is not surprising to  
13 encounter controversy regarding its diagnosis and management.(5, 6) A  
14 recent article argues that modern CTPA makes increasingly sensitive  
15 detection of ‘small emboli’, and so alters the spectrum of diagnosis.(7)  
16 Figure 1 shows some example CTPA images. The authors hypothesised  
17 that additional inclusion of small emboli (previously undetectable)  
18 effectively causes overdiagnosis and overtreatment. They highlighted an  
19 experimental study reported in 2007,(8) in which patients with suspected  
20 PE were randomised to either V/Q scanning or CTPA. Appropriate  
21 patient selection, sufficient numbers and modern techniques made this a  
22 robust comparison. More PE were detected in the CTPA arm, but no  
23 significant differences in outcome were observed. In the CTPA group,  
24 7% of those with PE had isolated, subsegmental emboli, less likely to be  
25 detected with a V/Q scan.

26 In combination, the findings above support the hypothesis: ‘It is not  
27 beneficial to anticoagulate patients with small PEs’. This was the topic of  
28 a systematic review,(9, 10) which found no includable studies and a  
29 multicentre trial in North America is currently recruiting to test it.(11)  
30 However it is worth considering that treatment of PE is partly secondary  
31 prevention. A PE causing presentation might be the forerunner of a  
32 preventable secondary event. In addition to dissolution of the embolus  
33 causing the presentation, the treatment also targets the thrombotic source  
34 of emboli.

35 Pulmonary embolism is a difficult clinical diagnosis with varied and  
36 sometimes minimal symptoms and signs. As a result, patients being  
37 investigated for suspected PE may have various other serious illnesses.  
38 Patients with clinically suspected PE in whom the diagnosis is refuted  
39 show a higher mortality than those in whom the diagnosis is confirmed  
40 (17% vs 11% at 6 months).(12) In a more recent study, patients with  
41 negative CTPA had a 14% 3-month mortality.(13) It is also relevant to  
42 consider that sub-clinical PE is a common incidental finding on CT scans  
43 performed for other reasons,(14) and also at *post mortem*.(15) In  
44 summary, patients being referred with suspected acute PE are a  
45 heterogeneous population with many other potential diagnoses and there  
46 is a recognised prevalence of sub-clinical VTE.

## 47 **Methods**

48 This work builds on previous published data from this institution.(16, 17)  
49 An earlier paper reports a cohort of consecutive positive CTPAs (n=504)  
50 from 2001 to 2004, with standardised severity scoring. We have  
51 performed a retrospective analysis of all CTPA and Q-scan referrals in  
52 the year ending 31/03/12, with comparable severity scoring using the

53 modified Miller score.(18) For some analyses, the Miller scores have  
54 been categorised as Mild (1-5), Moderate (6-10), and Severe (11-16).  
55 With specific regard to subsegmental emboli, each bronchopulmonary  
56 segment containing an embolus (or emboli) would contribute one point to  
57 the score, analogous to ‘involvement’ in the Miller Score(19), unless  
58 superceded by a more proximal embolus. The project was approved by  
59 the local research ethics authority.

## 60 Retrospective Case Reviews

61 All CTPA and Q scan records in the year ending 31/03/12 were retrieved  
62 from the hospital information system, numbering 2 138. Referrals and  
63 reports were evaluated by two independent physicians. 17 cases were  
64 excluded because the indication was not suspected acute PE, for instance  
65 the investigation of pulmonary hypertension. CTPA reports detailing new  
66 PEs were identified. These cases were reviewed and PE severity  
67 quantified with a Modified Miller score, under supervision of a chest  
68 radiologist with 20 years of experience.

69 Similar hospital record searches were used to identify the rates of  
70 referral for Q-scans and CTPAs in the years between 2001 and 2012.

71 In seeking to quantify the incidence of PE, this study is limited to  
72 cases where suspected acute PE has been referred to Clinical Radiology  
73 for imaging with Q-scan or CTPA. There may be other clinical routes for  
74 diagnosis of PE that are not included in this analysis.

