

# Out of Hours Multidetector Computed Tomography Pulmonary Angiography:

## *Are Specialist Resident Reports Reliable?*

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**Rationale and Objectives:** The purposes of this study were to assess the accuracy of trainee radiologists' reports for computed tomographic pulmonary angiographic (CTPA) imaging and to determine agreement or discrepancy with final verified consultant reports.

**Materials and Methods:** A total of 100 consecutive out-of-hours CTPA examinations were prospectively analyzed. Fifty-one male and 49 female subjects were included in the study. The mean age of patients scanned was 63.7 years (range, 17–98 years).

**Results:** Eighteen of the 100 subjects (18%) had findings positive for pulmonary embolism. The interobserver agreement for pulmonary embolism between on-call radiology residents and consultant radiologists was almost perfect ( $\kappa = 0.932$ ; 95% confidence interval, 0.84–1.0;  $P < .0001$ ). There was one false-negative CTPA report. Eighty-two CTPA scans (82%) were reported as negative for pulmonary embolism by consultant radiologists. In this group, there was a single false-positive interpretation by the on-call specialist resident. The interobserver agreement for all findings between resident and consultant reports was almost perfect (weighted  $\kappa = 0.87$ ; 95% confidence interval, 0.79–0.96;  $P < .0001$ ). The overall discrepancy rate, including both false-positive and false-negative findings, between the on-call radiology resident and consultant radiologist was 8% (eight of 100).

**Conclusions:** CTPA reports by radiology residents can be relied and acted upon without any major discrepancies. There is a relatively much higher proportion of patients with alternative diagnoses, mainly infective consolidation and heart failure presenting with similar symptoms and signs as pulmonary emboli. It is imperative for trainees to be systematic and review all images if observational omissions are to be reduced.

**Key Words:** CTPA; resident; reports.

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Multidetector computed tomographic (CT) pulmonary angiographic (CTPA) imaging is now the most common imaging modality in the evaluation of suspected pulmonary embolism (PE). A large number of CTPA studies are performed out of hours, and in teaching hospitals, the initial provisional reports are issued by trainee radiologists and are not checked until the following morning by consultant radiologists. These trainee radiologists are referred to as specialist residents, and they undergo structured specialist training in their chosen fields of medicine. This is at least over a 5-year period in radiology, at the end of which residents are considered trained, ready to be consultants (1).

Specialist residents do on-site training out of normal working hours on a rotational basis, which is referred to as on-call rotation. These provisional reports are crucial, as they provide the basis for out-of-hours clinical decisions. The purposes of this study were to assess the accuracy of trainee radiologists' reports for CTPA scans and to determine agreement or discrepancy with the final verified consultant reports. To the best of our knowledge, this is the first study of its kind performed in a UK teaching hospital.

## MATERIALS AND METHODS

We prospectively analyzed 100 consecutive out-of-hours CTPA examinations. These were performed during a 28-day period from August to September 2008. Sixty-four scans were performed on a 16-slice multidetector CT system (Somatom Sensation; Siemens AG, Munich, Germany) (tube voltage, 120 kV; effective tube current–time product, 140 mAs; rotation time, 0.5; collimation, 0.75; reconstruction slice thickness, 1 mm; reconstruction interval, 0.5 mm). Thirty-

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six scans were performed on a 64-slice multidetector CT system (Aquilion; Toshiba Corporation, Tokyo, Japan) (tube voltage, 120 kV; effective tube current–time product, 182 mAs; rotation time, 0.5; pitch, 0.828; reconstruction slice thickness, 1 mm; reconstruction interval, 0.5 mm).

Images were acquired after the injection of 100 mL of iohexol 350 (350 mg iodine/mL; GE Healthcare, Oslo, Norway) using a bolus trigger set at 100 Hounsfield units on the pulmonary trunk. Images were reviewed on a picture archiving and communication system workstation (Agfa Impax 5.1; Agfa, Morstel, Belgium). Analysis of CT images was performed on axial, coronal, and sagittal reformatted images (1-mm multiplanar reconstructions). Both soft tissue and lung windows were used to identify subsegmental bronchi and arteries.

Acute PE was diagnosed when there was a filling defect within the vessel or when vessel truncation implied the presence of an occlusion. The level of PE was categorized as central, lobar, segmental, or subsegmental.

