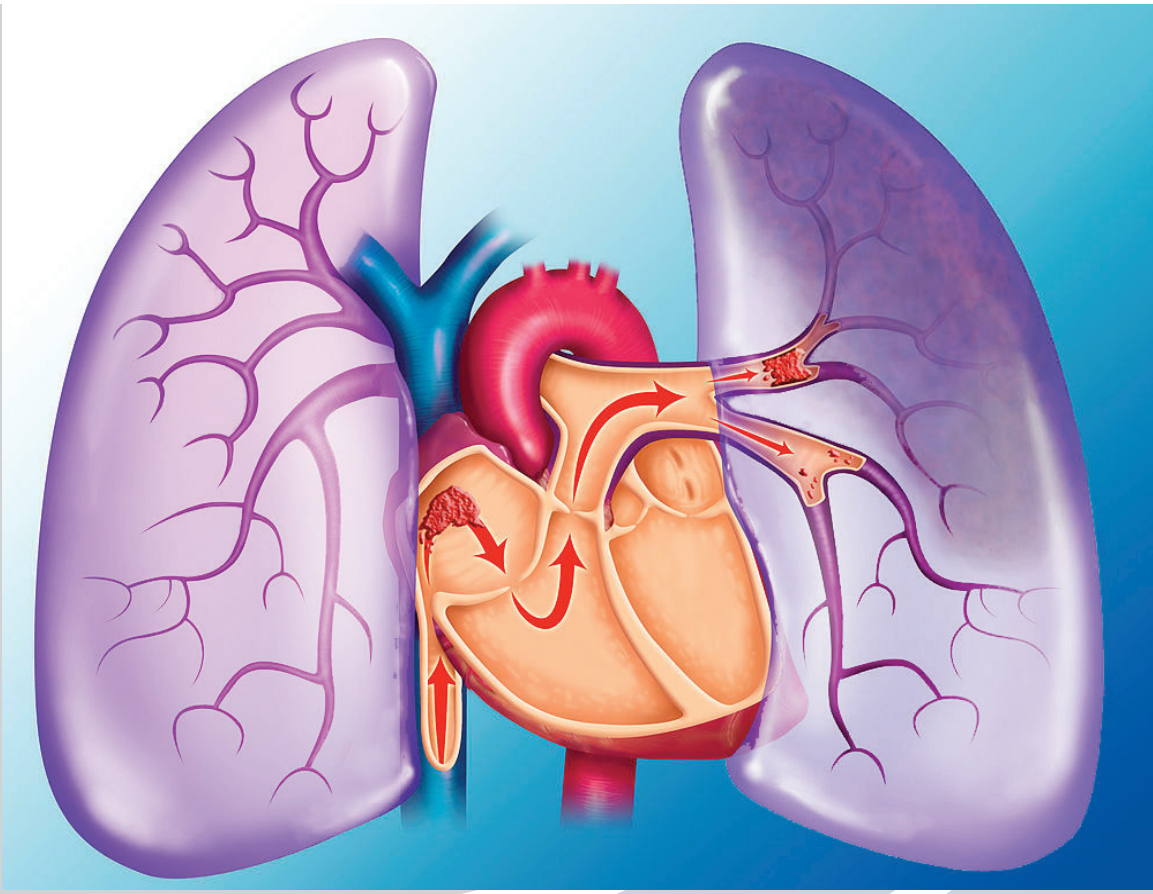
Know the Score

A review of the quality of care provided to patients aged over 16 years with a new diagnosis of pulmonary embolism



NCEPOD

Improving the quality of healthcare

Know the Score

A review of the quality of care provided to patients aged over 16 years with a new diagnosis of pulmonary embolism.

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Foreword

It is only fair that the introduction to a study of acute pulmonary embolism (PE) starts by acknowledging the contributions of Rudolf Virchow who in 1856 after decades of work, provided the evidence that blood clots in the pulmonary artery originated from veins in the lower limbs.[1] He also introduced the term "embolism" to this phenomenon and noted the wide variation in the clinical history, signs and outcome of acute PE.

Since then the discovery of the anticoagulant properties of heparin in 1916, followed by oral anticoagulants like bishydroxycoumarin in the 1940s has led to a reduction in mortality from PE. The prevention of in-hospital thromboembolic disease has received an enormous amount of attention over the past 30 years, and in consequence of several target and financially incentivised initiatives, compliance with risk assessment and prophylaxis is high. However the management of suspected and newly diagnosed PE has received far less attention.

This report reminded me of my first traumatic experience of PE when working as a junior surgeon. Whilst performing a routine operating list, which it had been anticipated would finish quickly, an emergency call was put out for a patient who required an immediate pulmonary embolectomy. My theatre was designated to take the patient. In fact I struggled to complete my operation which turned out to be more difficult than anticipated, so the cardiothoracic surgeon was forced to undertake the pulmonary embolectomy in the anaesthetic room. This episode made me henceforth acutely mindful of the serious consequences of thromboembolic disease. Thankfully today, most PE is managed by thrombolysis, albeit there is still a place for surgical intervention in a small number of cases. This report explores current practice through a snapshot of patients who were ultimately diagnosed with PE. As with many NCEPOD reports, caution must be taken when interpreting the data, as sampling has been deliberately skewed to maximise the learning points. In particular there is a disproportionately high number of patients who went to critical care or who died included in the sample than in the population as a whole.

Pulmonary embolism can be catastrophic and lead to sudden death. As some of the case studies illustrate PE can also affect young and otherwise heathy patients. The report stresses the importance of undertaking and documenting a PE probability score for all patients with a suspected PE, and ensuring that a standardised protocol is followed, to ensure the consistent delivery of an appropriate package of care in an appropriate setting.

The report identifies that avoidable delays are occurring in relation to access to investigations and senior clinical review. Given the high mortality risk it is imperative that delays are kept to a minimum, and therapy is initiated as soon as possible.

This report is relevant to all healthcare practitioners in hospital and primary care to ensure prompt diagnosis, effective treatment and clear ongoing management plans. I therefore hope that practitioners and managers will read the report and assess their own services against the accompanying NCEPOD audit tool, and where necessary take steps to remediate practice. Furthermore I hope that patients and their families will use the report to understand the service they should expect to receive and feel able to ask questions about the treatment and ongoing care they receive, whilst underpinning the importance of the treatment provided when not in hospital.

As ever I must thank the hard work and dedication of the study advisory group and case reviewers, who have given so generously of their time. I would also like to place on record the hard work done by the NCEPOD staff and coordinators, who have once again delivered a high quality report which has the potential to improve care and save lives; for at the end of the day that is what makes the work of NCEPOD so valuable and rewarding.

Ian C Martin, Chair

Introduction

Despite advances in the ability to prevent, diagnose and treat acute pulmonary embolism (PE) it remains an important cause of morbidity and mortality. Its association with air travel, hospitalisation, active cancer, pregnancy and some chronic conditions is well recognised and involves all age groups, including the young. Estimates suggest that there are more than 25,000 hospital deaths in the UK each year from venous thromboembolism (VTE),[2] and previous studies have shown that for every diagnosed case of a non-fatal PE there are 2.5 cases of fatal PE that were not diagnosed.[3]

Key steps to effective care for patients includes prevention, prompt diagnosis and treatment:

- Prevention of healthcare-related deep vein thrombosis (DVT) includes the use of anticoagulants or mechanical methods. The Commissioning for Quality and Innovation (CQUIN) for VTE introduced in England in 2010 requiring all hospitalised patients to have a VTE risk assessment at admission, has resulted in significant improvement in the assessment and prevention of VTE.[4]
- CT Pulmonary Angiography (CTPA) is commonly used to diagnose PE.[5] However, to be effective this service should be available, promptly in all hospitals, especially out-of-hours. Also, because of the risk posed by x-rays and iodinated contrast media, alternative strategies are required in high-risk patients such as pregnant patients suspected to have an acute PE.
- The standard treatment is anticoagulation. The combined recommendations from NICE guideline 144 and Quality Standard 29 recommends that heparin therapy should be started immediately if the time taken to confirm the diagnosis is likely to be more than one hour.[5,8] This can expose patients to unnecessary treatment and the associated risks of anticoagulation. Furthermore, inadequate monitoring of some anticoagulant medications can lead to under-treatment of PE or adverse effects, like excessive bleeding. Unrecognised drug interactions, particularly with antibiotics, can also contribute to harm.