## 75 Imaging Protocols

76 Although our imaging practices have developed over the period of study,  
77 the extraction of standardised categorical data means that valid  
78 comparisons can be made. Current protocols are described:

## 79 *CT Pulmonary Angiography*

80 CTPA is performed using a 75ml injection of Intravenous contrast  
81 medium (Iomeron 400), given by pump injection at 4.5 ml/s (Dose  
82 reduced to 50mls when age >40 and mass <95kg). 64-slice helical CT  
83 acquisition from hyoid to costophrenic angles following an inspiratory  
84 breath-hold instruction, with arms abducted. The scan is triggered on  
85 detection of the leading contrast in the right atrium.

## 86 *Pulmonary Scintigraphy*

87 Planar images of the thorax are obtained in 8 projections, beginning  
88 immediately after intravenous injection of 80 MBq of Tc99 labelled  
89 macro-aggregated albumin. Total scan time is approximately 15 minutes  
90 using a 2-head gamma camera, and low-energy high-resolution parallel  
91 collimators.

## 92 **Analyses**

93 Statistical and graphical analyses were performed by NM using Microsoft  
94 Excel and GraphPad Prism. Each patient's age in complete years was  
95 calculated using the date of birth and date of scan. Age distributions were  
96 assessed with 10-year histogram bins, centred on each multiple of 10 (i.e.  
97 5-14, 15-24 etc.). In addition to graphical analysis, distribution of PE  
98 severity scores was assessed for change using Chi-squared analysis of  
99 normalised data, the table having 16 rows and 2 columns, therefore 15  
100 degrees of freedom.

## 101 **Results**

### 102 **Increased rate of investigation and shift to CTPA**

103 From 2002 to 2012 there was a 163% increase in the annual rate of  
104 investigation for suspected acute PE (from 805 to 2 121). In this same  
105 period the number of CTPAs performed per year has increased by 325%

106 (from 475 to 2 019). This is a change from 45% of total investigations to  
107 96% as% . Over the same period, Q-scans have fallen from 566 to 102 per  
108 year, from 55% to 4% of investigations. These changes are illustrated in  
109 Figure 2. Further analysis of the referrals in the first and last of these  
110 years in Figure 3 reveals that Q-scanning is now most commonly  
111 performed in younger patients, peaking at approximately 30 years of age.

## 112 Increased Detection of PE

113 Detection of PE increased by 121% (from 193 to 426 per annum). The  
114 number of investigations has increased even more, resulting in a slight  
115 decrease in PE-positive scan rate from 24% to 20%. In the final year 9%  
116 of 102 Q scans and 20% of 2 019 CTPAs were positive. The population  
117 served by our hospital has increased by 7% over this period,(20) so a  
118 greater rate of diagnosis in our practice represents increased incidence of  
119 acute PE diagnosed radiologically.

## 120 Distribution of PE Severity Scores

121 PE severity scores show a stable distribution over the recent decade  
122 (Figure 4), with the proportion of severe PEs (modified Miller score 11 or  
123 greater) stable at 36% (p=0.85). There is no significant difference  
124 between samples on Chi-squared analysis of the categorical data. (Chi-  
125 square=9.58, p=0.85). Although variation is not significantly different  
126 when considering the distribution of all scores, the proportion of cases  
127 with a modified Miller score of 1 has increased from 11% to 16%.

128 The comparison above uses the cohort previously described by Wong  
129 et al.,(17) with data from more than one year in the older set. Subset  
130 analysis of the year ending March 31st 2002, is not shown, but a similar  
131 pattern is present (Chi-square=17.5, p=0.29). That sample is smaller,  
132 n=134, in part because during that year many patients had PE diagnosed

133 by scintigraphy and so modified Miller scoring of severity is not  
134 applicable.

### 135 **Age of Population Being Investigated**

136 The mean age of patients being investigated for PE (both Q-scan and  
137 CTPA) has increased from 56 years in 2001/02 to 63 years in 2011/12  
138 (95% CI +6.1 to +8.9 years). The proportion of patients being  
139 investigated who are over 80 years of age has increased from 12% to  
140 21%. Increasing age is represented in the Figure 3 histograms, where the  
141 mode changes from 65 to 80.

142 The population of patients being investigated with CTPA is also older, as  
143 seen in Figure 5. The mode has changed from 70 to 80, and the mean  
144 from 61 to 65 (95% CI +1.6 to +5.2).