The initial provisional reports issued by the on-call specialist resident were prospectively collected and findings documented. All trainees on the on-call rotation had completed  $\geq 2$  years of specialist radiology training and had been signed off to at least level 3 to report CTPA imaging according to the Royal College of Radiology trainee portfolio (1).

The provisional reports were verified by consultant radiologists within 24 hours of the examinations, and the consultant reports were used as the reference standard. Both the trainee resident and consultant groups were unaware of the study in progress at the time of their reports, to avoid bias.

Two cardiothoracic radiologists (J.E. and A.B.), who were blinded to both the initial resident and final verified consultant reports, reviewed the cases with discrepancies and issued a final report by consensus.

Statistical analysis was performed using SPSS for Windows version 16.0.1.2008 (SPSS, Inc, Chicago, IL) and a statistical computation Web site (<http://faculty.vassar.edu/lowry/kappa.html>). Indices of agreement were calculated as described previously (1). Unweighted and weighted  $\kappa$  statistics were used for an interobserver reliability analysis. Kappa statistics were interpreted as indicating poor ( $\kappa < 0.2$ ), fair ( $0.21 < \kappa < 0.4$ ), moderate ( $0.41 < \kappa < 0.6$ ), substantial ( $0.61 < \kappa < 0.8$ ), or almost perfect ( $0.81 < \kappa < 1.0$ ) observer agreement (2,3). *P* values  $< .05$  were considered to indicate statistical significance.

**RESULTS**

One hundred consecutive out-of-hours CTPA examinations performed at a university teaching hospital over a 16-day period were prospectively included in this study. These were reported by 16 different specialist residents, and the final reports were verified by six consultants, three of whom were subspecialist consultants in cardiothoracic radiology. Fifty-one male and 49 female subjects underwent CTPA examinations. The mean age of patients scanned was 63.7 years (range, 17–98).

Eighteen of the 100 subjects (18%) had findings positive for PE. The interobserver agreement for PE between on-call

**TABLE 1. Correlation between Consultant and Specialist Resident Reports**

Radiology Resident Report	Consultant Report		Total
	Positive	Negative	
Positive	17	1	18
Negative	1	81	82
Total	18	82	100

Overall proportion of agreement = 0.98; proportion of positive agreement = 0.94; proportion of negative agreement = 0.99.

**TABLE 2. Summary of Additional Chest Findings in Patients with Pulmonary Embolism (n = 18)**

Finding	n
None	12
<b>Lung findings</b>	
Infarcts	1
Consolidation	2
<b>Cardiac</b>	
Right heart strain	1
Right heart strain and bronchiectasis	1
Right heart strain, atelectasis, and pleural effusion	1

radiology residents and consultant radiologists was almost perfect ( $\kappa = 0.932$ ; 95% confidence interval, 0.84–1.0; *P*  $< .0001$ ). There was one false-negative CTPA report in the specialist resident group. This was for a PE in a single segmental pulmonary artery branch. Six of the 18 subjects with PE had other concurrent chest findings. These were all correctly reported by the resident. A summary of positive and negative interpretation of CTPA scans for PE by on-call radiology residents and consultant radiologists is presented in Table 1. Table 2 is a summary of any additional chest findings in the 18 subjects with PE.

Eighty-two CTPA scans (82%) were reported as negative for PE by consultant radiologists. In this group, there was a single false-positive interpretation by the on-call specialist resident. The consultant opinion in the false-positive case was that the finding was the result of an artifact and caused by suboptimal pulmonary opacification in a technically inadequate examination. The expert panel agreed with this assessment.

Forty-four of the 82 subjects with no PE had significant other chest findings on CTPA imaging sufficient to explain the clinical symptoms. Six of the 44 were unreported by the resident. The six cases included two subjects with CT evidence of heart failure, a subject with CT features of hypertrophic obstructive cardiomyopathy (HOCM; Fig 1), a missed small pneumothorax, a subject with bronchiectasis, and another with subtle early interstitial lung disease. One subject had an incidental interatrial septal aneurysm that was not felt to have been the cause of symptoms (Fig 2). The remaining 37 of the 82 subjects with no PE had no other additional chest findings and had completely normal CTPA results. Table 3 is a summary of the

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