To aid safe and effective treatment it is possible to estimate the risk of adverse outcomes of PE, following diagnosis, using prediction tools like the Pulmonary Embolism Severity Index (PESI) (See Appendix 1). CTPA can also provide objective evidence of right heart strain, an indicator of PE severity, but the consistency with which this is acted upon is unknown.

Following the success of DVT management in outpatient settings, selected patients with an acute PE are now being considered for ambulatory care. However, the risk assessment and governance of outpatient management for PE has not yet been standardised. In fact there were no UK national standards for the outpatient management of PE until the British Thoracic Society (BTS) published their guideline for the initial outpatient management of PE in 2018.[6] More recently the Cochrane Library published a systematic review on the outpatient versus inpatient treatment for acute PE. It concluded that only low-quality evidence is available from two published randomised controlled trials on outpatient versus inpatient treatment in low-risk patients with acute PE. The studies did not provide evidence of any clear difference between the two pathways in overall mortality, bleeding or recurrence of PE.[7]

There is a large body of existing UK guidance on the care for patients with venous thromboembolism which has been used as reference material in this study:

- NICE Clinical Guideline 144 (Venous Thromboembolic Diseases: diagnosis, management and thrombophilia testing) (2012 updated in 2015)[5]
- NICE Quality Standard QS29 for the diagnosis and management of venous thromboembolism (2013)[8]
- British Thoracic Society (BTS) guideline for the initial outpatient management of pulmonary embolism - Quality Standards for the outpatient management of pulmonary embolism (PE) are being drafted[6]
- The Scottish Intercollegiate Guideline Network (SIGN) Guideline 122 (Prevention and Management of Venous Thromboembolism) (2010 updated in 2014).[9]

In addition, a range of international guidelines and scientific statements are also available including:

- European Society of Cardiology Guidelines on the Diagnosis and Management of Acute Pulmonary Embolism (2014)[10]
- American Heart Association Scientific Statement on the Management of Massive and Sub-massive Pulmonary Embolism, Iliofemoral Deep Vein Thrombosis and Chronic Thromboembolic Pulmonary Hypertension (2011)[11]
- The Best Practice Advice from the Clinical Guidelines Committee of the American College of Physicians (2015): Evaluation of Patients with Suspected Acute Pulmonary Embolism[12]
- The American College of Chest Physicians Guideline and Expert Panel Report (2016) which included guidance on the management of isolated sub-segmental PEs[13]

At the opposite end of the severity spectrum from those patients cared for as outpatients or on an ambulatory care pathway are patients with a massive PE, identified by the presence of haemodynamic compromise. These patients are at a high risk of death and should be considered for thrombolysis. A more controversial area is the optimal care for patients with a sub-massive PE. These patients are haemodynamically normal, but have evidence of right heart strain on CTPA or echocardiography and raised biomarkers like troponin or brain-type natriuretic peptide (BNP).

The study described in this report aimed to identify and explore remediable factors in the process of care for patients with a new diagnosis of PE, who either presented to hospital with symptoms of PE and who were cared for as outpatients or were admitted to hospital, or who developed PE whilst in hospital being treated for another condition.

Executive summary

Aim

The aim of this study was to highlight areas where care could be improved in patients with a new diagnosis of acute pulmonary embolism (PE).

Method

A retrospective case note and questionnaire review was undertaken in 526 patients aged 16 and over who had a PE either presenting to hospital or who developed a PE whilst as an inpatient for another condition.

Key messages

One delay or more in the process of care was identified in 161/420 (38.3%) patients, with recognition, investigations and treatment being the most common.

The primary treatment for PE is anticoagulation. It is imperative that this is started as soon as possible. Where there might be a delay to the diagnosis of acute PE anticoagulation should be commenced. In this study the case reviewers reported an avoidable delay in commencing treatment in 90/481 (18.7%) patients.

Once PE has been diagnosed an assessment of PE severity needs to be undertaken in order to treat patients effectively. In 144/179 (80.4%) hospitals their PE policy/guideline included the assessment of PE severity.

This severity assessment was based on a validated scoring system such as PESI or Hestia in 128/142 (90.1%) hospitals. Case reviewers found no evidence of a PE severity assessment in the majority of patients (436/483; 90.3%).

Severe (massive) PE requires additional or alternative treatment. A guideline/protocol for the diagnosis and care of patients with PE was provided at 151/180 (83.9%) hospitals.

Ambulatory care has recently become a recognised pathway for PE management in those patients with low-risk of adverse outcomes. An ambulatory care pathway was used for all or part of the patient journey in 77/474 (16.2%) patients in this study. Wide variation in the selection of patients for ambulatory care was observed, with some high-risk patients being selected on this pathway and low-risk patients not being considered for it, resulting in unnecessary hospital admissions.

Patients should receive all the information they need to make an informed choice, particularly with respect to taking anticoagulation. Treating clinicians were unable to determine if the patient was given verbal or written information regarding PE in 336/600 (56.0%) instances and specific information/ education regarding PE was not routinely provided to patients at 55/167 (32.9%) hospitals.

An outpatient follow-up was not routinely arranged following a PE diagnosis in 32/179 (17.9%) hospitals. Where routine outpatient follow-up was a standard arrangement, it included a decision on the duration of anticoagulation in 138/147 (93.9%) hospitals and an assessment of whether the PE was provoked or unprovoked in 135/143 (94.4%). Case reviewers were of the opinion that follow-up was inadequate for 50/308 (16.2%) patients where there was adequate information for them to make a determination.

Recommendations

These recommendations have been formed by a consensus exercise including all those listed in the acknowledgements and highlight a number of areas that are suitable for local quality improvement initiatives.

Recommendations 1 to 6 have been highlighted as being the primary focus for action.

PRINCIPAL RECOMMENDATIONS		Key findings and guidelines that support the recommendation. The #number is the key finding number in the report	
1	Give an interim dose of anticoagulant to patients suspected of having an acute pulmonary embolism (unless contraindicated) when confirmation of the diagnosis is expected to be delayed by more than one hour. The anticoagulant selected, and its dose, should be personalised to the patient. This timing is in line with NICE QS29 2013. *(All Clinicians, Quality Improvement Lead)*	**CHAPTER 8 – PAGE 58** #52. Case reviewers were of the opinion that there was an avoidable delay in commencing treatment in 90/481 (18.7%) patients **CHAPTER 8 – PAGE 58** #53. More than half of the avoidable delays recorded were because an anticoagulant was not prescribed 44/90 (48.9%) and/or not administered 5/90 (5.5%)	NICE QS29 - Venous thromboembolism in adults: diagnosis and management
2	Document the severity of acute pulmonary embolism immediately after the confirmation of diagnosis. Severity should be assessed using a validated standardised tool, such as 'PESI' or 'sPESI'. This score should then be considered when deciding on the level of inpatient or ambulatory care. *(All Clinicians)*	**CHAPTER 7 – PAGE 53** #45. Case reviewers found no evidence of a formal assessment of PE severity in 436/483 (90.3%) cases reviewed **CHAPTER 7 – PAGE 53** #46. Data from clinician questionnaires revealed that PE severity was not recorded in 456/559 (81.6%) patients	Howard LSGE, Barden S, Condliffe R, et al British Thoracic Society Guideline for the initial outpatient management of pulmonary embolism (PE) Thorax 2018;73:ii1-ii29