### 145 146 **Incidence of PE in all age groups**

147 To further investigate the increased incidence of PE, and the relationship  
148 to the changing age of the population, relative frequency plots are given  
149 for comparison in Figure 6. The positive results in each severity bracket  
150 are distributed across the age range, and reflect the age distribution of all  
151 CTPAs. There does not appear to be any anomalous increase in positive  
152 cases or severe cases associated with the increase in older patients.

## 153 **Discussion**

154 The incidence of PE diagnosed radiologically has more-than-doubled in a  
155 decade. This is a surprising finding, and might reasonably lead to the  
156 hypothesis that the 'Increased number of emboli is due to detection of  
157 smaller emboli', as advanced by Wiener, Schwartz and Woloshin.(7)  
158 However that hypothesis is refuted by our analysis of PE severity. The

159 proportion of patients diagnosed with massive PE, within the group of  
160 patients with CTPA confirmed emboli, remains the same. This refutes the  
161 hypothesis that modern CTPA has caused a particular increase in  
162 diagnosis of small PE. The incidence of small PE has increased, but in  
163 proportion to the overall incidence.

164 We do not contest that replacing isotope scintigraphy with CTPA in  
165 imaging for suspected PE has resulted in a greater number of smaller  
166 emboli being diagnosed, as demonstrated by Anderson et al. 2007.(8) Our  
167 data primarily relates to a continuing rise in the diagnosis of PE within  
168 patients investigated with CTPA.

169 The size of PE that a scanner is able to identify is limited by the  
170 spatial resolution of CT, and this has remained fairly static at around  
171 1mm over the decade under investigation. Greater number of detectors  
172 and decreased acquisition times do improve co-ordination with the  
173 contrast bolus and breath hold to reduce artefacts from contrast dilution  
174 and respiratory motion respectively, but when the technique was  
175 satisfactory these were not restricting factors. The small increase in the  
176 proportion of PE with a severity score of 1 (from 11% to 16%, see Figure  
177 4) may represent an effect of increased sensitivity to detection of smaller  
178 emboli but it does not account for the increased rate of detecting PE.

179 A number of factors may underlie the increase in incidence during the  
180 study period. Although the population being investigated contains a  
181 greater proportion of older people, the age distribution of PE has changed  
182 in a similar fashion, without any major discrepancy in the age distribution  
183 of PE. Younger patients still have a similar proportion of positive studies,  
184 with no gross change in severity categorisation (Figure 6). The increased

185 number of studies being performed means that the rate of diagnosis in  
186 each category has increased proportionally.

187 We know from other reports that incidental PE are identified on CT  
188 scans investigating other diseases in both inpatients,(14) outpatients,(21)  
189 and on post mortem examinations.(15) Thus sub-clinical PE is a real  
190 entity and there may be an iceberg phenomenon, where we see only the  
191 tip and a significant proportion of disease remains undiagnosed. Increased  
192 suspicion of relevant symptoms by patients and clinicians could lead to  
193 an increased referral rate for imaging and thereby increased diagnosis,  
194 transferring subclinical PE to clinical PE. Because we are observing this  
195 increase in investigations that have been targeted to symptomatic PE, this  
196 would require a historical context when symptoms were previously not  
197 investigated, or were given an alternative (incorrect) diagnosis.

198 It is possible that public awareness has increased causing more  
199 patients to present to medical care with their symptoms. We are  
200 anecdotally aware of recent media exposure of VTE and the emotive,  
201 politically polarised name ‘economy class syndrome’ has helped to raise  
202 its profile, although it is not necessarily accurate.(22) Another change  
203 may be that patients more often present directly to an emergency  
204 department rather than to primary care. In a hospital setting, there is  
205 easier access to PE diagnostic imaging, and the way in which patients  
206 with suspected primary PE are looked after and investigated is changing  
207 which could partially explain the increase in radiological referrals. For  
208 instance there are new ‘ambulatory care’ pathways whereby patients can  
209 be anticoagulated and return the following day for CTPA.

210 We are also aware of recent activity to develop new injected and oral  
211 anticoagulants(23, 24) which contributes to a high awareness of thrombo-



212 embolic disease among medical professionals. Prescription of prophylaxis  
213 means that thrombo-embolic disease is routinely considered when  
214 admitting inpatients.

215 The increasing rate of pulmonary emboli may reflect a decrease in  
216 the health of our population. Prevalence of chronic illness is  
217 increasing,(25) and the ensuing ‘multimorbidity’ is now seen as a  
218 significant challenge to healthcare providers.(26, 27) Successful  
219 management of previously fatal diseases (including thrombo-embolic  
220 disease) may be increasing the prevalence of chronic illness, and  
221 increasing the risk of secondary VTE. This may be a paradoxical effect of  
222 improved healthcare.

223 CTPA ~~has become~~is currently the first line test of choice for the  
224 investigation of suspected acute PE. For patients with suspected PE, a  
225 normal chest radiograph, and no history of asthma or chronic obstructive  
226 pulmonary disease, pulmonary perfusion scintigraphy remains the  
227 preferred investigation in our institution. When the radiograph is  
228 abnormal, or there is a history of chronic lung-disease, patients are  
229 referred for CTPA. It is suggested that increasing patient age and co-  
230 morbidity mean that a larger proportion of patients are excluded from Q-  
231 scans on the basis of chronic respiratory illness or chest radiograph  
232 abnormalities.

233 Investigating suspected PE in pregnancy and the puerperium is a  
234 special clinical scenario. Q-scan is the preferred method due to a lesser  
235 dose of ionising radiation to maternal breasts.(28) This may, at least in  
236 part, explain why the Q-scan age distribution in Figure 3 has a mode of  
237 30 years.

238 In most cases of suspected PE presenting outside daytime hours,  
239 patients are treated with subcutaneous low-molecular weight heparin, and  
240 imaging is deferred until the following morning. In cases where  
241 anticoagulation is contraindicated (*e.g.* some recent operations or a recent  
242 bleeding illness), or when important diagnostic doubt exists, imaging may  
243 be required immediately, which favours CTPA.

244 The widespread use of CT in many other clinical scenarios means that  
245 CT services are well established and available. Intravenous contrast  
246 medium can be used ‘off the shelf’ and has a long shelf life, whereas  
247 Tc<sup>99m</sup> labelled Macro-aggregated albumin requires on-site expertise for the  
248 harvesting and combination of radioisotope, whose mode of action  
249 requires instability. With few other indications for emergency  
250 radionuclide imaging, this is not available over the weekend in our  
251 institution. Meantime CTPA, being available, has become well accepted  
252 in emergencies, and imaging suspected PE over the weekend is  
253 commonplace. It may follow that Q-scanning has become less familiar as  
254 a result of the success of CTPA, to the extent that it is not considered by  
255 referring clinicians, or even by some radiologists when prioritising CT  
256 referrals. SPECT V/Q scanning techniques are becoming established  
257 elsewhere and we believe that this will play an increasing part in  
258 investigation of suspected PE. (29, 30)

## 259 **Conclusions**

260 In our practice, the rate of investigations for acute PE has increased by a  
261 factor of 2.6 in the recent decade, with a large increase in CTPA and a  
262 reduction in Q-scans.

263 The incidence of PE has increased by a factor of 2.2. The cause of the  
264 increased incidence of PE is not clear. Contrary to expectation, the later

265 cohort of diagnosed PE shows a similar distribution of severity to the  
266 historic comparison. Frequent diagnosis of smaller emboli does not  
267 explain the increase in total numbers of PE being diagnosed.

268 The most likely explanation for our findings is that prevalence of PE  
269 is greater than we were previously aware of (either clinically or  
270 radiologically). We hypothesise an iceberg phenomenon of undiagnosed  
271 disease. In this context, increased investigation will lead to increased  
272 detection. This would imply that our understanding of PE could still be  
273 improved. Another hypothesis is that our population is becoming less  
274 healthy, perhaps as a paradoxical consequence of greater investment in  
275 healthcare.

276 PE is a spectrum of disease and the least severe PE (embolus in a  
277 single segmental artery or smaller) do represent a significant proportion  
278 of cases (16%). The optimal management of these patients remains  
279 unclear and it may be that these patients could be better treated without  
280 anticoagulants.

281

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374

## 375 **Figure Legends**

376 **FIGURE 1.** Axial Images from Positive CT Pulmonary Angiograms

377 Patients are scanned shortly after injection of intravenous contrast, timed for  
378 greatest opacification in pulmonary arteries. **A:** Multiple small emboli are  
379 present. Three centri-luminal filling defects are shown in cross-section in lower-  
380 lobe segmental arteries. **B:** Another patient with a ‘saddle embolus’ astride the  
381 pulmonary trunk bifurcation and filling defects in the proximal pulmonary  
382 arteries. Secondary *cor pulmonale* causes retrograde opacification in the  
383 azygous vein and delayed opacification of the aorta.