PRINCIPAL RECOMMENDATIONS		Key findings and guidelines that support the recommendation. The #number is the key finding number in the report	
3	Standardise CT pulmonary angiogram reporting. The proforma should include the presence or absence of right ventricular strain. The completion of these proformas should be audited locally to monitor compliance and drive quality improvement. *(At a national level, the Royal College of Radiologists with input from other clinical specialist societies such as the British Thoracic Society).* *(Clinical Lead for Radiology and Quality Improvement Lead)*	**CHAPTER 2 – PAGE 22** #7. Proformas or other structured reporting systems for CTPA were only used in 22/156 (14.1%) hospitals **CHAPTER 5 – PAGE 47** #37. In 177/349 (50.7%) CTPA reports no comment was made on the thrombus burden **CHAPTER 5 – PAGE 47** #38. Right heart strain was identified in 93/333 (27.9%) patients and 115/333 (34.5%) of reports commented on its absence. In 125/333 (37.5%) no comment was made on the right ventricle **CHAPTER 5 – PAGE 49** #40. Case reviewers considered half of CTPA reports to be less than good (179/346; 51.7%), including 33/346 (9.5%) which were graded as poor; most commonly due to the lack of comment on the right heart (30/33; 90.9%) **CHAPTER 5 – PAGE 49** #41. Where a CTPA report was only rated as adequate and a reason was given (99/146; 67.8%) the most common concerns were a failure to comment on the right ventricle in 55/99 (55.6%)	
4	Look for indicators of massive (high-risk) or sub-massive (intermediate-risk) pulmonary embolism, in addition to calculating the severity of acute pulmonary embolism in the form of: i. Haemodynamic instability (clinical) ii. Right heart strain (imaging) iii. Elevated troponin or brain natriuretic peptide (biochemical). Escalate promptly based on local guidance and document in the case notes. *(All Clinicians)*	**CHAPTER 2 – PAGE 21** #4. A guideline/protocol for the diagnosis and care of patients with massive PE was not provided in 29/180 (16.1%) hospitals. The corresponding figure for sub-massive PE diagnosis and management was 65/176 (36.9%) **CHAPTER 4 – PAGE 43** #31. Initial investigations which might have altered management were not performed in 143/486 (29.4%) patients in the opinion of the case reviewers and in 119/689 (17.3%) patients in the view of the clinicians at the hospital **CHAPTER 4 – PAGE 43** #32. In the opinion of the case reviewers, investigations which are usually used to diagnose sub-massive PE (point of care echocardiography) or assess the risk of sub-massive PE patients dying (troponin, BNP/ NT-pro-BNP) were omitted in 11/486 (2.3%), 41/486 (8.4%) and 15/486 (3.1%)	

PRINCIPAL RECOMMENDATIONS		Key findings and guidelines that support the recommendation. The #number is the key finding number in the report	
5	Assess patients suspected of having an acute pulmonary embolism for their suitability for ambulatory care and document the rationale for selecting or excluding it in the clinical notes. *(All Clinicians)*	**CHAPTER 6 – PAGE 51** #42. 77/474 (16.2%) patients who presented to hospital with clinical suspicion of PE, were cared for on an ambulatory care pathway for all or part of their patient journey **CHAPTER 6 – PAGE 51** #43. Case reviewers were of the opinion that a further 43/366 (11.7%) patients could have benefitted from an ambulatory pathway **CHAPTER 7 – PAGE 53** #45. Case reviewers found no evidence of a formal assessment of PE severity in 436/483 (90.3%) cases reviewed **CHAPTER 7 – PAGE 53** #46. Data from clinician questionnaires revealed that PE severity was was not recorded in 456/559 (81.6%) patients **CHAPTER 7 – PAGE 54** #47. Retrospective calculation of PE severity by the case reviewers identified 194 patients in the PESI low-risk groups (Class I and II), 133 patients in the intermediate risk group (Class III) and 162 patients in the higher risk groups (Class IV and V) **CHAPTER 7 – PAGE 55** #48. 43/188 (22.9%) low-risk patients were treated on an ambulatory pathway, suggesting potential missed opportunities for the remaining 145/188 (77.1%) low-risk patients **CHAPTER 7 – PAGE 55** #49. 24/214 (11.2%) with intermediate risk and 6/74 (8.1%) with high-risk scores were ambulated, suggesting excessive risk taking	Commissioning for Quality and Innovation (CQUIN) Guidance for 2019-2020

PRINCIPAL RECOMMENDATIONS		Key findings and guidelines that support the recommendation. The #number is the key finding number in the report	
6	Provide every patient with an acute pulmonary embolism with a follow-up plan, patient information leaflet and, at discharge, a discharge letter which should include: i. The likely cause of the pulmonary embolism ii. Whether it was provoked or unprovoked iii. Details of follow-up appointment(s) iv. Any further investigations required v. Details of anticoagulant prescribed and its duration, in line with NICE CG144 *(All Clinicians, Service Users, General Practitioners)*	**CHAPTER 2 – PAGE 28** #17. Specific information/education regarding PE was not routinely provide to patients at 55/167 (32.9%) hospitals **CHAPTER 2 – PAGE 29** #18. Outpatient follow-up was not routinely arranged following a PE diagnosis in 32/179 (17.9%) hospitals. Where routine outpatient follow-up was arranged it included a decision on the duration of anticoagulation in 138/147 (93.9%) hospitals and an assessment of whether the PE was provoked or unprovoked in 135/147 (91.8%) **CHAPTER 9 – PAGE 65** #62. Treating clinicians were unable to determine if patients were given verbal and written information regarding PE in 336/600 (56.0%) cases **CHAPTER 9 – PAGE 66** #63. Case reviewers were of the opinion that follow-up was inadequate for 50/308 (16.2%) patients where there was adequate information to make a determination	Howard LSGE, Barden S, Condliffe R, et al British Thoracic Society Guideline for the initial outpatient management of pulmonary embolism (PE) Thorax 2018;73:ii1-ii29 NICE CG92 Venous thromboembolism: reducing the risk for patients in hospital NICE NG89 Venous thromboembolism in over 16s: reducing the risk of hospital-acquired deep vein thrombosis or pulmonary embolism NICE CG144 Venous thromboembolic diseases: diagnosis, management and thrombophilia testing

ADDITIONAL RECOMMENDATIONS		Key findings and guidelines that support the recommendation. The #number is the key finding number in the report	
7	Calculate the clinical probability of pulmonary embolism in all patients presenting to hospital with a suspected new diagnosis of pulmonary embolism using a validated score, such as the 'Wells' Score'. Record the score in the clinical notes. This is in line with NICE CG144. *(Clinicians, particularly Emergency and Acute Medicine Physicians)*	**CHAPTER 4 – PAGE 39** #30. A PE clinical probability score was documented in the notes for only 80/407 (19.7%) cases where the patient presented with symptoms of PE	NICE CG144 Venous thromboembolic diseases: diagnosis, management and thrombophilia testing Thromboembolic Disease in Pregnancy and the Puerperium: Acute Management. Green-top Guideline No. 37b J. 2015
8	Ensure there are hospital protocols/ guidance for assessing the severity of pulmonary embolism soon after diagnostic confirmation. Include timely access to point of care ultrasonography (POCUS)/ echocardiography and measuring biomarkers like troponin and BNP *(Hospital Executive Board)*	**CHAPTER 2 – PAGE 20** #3. A policy/guideline for the assessment of the severity of PE was provided at 144/179 (80.4%) hospitals. In 128/142 (90.1%) hospitals severity assessment was based on a validated scoring system such as PESI	
9	Ensure there is a robust system in place to alert the clinician who requested a CTPA or V/Q scan or V/Q SPECT scan of any amendments or updates to the report. This in line with the Royal College of Radiologist's communication standards for radiology reports 2016. *(Clinical Lead for Radiology)*	**CHAPTER 2 – PAGE 23** #8. A radiology report alteration alert system had been implemented in 132/169 (78.1%) hospitals	Royal College of Radiologist's communication standards for radiology reports 2016
10	Develop and document a monitoring and treatment escalation plan for, and with, all patients diagnosed with acute pulmonary embolism. Any reason for not doing so should also be documented in the case notes. *(All Clinicians, Clinical Directors)*	**CHAPTER 8 – PAGE 60** #55. There was no evidence of a treatment escalation plan in 211/386 (54.7%) patients	

ADDITIONAL RECOMMENDATIONS		Key findings and guidelines that support the recommendation. The #number is the key finding number in the report	
11	Document whether the inferior vena cava (IVC) filter inserted into a patient with pulmonary embolism is intended to be permanent or temporary. Temporary filters should have a retrieval date booked at the time of insertion and have a fail-safe tracking system to ensure the filter is removed, unless this becomes clinically inappropriate. This is in line with MHRA 2013 guidance. *(Interventional Radiologists)*	**CHAPTER 2 – PAGE 27** #13. For hospitals with an IR department only 63/118 (53.3%) could identify how many temporary IVC filters were placed in 2017 and 66/118 (55.9%) for permanent filters	Medicines and Healthcare products Regulatory Agency Device Alert. Retrievable inferior vena cava (IVC) filters - serious complications associated with attempted IVC filter retrieval. 2013
12	Ensure an ambulatory care pathway is available 7 days a week, at all hospitals where patients with an acute pulmonary embolism present. *(Hospital Executive Boards, Clinical Directors in the Emergency Department and Acute Medicine, Quality Improvement Lead)*	**CHAPTER 2 – PAGE 23** #1. An ambulatory care centre was present in 157/189 (83.1%) hospitals and a further 19 without a designated centre had an ambulatory care pathway that operated separately from a specific centre, raising the total number of hospitals with ambulatory care to 176/189 (93.1%) **CHAPTER 2 – PAGE 23** #14. Ambulatory care centres were open 7 days/ week at 81/157 (51.6%) hospitals whilst 55/157 (35.0%) were only open on weekdays **CHAPTER 2 – PAGE 24** #16. A lack of capacity in ambulatory care that sometimes resulted in patients being admitted was reported from 24/142 (16.9%) hospitals with a PE ambulatory care pathway **CHAPTER 4 – PAGE 37** #26. most common reason was the patient not going to the GP or the emergency department (61/91; 67.0%) although patients presented throughout the week **CHAPTER 6 – PAGE 51** #42. 77/474 (16.2%) patients who presented to hospital with clinical suspicion of PE, were cared for on an ambulatory care pathway for all or part of their patient journey **CHAPTER 6 – PAGE 51** #43. Case reviewers were of the opinion that a further 43/366 (11.7%) patients could have benefitted from an ambulatory pathway **CHAPTER 7 – PAGE 54** #47. Retrospective calculation of PE severity by the case reviewers identified 194 patients in the PESI low-risk groups (Class I and II), 133 patients in the intermediate risk group (Class III) and 162 patients in the higher risk groups (Class IV and V)	

ADDITIONAL RECOMMENDATIONS		Key findings and guidelines that support the recommendation. The #number is the key finding number in the report	
13	Formalise pulmonary embolism treatment networks for access to catheter-directed thrombolysis, surgical embolectomy or mechanical thrombectomy for the treatment of patients with pulmonary embolism who either fail to improve or have absolute contraindications to systemic thrombolysis. *(Hospital Executive Boards, Commissioners, Clinicians)*	**CHAPTER 2 – PAGE 26** #10. Catheter-directed thrombolysis was unavailable on-site or off-site in 60/168 (35.7%) hospitals. In 80/156 (51.3%) hospitals and 60/166 (36.1%) hospitals, mechanical thrombectomy and surgical embolectomy were not treatment options **CHAPTER 2 – PAGE 26** #11. Surgical embolectomy for PE was available on-site in 24/174 (13.8%) hospitals with a further 90/174 (51.7%) having off-site access to this treatment **CHAPTER 2 – PAGE 26** #12. In those hospitals with off-site access to surgical embolectomy this was formalised in a service agreement or a formal network in 16 hospitals (16/75; 21.3%). The most common situation was for this to be an ad-hoc arrangement (42/81; 51.9%)	NICE IPG 523 - Ultrasound-enhanced, catheter-directed thrombolysis for deep vein thrombosis interventional procedures guidance (IPG523)

1

Method and data returns

Study Advisory Group (SAG)

A multidisciplinary group of clinicians in: cardiology, acute medicine, critical care, emergency medicine, cardiothoracic surgery, radiology, trauma and orthopaedics, respiratory medicine, anaesthetics, general practice, specialist nursing, pharmacy and lay/patient representatives. This group steered the study from design to completion.

Study aim

To identify and explore avoidable and remediable factors in the process of care for patients diagnosed with pulmonary embolism (PE), both as an inpatient and those on an ambulatory care pathway.

Objectives

The SAG identified a number of objectives that would address the primary aim of the study, these included:

- Risk assessment and prevention of venous thromboembolism
- Availability, timeliness and quality of diagnostic assessment
- Risk stratification and treatment
- Appropriate patient selection and application of ambulatory care
- Management of high-risk patients and escalation decisions
- Organisational aspects of care delivery for ambulatory and inpatient pathways

Study population and case ascertainment

Inclusion criteria

- All patients aged 16 years and older who presented to hospital with symptoms of a PE or who developed PE as an inpatient (using ICD10 codes I26.0 and I26.9) between 1st July 2017 and 31st August 2017 inclusive
- Ambulatory care/same day emergency patients and patients admitted to hospital were included in the study

Selection of patients into the study was biased towards those more likely to have a severe PE. This was done by dividing patients into 3 categories and where the number of cases allowed, two patients from each category were included per hospital:

1) Primary coding diagnosis of PE with a length of stay ≤ 3 days
2) Any coding of PE with a length of stay > 3 days
3) Primary coding diagnosis of PE, admitted to critical care and/or who died with any length of stay

Hospital participation

National Health Service hospitals in England, Scotland, Wales and Northern Ireland were expected to participate as well as public hospitals in the Isle of Man, Guernsey and Jersey. Within each hospital, a named contact, referred to as the NCEPOD Local Reporter, acted as a link between NCEPOD and the hospital staff, facilitating case identification, dissemination of questionnaires and data collation.

Data collection

Spreadsheet

A pre-set spreadsheet was provided to every Local Reporter to identify all patients meeting the study criteria during the defined time period. From this initial cohort the sampling for inclusion into the study took place.

Questionnaires

Two questionnaires were used to collect data for this study: a clinician questionnaire for each patient and an organisational questionnaire for each participating hospital.

Clinician questionnaire

This questionnaire was sent to the named consultant caring for the patient at the time of their inpatient/ambulatory care discharge. Information was requested on the patient's presenting features/comorbid conditions, previous hospital attendances, initial management, investigations, escalation in care and follow-up.

Organisational questionnaire

The data requested in this questionnaire included information on ambulatory care provision for patients with PE, guidelines and standard operating procedures relevant to the care of patients with PE and availability of specific investigations and interventions.

Case notes

Copies of case note extracts were requested for peer review:

- General practitioner referral letter
- Ambulance service Patient Report Form/notes
- All inpatient annotations/medical notes/nursing notes
- Ambulatory care notes
- Emergency department clerking proforma/records
- Venous thromboembolism proformas
- Critical care notes/charts
- Microbiology reports
- Haematology/biochemistry results
- Blood gas reports
- Operation/procedure notes
- Radiology investigation reports
- Observation charts
- Fluid balance charts
- Drug charts including anticoagulation charts
- Consent forms
- Do not attempt cardiopulmonary resuscitation forms
- Treatment escalation forms
- Discharge letter/summary
- Medical/nursing notes for any follow-up appointments or readmissions for the 6 months post-discharge

Peer review of the case notes and questionnaire data

A multidisciplinary group of case reviewers comprising consultants, trainees and clinical nurse specialists from: cardiology, anaesthesia, intensive care medicine, acute medicine, emergency medicine, respiratory medicine, neurosurgery and radiology was recruited to peer review the case notes and associated clinician questionnaires.

Questionnaires and case notes had all patient identifiers removed by the non-clinical staff at NCEPOD before being presented to the group. Each set of case notes was reviewed by at least one reviewer within a small multidisciplinary meeting using a semi-structured electronic questionnaire. At regular intervals throughout the meeting the Chair allowed a period of discussion for each reviewer to summarise their cases and ask for opinions from other specialties or raise aspects of the case for discussion.

The grading system below was used by the case reviewers to grade the overall care each patient received:

- **Good practice:** A standard that you would accept from yourself, your trainees and your institution
- **Room for improvement:** Aspects of **clinical** care that could have been better
- **Room for improvement:** Aspects of **organisational** care that could have been better
- **Room for improvement:** Aspects of both **clinical and organisational** care that could have been better
- **Less than satisfactory:** Several aspects of clinical and/or organisational care that were well below that you would accept from yourself, your trainees and your institution
- **Insufficient data:** Insufficient information submitted to NCEPOD to assess the quality of care

Information governance

All data received and handled by NCEPOD comply with all relevant national requirements, including the General Data Protection Regulation 2016 (Z5442652), Section 251 of the NHS Act 2006 (PIAG 4-08(b)/2003, App No 007), PBPP (1718-0328) and the Code of Practice on Confidential Information.