384 **FIGURE 2.** Frequency of Investigations for Acute PE (stacked columns)

385 **FIGURE 3.** Referrals for CTPA and Q Scan by Patient Age (stacked bars)

386 **FIGURE 4.** Distributions of PE Severity Score

387 Normalised frequency distributions of PE severity score on positive CTPAs in a  
388 previous cohort (n=504) and in 2011/12 (n=400).

389 **FIGURE 5.** *Histograms of CTPA Results by Patient Age*

390 **FIGURE 6.** Normalised Frequency distributions of CTPA Referrals and Results

391 Age distribution of all CTPAs is shown as a line. Age distribution of positive  
392 cases is shown as bars which are subdivided by severity.

Figure 1  
[Click here to download Figure: Figure 1.tif](#)

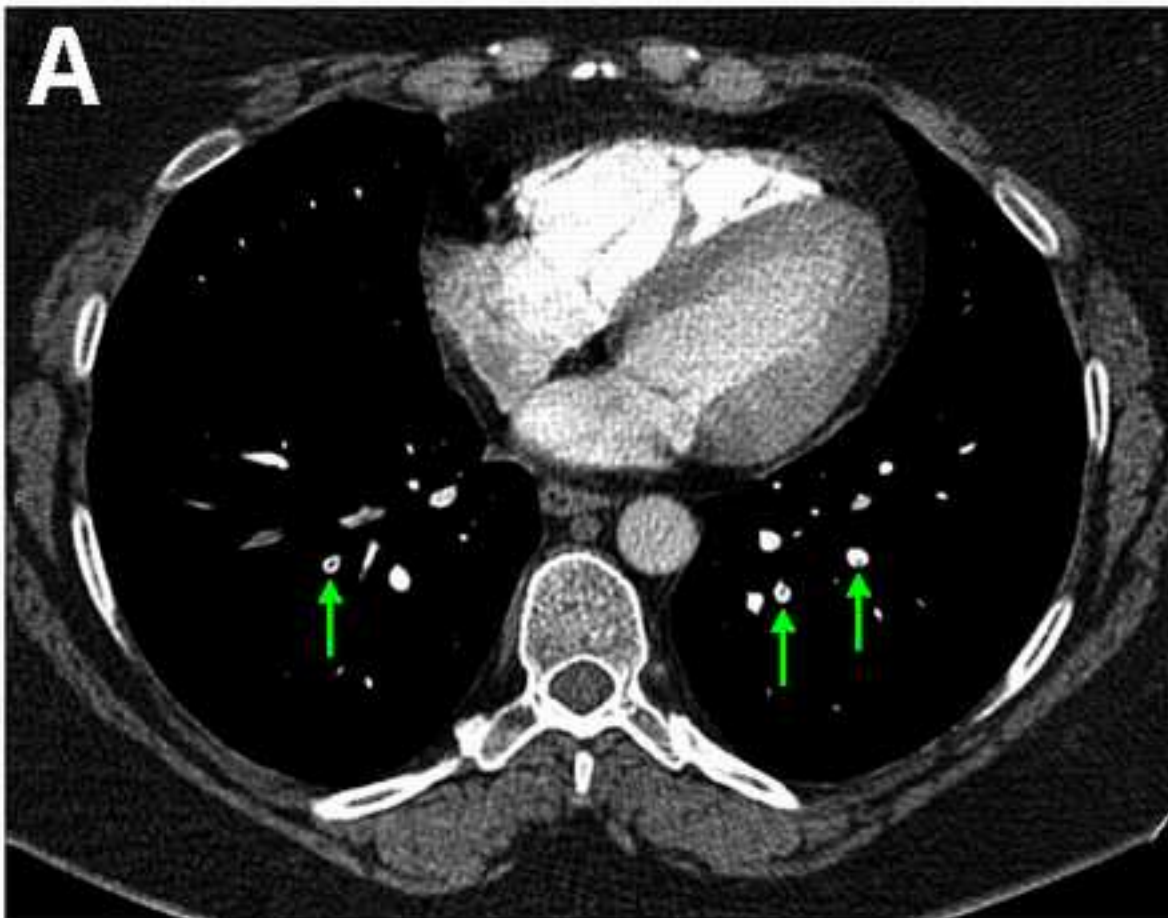




Figure 2

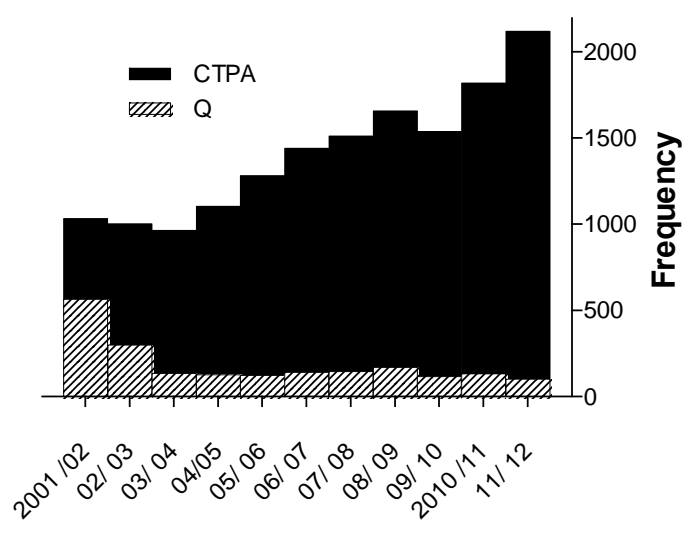


Figure 3

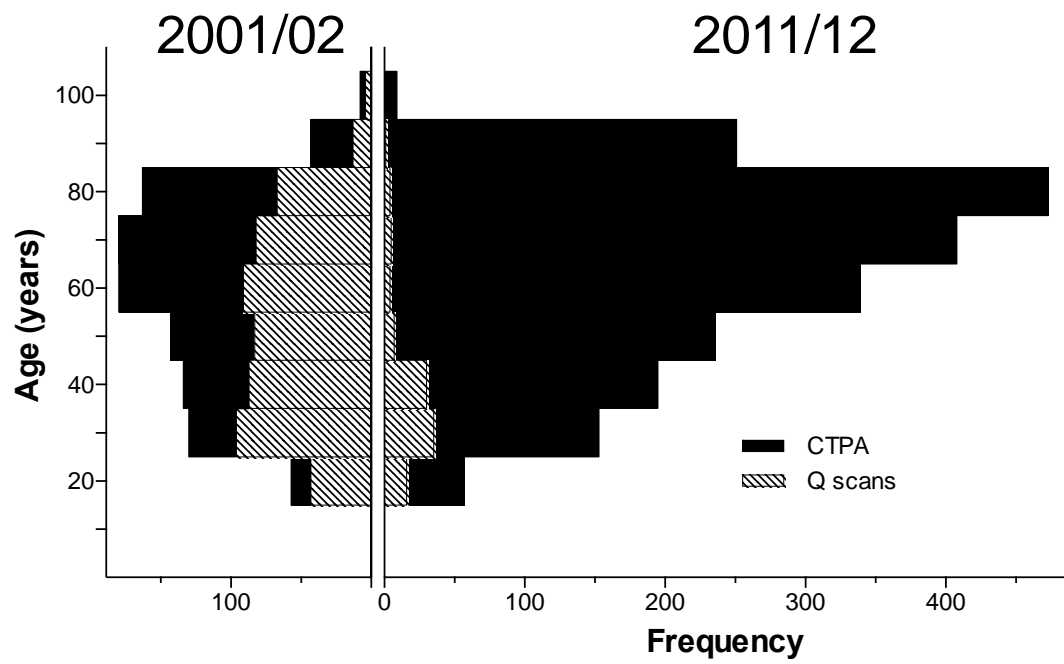
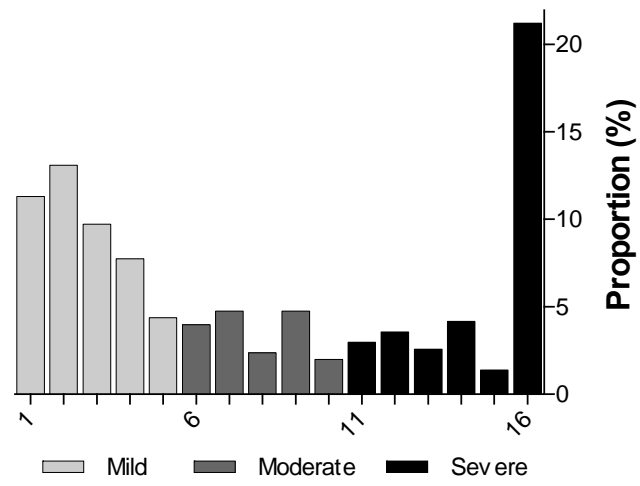