Each patient was given a unique NCEPOD number. The data from all paper questionnaires received were electronically scanned into a pre-set database. All electronic questionnaires were submitted through a dedicated online application. Prior to any analysis taking place, the data were cleaned to ensure that there were no duplicate records and that erroneous data had not been entered. Any fields that contained data that could not be validated were removed.

Data analysis

Following cleaning of the quantitative data, descriptive data summaries were produced.

Qualitative data collected from the case reviewers' opinions and free text answers in the clinician questionnaires were coded, where applicable, according to content to allow quantitative analysis. The data were reviewed by NCEPOD Clinical Co-ordinators, a Clinical Researcher and Researcher to identify the nature and frequency of recurring themes.

Case studies have been used throughout this report to illustrate particular themes.

The findings of the report were reviewed by the Study Advisory Group, Case Reviewers, NCEPOD Steering Group including Clinical Co-ordinators, Trustees and Lay Representatives prior to publication.

Data returns

Clinical data

In total 10,239 patients were identified as meeting the study inclusion criteria (Figure 1.1). Up to six patients per hospital was selected in accordance with the sampling criteria defined above. This resulted in 1,318 patients being included in the initial sample. 259 patients were excluded as they did not appear to have had a diagnosis of PE (mainly on review of the case notes). Of the remaining sample of 1,059 patients, 766 completed clinician questionnaires were returned and 526 sets of notes were included in the peer reviewed by the case reviewers.

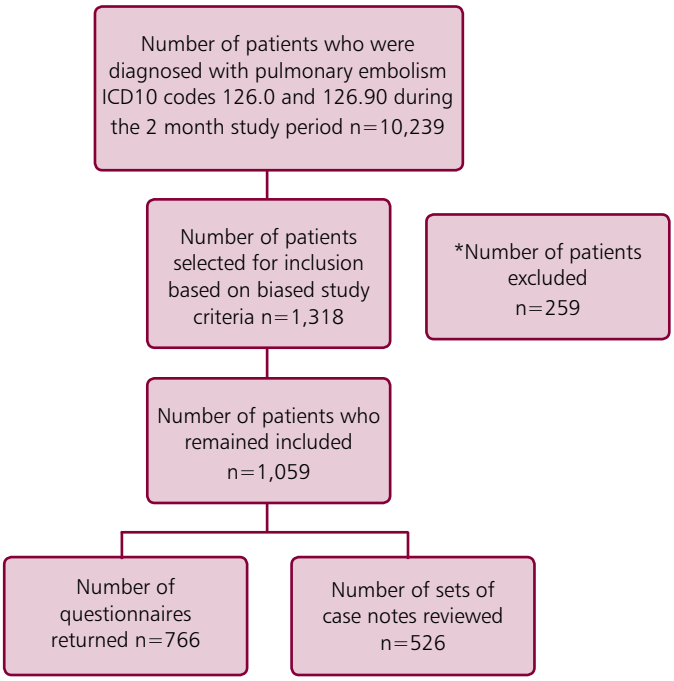

Figure 1.1 Data returns

Table 1.1 shows the types of patient, in terms of outcome, length of stay and diagnosed position of PE whose cases were reviewed by the case reviewers, compared to the overall dataset (all patients). This demonstrates the bias of the peer review sample towards patients who had a worse outcome/longer length of stay.

Organisational data

Organisational questionnaires were returned from 189/218 (86.7%) hospitals.

Table 1.1 Patients included into the study sample

	Admitted – length of stay ≤ 3days		Admitted – length of stay > 3days		
Primary diagnosis of pulmonary embolism	**Alive**	**Died/ admitted to critical care**	**Alive**	**Died/ admitted to critical care**	**Total**
All patients	3,157 (60.2%)	114 (2.2%)	1,743 (33.2)	229 (4.4%)	**5,243**
Selected for peer review	184 (43.4)	23 (5.4%)	170 (40.1%)	47 (11.1%)	**424**
Other primary diagnosis (inpatient PE)	**Alive**	**Died/ admitted to critical care**	**Alive**	**Died/ admitted to critical care**	**Total**
All patients	1,789 (42.3%)	130 (3.1%)	1,801 (42.6%)	507 (12.0%)	**4,227**
Selected for peer review	0	0	71 (69.6%)	31 (30.4%)	**102**

2

Organisational data

As described in the introduction, there is a body of evidence describing the best practice for aspects of care for patients with pulmonary embolism (PE). This chapter reports on the services that are provided for patients who present to hospital with symptoms of a PE or who develop a PE whilst as an inpatient for another condition.

Use of PE guidelines

A guideline or protocol for the care of patients with PE was available in 165/181 (91.2%) hospitals in which patients with a PE could be treated (Table 2.1).

Table 2.1 Guideline/protocol for the diagnosis and management of PE available

	Number of hospitals	%
Yes	165	91.2
No	16	8.8
Subtotal	**181**	
Unknown	8	
Total	**189**	

It was more common for modified versions of national guidelines (112/154; 72.7%) to be available than for them to be adopted directly (42/154; 27.3%) and was unknown in 11. The pharmacological management of thromboembolic disease has evolved since the publication of NICE CG144,[5] with wider use of direct oral anticoagulants (DOACs). This may account for the greater use of modified national guidance.

The frequency of inclusion of specific components of the PE pathway in the guideline/protocol are shown in Table 2.2. The components listed cover assessment to discharge for a patient with an uncomplicated PE. A guideline/protocol which does not include these increases the chance of variation in, and sub-optimal care. Only 81/164 (49.4%) hospitals had a protocol/guideline that covered all 5 points.

Table 2.2 Components of the PE pathway included in the guideline/protocol

	Number of hospitals	%
Emergency imaging	156	95.1
Acute anticoagulation management after diagnosis is confirmed	152	92.7
Discharge anticoagulation choice	125	76.2
Policy regarding use of heparin when imaging is delayed beyond 1 hour	122	74.4
Duration of anticoagulation	110	67.1
Other (specified)	16	9.8

Answers may be multiple; n=164

The combined recommendations of NICE CG144 and QS29 is that an interim therapeutic dose of low molecular weight heparin (LMWH) is administered when the CT pulmonary angiogram (CTPA) report will be delayed by 1 hour or more.[5,8] In 42/164 (25.6%) hospitals this was not included in the guidance. This low figure may be explained partly by a recent shift towards the use of DOACs, where appropriate, as an interim anticoagulant whilst the imaging assessment is pending.

The British Thoracic Society (BTS) guideline for the initial outpatient management of pulmonary embolism recommends using a single direct oral anticoagulant (DOAC) to minimise potential confusion over dosing and administration.[6]

Guidelines on pulmonary embolism in pregnancy

The diagnosis and treatment of acute PE can be challenging in pregnant patients,[14] and in 37/168 (22.0%) hospitals this was not formalised in a specific guideline/ protocol (Table 2.3).

Table 2.3 Specific guideline/protocol for the diagnosis and treatment of PE during pregnancy

	Number of hospitals	%
Yes	131	78.0
No	37	22.0
Subtotal	**168**	
Unknown	21	
Total	**189**	

Where a pregnancy specific protocol was in place, modification of the standard PE diagnostic imaging to reduce the radiation dose was included in only 90/130 (69.2%) hospitals. This was despite the 2015 Royal College of Obstetricians and Gynaecologists' (RCOG) guideline having included the recommendation that there should be an agreed protocol between obstetricians, radiologists, physicians and haematologists for the diagnosis of suspected VTE during pregnancy.[14]

Where a pregnancy specific protocol was in place it included a clinical probability score for PE in 31/130 (23.8%) hospitals with a guideline despite the RCOG stating in 2015 that there was no evidence to support the use of pre-test probability assessment in pregnancy.[14]

Table 2.4 shows the in-hospital management of PE in pregnancy was specified in 100/130 (76.9%) hospitals. The RCOG recommends that LMWH, dosed by pre- or early pregnancy weight, as the initial and maintenance treatment of PE and that there should be clear local guidelines on the dose to be used.[14] In just 75/130 (57.7%) hospitals was there a specified clinical team who would be responsible for the patient's in-hospital PE management. Ambulatory care was an option for pregnant patients in 51/130 (39.2%) hospitals. Ambulatory care was not considered in the 2015 RCOG guidance but is part of the BTS guidelines for outpatient management of PE.[6]

Table 2.4 Components included in pregnancy guidance/protocol for PE

	Number of hospitals	%
Treatment strategies	102	78.5
In-hospital management of PE	100	76.9
Modified (radiation reduction) imaging strategies	90	69.2
Specify who manages PE in pregnant women	75	57.7
Ambulatory care	51	39.2
Clinical likelihood score	31	23.8
Other (specified)	13	10.0

Answers may be multiple; n=130

Of the patients selected for case note review only 3/455 (0.7%) were pregnant or within 6 weeks of delivery. Whilst PE is a relatively rare occurrence in pregnancy, it should be recognised and anticipated that this patient group require a modified PE assessment and treatment pathway. These data are not covered in the detailed case review due to the small numbers involved. However, a confidential enquiry on this will be undertaken in 2020 by MBRRACE-UK.

Clinical Pulmonary Embolism Rule-Out Criteria (PERC)

The Pulmonary Embolism Rule-out Criteria (PERC) when applied to low-risk patients, has been shown to identify patients who can be discharged safely without further investigations.[15] PERC has not yet been included in a UK National Guideline, however it was reported to be in use in 58/169 (34.3%) hospitals (Table 2.5).

In 33/54 (61.1%) hospitals where PERC was in use, and where the question was answered, there was no restriction in terms of the seniority of clinician who could apply it.

Table 2.5 Pulmonary Embolism Rule-Out Criteria (PERC) was routinely used to identify patients WHO DID NOT require further investigation for PE

	Number of hospitals	%
Yes	58	34.3
No	111	65.7
Subtotal	**169**	
Unknown	20	
Total	**189**	

Application by less senior clinicians may risk higher rates of missed PEs as a PERC validation study using intuitive decision-making based on experience of a senior clinician appeared to increase with clinical experience.[16]
PE prognostic scores

In 144/179 (80.4%) hospitals there was a policy/guideline for the assessment of the severity of PE following imaging diagnosis (Table 2.6). Table 2.7 shows the types of score that were used.

Table 2.6 Policy/guideline for the assessment of PE severity available

	Number of hospitals	%
Yes	144	80.4
No	35	19.6
Subtotal	**179**	
Unknown	10	
Total	**189**	

Table 2.7 Types of PE prognostic scores used

	Number of hospitals	%
Pulmonary Embolism Severity Index (PESI)	94	65.3
Simplified PESI (sPESI)	49	34.0
National Early Warning Score (NEWS)	36	25.0
Hestia criteria	12	8.3
Geneva score	4	2.8
Other (specified)	22	15.3

Answers may be multiple; n=144

Use of a validated scoring system (PESI, simplified PESI or Hestia) for PE was declared by 128/142 (90.1%) hospitals and it was reported from 36/142 (25.4%) hospitals that the National Early Warning Score (NEWS) was used to assess the severity of PE. Whilst NEWS has not been validated for the assessment of PE severity, performing a NEWS score in the emergency department at the same time as a clinical severity score of PE can be an additional benefit to establish the patient's physiological baseline at presentation. In 27/36 (75%) hospitals in which NEWS was used it was in addition to a PE-specific score.

Clinical classification of PE severity

The American Heart Association (2011) published a risk stratification nomenclature for PE comprising three categories: massive, sub-massive and low-risk.[11] The European Society of Cardiology (2014) published a similar classification: High-risk (equivalent to massive), intermediate high-risk (equivalent to sub-massive), intermediate low and low-risk.[10]

Massive PE is characterised by cardiac arrest, systemic hypotension or shock.[17] In-hospital mortality is 15% for those with arterial hypotension, 25% for those with cardiogenic shock and 65% if cardiopulmonary resuscitation is required.[18] About 80% of patients have normal systemic arterial pressure at the time of presentation.[19] Sub-massive PE refers to those patients with acute PE without systemic hypotension but with evidence of either right ventricle (RV) dysfunction or myocardial necrosis. RV dysfunction is characterised by RV dilation, hypokinesis, or elevation of brain-type natriuretic peptide (BNP); myocardial necrosis is suggested by elevated troponin. Around 30% of patients have echocardiographic evidence of RV dysfunction without arterial hypotension. This has an in-hospital mortality of 5-8%.[19]

Guidelines are consistent in their recommendation of systemic thrombolysis for patients with a massive PE without a contraindication to thrombolysis.[5,10,11,13] Thrombolysis reduces total mortality, PE-related mortality and PE recurrence in massive PE compared to anticoagulation but at the expense of increased major haemorrhage including stroke.[20] The management of sub-massive PE is controversial. Thrombolysis has not been shown to impact the mortality of sub-massive

PE.[20] It has been shown to result in earlier resolution of RV dysfunction and reduce the rate of haemodynamic decompensation in some studies.[21] Consequently some clinicians will consider offering some patients with sub-massive or intermediate high-risk PE, in the context of shared decision-making, systemic thrombolysis (see Chapter 8). This requires careful consideration of the risks and benefits involved based on the patient's anticipated clinical course, comorbidities, and bleeding risk before administering thrombolytic therapy. Whilst the evidence is inconclusive, it should be noted that the 2016 CHEST guidelines recommend against the administration of thrombolytics in patients with acute PE in the absence of hypotension (grade 1B).[13] Similarly, the European Society of Cardiology guidelines recommend against the routine use of thrombolysis in these patients (class III, level B).[10]

Despite its high mortality and fact that PE may complicate any admission, in 29/180 (16.1%) hospitals there was no guideline/protocol for the diagnosis and management of massive PE, with that figure increasing to 65/176 (36.9%) for sub-massive PE (Table 2.8).

Imaging

There are a number of different imaging modalities for the diagnosis and risk stratification of PE. The imaging strategy may be modified in certain conditions such as women of child-bearing age, iodinated contrast allergy or severe renal impairment.

Echocardiography

When CTPA is not immediately available echocardiography can be used as a bedside test to support a clinical diagnosis of massive PE. Demonstration of right ventricular (RV) dilatation and/or dysfunction on echocardiography identifies patients at increased risk of adverse outcomes from acute PE.[11] In patients with a suspected massive PE, it can help speed up the delivery of thrombolysis. Whilst this is not included in current NICE guidance it is included in other guidelines including in the European Society of Cardiology Guideline (2014) and SIGN 122 (2014).[9,10] On-site formal (cardiology) transthoracic echocardiography was available in 180/182 (98.9%) hospitals. This was available 24 hours a day, 7 days a week in only 40/180 (22.2%) (Table 2.9).

Table 2.8 Available guideline/protocol for the diagnosis and management of massive/sub-massive PE

	Massive PE		Sub-massive PE	
	Number of hospitals	**%**	**Number of hospitals**	**%**
Yes	151	83.9	111	63.1
No	29	16.1	65	36.9
Subtotal	**180**		**176**	
Unknown	9		13	
Total	**189**		**189**	

Table 2.9 Availability of on-site echocardiography

	Number of hospitals	%
24 hours a day, 7 days/week	40	22.2
Normal working hours (08:00-18:00) 7 days/week	17	9.4
Normal working hours (08:00-18:00) Monday-Friday	105	58.3
Other	18	10.0
Subtotal	**180**	
Unknown	2	
Total	**182**	

Point of care echocardiography (non-cardiology service) was available on-site in 89/164 (54.3%) hospitals, off-site in three and unknown in 25. In 45 hospitals where it was answered this was available 24 hours a day, 7 days a week.

CASE STUDY 1

A middle-aged patient with chronic obstructive pulmonary disease (COPD) presented to hospital with hypoxia and cardiogenic shock after a 4 hour flight. There was a 4 hour delay to diagnosis by CT pulmonary angiogram. Admission to critical care was delayed due to a lack of beds, but following admission the patient was thrombolysed. The patient died despite full supportive care including consideration of extra-corporeal membrane oxygenation.

The case reviewers recognised a missed opportunity to assess the patient with echocardiography and institute earlier thrombolysis. Thrombolysis should be given at the earliest opportunity in massive PE and should not be delayed by bed availability.