Figure 4

Wong et.al  
2001- 04



2011/12

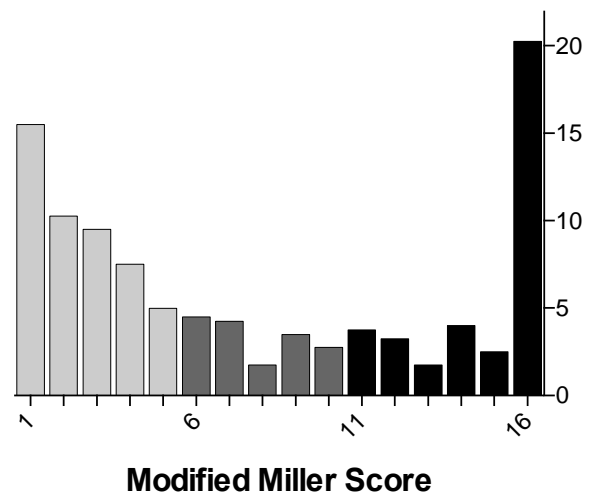
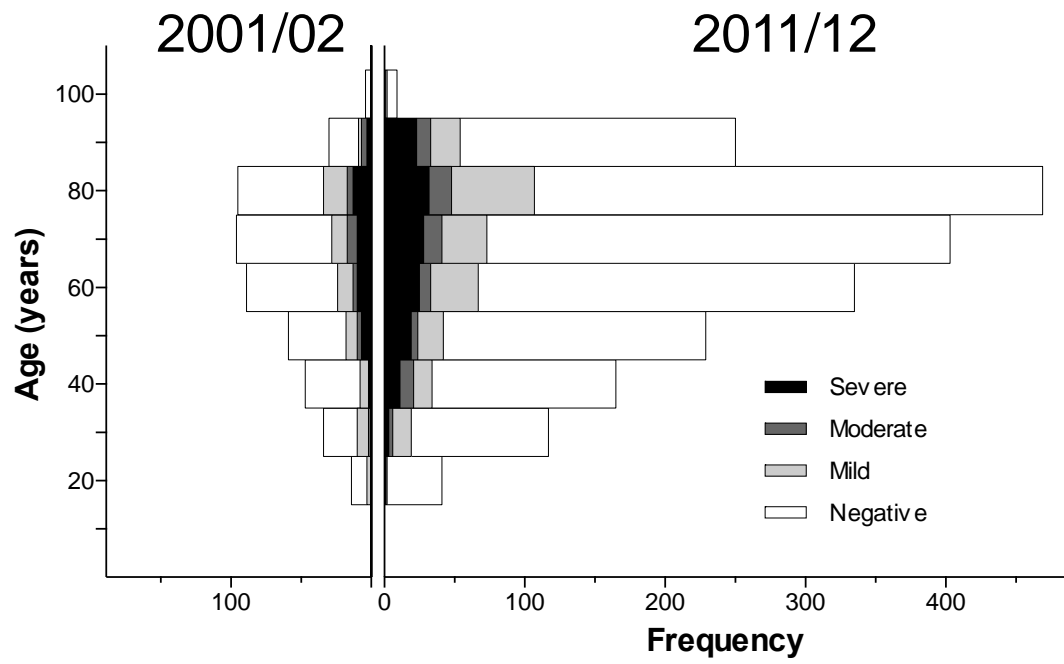


Figure 5





## Highlights

We have examined PE incidence, severity and rate-of-investigations over a decade.

The rate of investigation has more-than doubled and PE incidence is increasing.

This occurs in all age groups and without change in distribution of severity scores.

This suggests an iceberg phenomenon due to subclinical disease.