CT pulmonary angiography (CTPA)

CTPA was widely available as a 24 hours a day, 7 days/week service (167/182; 91.8%) (Table 2.10)

Table 2.10 Availability of CT pulmonary angiography

	Number of hospitals	%
24 hours a day, 7 days/week	167	91.8
Normal working hours (08:00-18:00) 7 days/week	4	2.2
Normal working hours (08:00-18:00) Monday-Friday	4	2.2
Other	7	3.8
Total	**182**	

Answers may be multiple; n=144

Proformas or other structured reporting systems for CTPA have been recommended by the European Society of Radiology,[22] as well as the American College of Radiology and the Radiological Society of North America, but were reported as being used in only 22/156 (14.1%) hospitals (Table 2.11). The use of such reporting systems provide a standardised communication between the radiologist and clinical staff caring for the patient and can act as an "aide memoire" for junior doctors to ensure pertinent negatives as well as positives, such as the presence or absence of right heart strain, are included in the report. They also allow retrieval of data by automated or semi-automated methods for the purposes of comparison, audit and research.

The BTS 2018 guidance on the initial outpatient management of PE recommends that patients with a confirmed PE on imaging with a negative Hestia score or low severity PESI/sPESI should be considered for outpatient management if the right ventricle (RV) is normal on CT or if it is dilated but biomarkers are normal.[6] Consequently failing to comment on the RV may result in a request for review of the CTPA, additional tests or an avoidable admission.

Table 2.11 Availability of a proforma/structured system for reporting CTPA

	Number of hospitals	%
Yes	22	14.1
No	134	85.9
Subtotal	**156**	
Unknown	33	
Total	**189**	

Ventilation perfusion (V/Q) planar and V/Q SPECT scanning

V/Q SPECT is a newer technology with similar sensitivity and specificity to CTPA for PE and can be used for patients who have contraindications to CTPA. In 2009 the European Association of Nuclear Medicine strongly recommended the use of V/Q SPECT over V/Q planar for PE diagnosis.[23] In 2012 NICE CG144 also recommended the use of V/Q SPECT over planar V/Q.[6]

Table 2.12 Availability of ventilation perfusion (V/Q) planar and V/QSPECT scanning

	Ventilation perfusion (V/Q) scanning		V/Q SPECT scanning	
Scanning availability	**Number of hospitals**	**%**	**Number of hospitals**	**%**
Available on-site	130	72.2	64	42.1
Available off-site	37	20.6	11	7.2
Unavailable	13	7.2	77	50.7
Subtotal	**180**		**152**	
Unknown	9		**37**	
Total	**189**		**189**	

Ventilation perfusion (V/Q) planar scanning was available on- or off-site in 167/180 (92.8%) hospitals (Table 2.12). V/Q SPECT was available on- or off-site in 75/152 (49.3%) hospitals. Off-site V/Q SPECT was available at 11 hospitals compared to 37 for V/Q planar scanning. Potential reasons for this include V/Q SPECT's more limited overall availability and its more recent introduction which has not yet been adopted into formal clinical networks. Similar findings were found for V/Q planar and V/Q SPECT reporting (data not presented).

Report alteration alerting systems

Provisional radiology reports produced out-of-hours by junior radiology reporters require a consultant radiologist review to produce the final verified report. Uncertain findings identified in a consultant radiologist report or a remote outsourced out-of-hours reporting service may also be reviewed and updated by a sub-specialist consultant radiologist. Various systems exist to alert the physician caring for the patient to any clinically significant change to the provisional report, including electronic and telephone alerts with verification and documentation of report communication. In 2016 the Royal College of Radiologists recommended IT systems should be implemented with interim measures until this could be achieved.[24] It was reported from only 132/169 (78.1%) hospitals that such a system was in place (Table 2.13). An audit for missed alerts was only reported as being undertaken in one hospital that had an alert system in place.

Table 2.13 Report alteration alerting system in place

	Number of hospitals	%
Yes	132	78.1
No	37	21.9
Subtotal	**169**	
Unknown	20	
Total	**189**	

Ambulatory care

An ambulatory care centre was present in 157/189 (83.1%) hospitals and a further 19 without a designated centre had an ambulatory care pathway that operated separately from a specific centre, raising the total number of hospitals with ambulatory care to 176/189 (93.1%).

Table 2.14 shows the hours during which the ambulatory care centres operated. There were 81/157 (51.6%) open 7 days/week, whilst 55/157 (35.0%) were only open on weekdays.

Table 2.14 Availability of ambulatory care centres

	Number of hospitals	%
24 hours a day, 7 days/week	6	3.8
Extended working hours 7 days/week	36	22.9
Normal working hours (08:00-18:00) 7 days/week	39	24.8
Extended working hours 5 days/week	17	10.8
Normal working hours (08:00-18:00) Monday-Friday	38	24.2
Extended hours but number of days/week not specified	21	13.4
Total	**157**	

There was no consistency about who could refer patients for ambulatory care beyond the 160/176 (90.9%) hospitals in which emergency department referrals were accepted (Table 2.15). Such inconsistencies across NHS hospitals risks confusion for healthcare professionals as to who to refer to.

Table 2.15 How ambulatory care referrals were made

	Number of hospitals	%
Emergency department referrals	160	90.9
GP referrals	140	79.5
Patient received directly from GP	127	72.2
Medical/Surgical specialities	100	56.8
All patients have to attend the emergency department	9	5.1
Other (specified)	22	12.5
Total	**157**	

Answers may be multiple; n=176

The BTS guideline on the outpatient management[6] was published after the patient selection period for this study but six months before organisational data submissions closed. The BTS recommended that patients with confirmed PE should be risk-stratified using a validated clinical risk score and that those in PESI class I/II, sPESI 0 or assessed to be Hestia negative should be considered for outpatient management of PE. The care available to low-risk patients with PE in the 38 hospitals that did not have an ambulatory care pathway is shown in Table 2.16.

Table 2.16 Care available in hospitals with no ambulatory care pathway

	Number of Hospitals
All referrals for PE admitted	9
Ad-hoc PE ambulatory care	7
Ambulatory care of PE not available	2
Transfer to another site for ambulatory care	3
Other	17
Total	**38**

A lack of capacity in ambulatory care that sometimes resulted in patients being admitted was reported from 24/142 (16.9%) hospitals with a PE ambulatory care pathway.

Table 2.17 shows how PE patients were identified for ambulatory care. Most commonly this was by clinical screening. It was of note that early warning scores were used in conjunction with other methods of screening, and from eight hospitals it was reported that such scores were the sole tool for patient selection (data not shown). Early warning scores are not validated for the identification of patients with PE suitable for ambulatory care.

Table 2.17 How PE patient suitability for ambulatory care were identified

	Number of hospitals	%
Patients screened by referring clinician	110	75.9
NEWS or other early warning score	66	45.5
PESI/sPESI/Hestia/BTS guidelines	20	13.8
AMB score	14	9.7
All patients sent to ambulatory care by default	13	9.0
Other (specified)	18	12.4

Answers may be multiple; n=145

Acute medicine was the most common speciality providing ambulatory care (126/145; 86.9%) followed by emergency medicine (48/145; 33.1%) and respiratory medicine (28/145; 19.3%) (Table 2.18).

Table 2.18 Teams providing ambulatory care for PE patients

	Number of hospitals	%
Acute medicine	126	86.9
Emergency medicine	48	33.1
Respiratory medicine	28	19.3
General medical clinic	13	9.0
Haematology	11	7.6
Specialty nurse led clinic	11	7.6
Oncology	5	3.4
Other (specified)	8	5.5

Answers may be multiple; n=145

Despite ambulatory care for patients with PE being a new service in many hospitals and carrying significant morbidity and mortality risks if applied to higher risk patients, the care pathway for PE was audited locally in only 63/130 (48.5%) hospitals where it was provided not in 67/130 (51.5%) and unknown in 17. This local audit was mainly led by acute medicine (46/61; 75.4%) (Table 2.19).

Table 2.19 Who audited the ambulatory care PE pathway

	Number of hospitals
Acute medicine	46
Emergency medicine	9
Respiratory medicine	9
Haematology	9
Other (specified)	4

Answers may be multiple: n=61

Learning from local audit of the ambulatory care pathway was most commonly shared at single or multiple speciality audit meetings. Methods for wider sharing of that learning and resulting quality improvements were not widely used (Table 2.20).

Table 2.20 How local audit results of the ambulatory care PE pathway disseminated for learning/ improvement

	Number of hospitals
Multispecialty audit meetings	33
Single speciality audit meetings	27
Email alert	8
Notice boards	2
Paper newsletter	1
Other (specified)	13

Answers may be multiple: n=63

Escalated treatments

Intravenous systemic thrombolysis

The selective use of thrombolysis in haemodynamically unstable patients reduces death compared to treatment with heparin alone.[26] Current NICE guidance recommends systemic thrombolytic therapy for patients with massive PE characterised by haemodynamic instability. It does not recommend systemic thrombolytic therapy for patients with PE and haemodynamic stability with or without right ventricular dysfunction.[5]

Systemic thrombolysis for PE was provided on-site in 176/180 (97.8%) hospitals, off-site in 4/180 (2.2%) and was unknown for 9. This was a 24/7 service in all except two hospitals (data not shown). Those hospitals currently unable to offer 24/7 on-site IV systemic thrombolysis for massive PE should review whether this could be safely provided on-site. If on-site provision is not an option they should establish a formal network.

A small number of hospitals (17/173; 9.8%) provided systemic thrombolysis without a hospital protocol for patient selection, thrombolysis administration and monitoring (Table 2.21).

Table 2.21 Hospital protocol for systemic thrombolysis

	Number of hospitals	%
Yes	156	90.2
No	17	9.8
Subtotal	**173**	
Unknown	3	
Total	**176**	

The wide range of clinical specialities who deliver systemic thrombolysis is shown in Table 2.22.

Table 2.22 Specialty delivering thrombolysis

	Number of hospitals	%
Acute medicine	116	71.2
Emergency department	114	69.9
Critical care	110	67.5
Cardiology	74	45.4
Respiratory medicine	70	42.9
Other (specified)	13	8.0

Answers may be multiple: n=163

Catheter directed treatments

A range of catheter directed treatments (CDT) exist to reduce the thrombus in massive PE. There is increasing evidence that catheter directed thrombolysis, particularly when combined with ultrasonic catheters, is as effective as systemic thrombolysis but with reduced rates of major bleeding and haemorrhagic stroke.[27]

CDTs require experienced clinicians to perform the procedure, most commonly interventional radiologists or cardiologists. When thrombolysis, or even anticoagulation, are absolutely contraindicated mechanical thrombus aspiration or fragmentation may be the only intervention option unless the patient is in one of the small number of hospitals that has access to surgical pulmonary embolectomy.

Catheter directed thrombolysis was available on-site in 52/168 (31.0%) hospitals and off-site to in 56/168 (33.3%) hospitals, unavailable in 60/168 (35.7%) and unknown in 21. For those patients accessing the catheter direct thrombolysis from another hospital this was based on an informal arrangement or ad-hoc referrals in 41. A formal network was only used in 10/51 (19.6%) hospitals.

Mechanical thrombectomy

Mechanical thrombectomy was less widely available with 34/167 (20.4%) hospitals providing an on-site service. It was not an option for 80/156 (51.3%) hospitals. Similar to the data for catheter directed thrombolysis, where this service was provided at another hospital it was rarely (14 hospitals) in the setting of a formal service agreement or part of a clinical network (data not shown).

Surgical embolectomy

Surgical embolectomy for PE was available on-site in 24/174 (13.8%) hospitals with a further 90/174 (51.7%) having off-site access to this treatment. In those hospitals with off-site access this was formalised in a service agreement or a formal network in 16 hospitals (16/75; 21.3%). The most common situation was for this to be an ad-hoc arrangement (42/81; 51.9%). In 60/166 (36.1%) hospitals surgical embolectomy was not a treatment option.

Inferior vena cava (IVC) filters

IVC filters are designed to trap emboli from the leg or pelvic veins and stop them moving to the lung and causing a PE. IVC filters have been shown to reduce the mortality in massive PE,[27] although they carry a small risk of IVC blockage, inferior cava wall perforation or metallic fracture and embolisation which increases over time. In a 3.5 year period between 2007-2011 the British Society of Interventional Radiology IVC filter registry had data submitted from 68 interventional radiology (IR) units with 1,434 IVC filter insertions (721 temporary) equating to at least 409/year in the UK. A trend of increasing use of temporary IVC filters was identified during the registry period.[28]

An IR service was available in 133/181 (73.5%) hospitals which appears to have increased since NCEPOD collected the same data in 2014 when it was 69.8%.[29] In 40/47 (85.1%) of those hospitals without an IR service there was access to IVC filter placement at another hospital with 19/40 (47.5%) having a formal service agreement. In seven hospitals, if an IVC filter was indicated, there was no arrangement to provide this.

IVC filters should be removed when a patient becomes eligible for anticoagulation treatment. NICE have advised that IVC filters should be removed at the earliest possible opportunity and that a provisional plan for removal is documented when the filter is inserted with temporary intent.[5] In 2013 the Medicines and Healthcare products Regulatory Agency (MHRA) also recommended that a retrieval date should be scheduled at the time of filter insertion to minimise the chances of patients being lost to follow-up.[30] Where the question was answered 34/97 (35.1%) hospitals with an IR department had a hospital guideline on the use and management of IVC filters. In a further 36 it was unknown.

In most IR departments where there was an IVC filter guideline, it included both the indications for IVC filter insertion (30/34) and a plan for retrieving temporary filters (28/34) in accordance with national guidance (Table 2.23).

Table 2.23 Contents of the IVC filter guideline

	Number of hospitals
List of indications	30
Plan for retrieval if temporary IVC filter	28
Fail safe system to ensure retrieval occurs	16
Imaging follow-up for permanent filters	7
Other	5

Answers may be multiple; n=34

Booking a filter retrieval appointment does not guarantee that the procedure is performed. Only 16/133 (12.0%) IR departments had a guideline which included a fail-safe system to prospectively track inserted filters and ensure all were either removed or that a risk: benefit decision was made with the patient that the IVC filter should be left permanently in place. It is possible that hospitals had a fail-safe system without a guideline. This would require knowledge that an IVC filter had been inserted. For hospitals with an IR department only 63/118 (53.4%) could identify how many temporary IVC filters were placed in 2017 with 66/118 (55.9%) for permanent filters; 21/66 (31.8%) IR units did not insert any permanent IVC filters in 2017 (Figure 2.1).

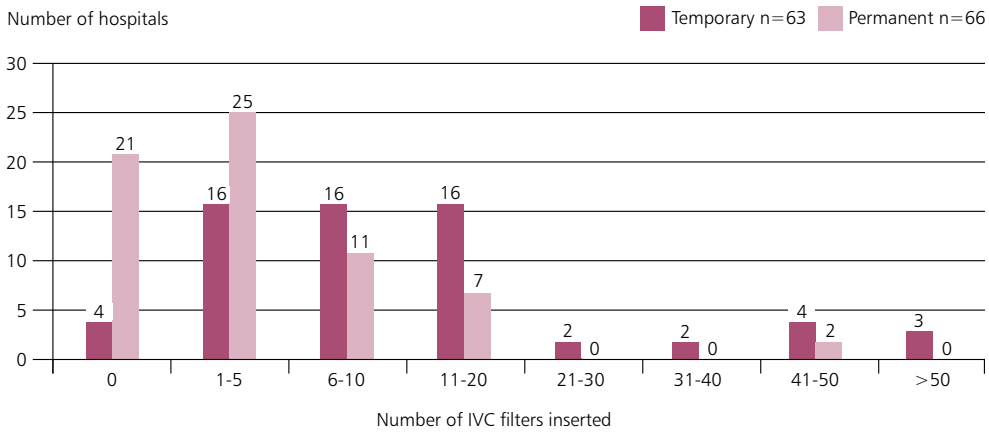

Figure 2.1 Number of IVC filters inserted in 2017

At least 786 temporary IVC filters and 318 permanent filters were inserted in the UK in 2017 (data not shown). This suggests a likely increasing use of IVC filters overall and temporary IVC filters in particular when compared to the 2007-11 British Society of Interventional Radiology registry data which was from a similar number of units contributing data and showed near equal numbers of permanent and temporary filters. The 1,104 IVC filters used in 2017 is likely to be a considerable under recording given the high number of units who were unable to provide simple numerical data.

Pulmonary embolism service

Whilst the care for the majority of patients with a PE can be managed by standardised protocols, a small number of patients require more personalised management and usually the expertise of more than one speciality. In other conditions multidisciplinary team meetings (MDTs) are the recognised method for ensuring input from all relevant specialities later in the care pathway although initial care will often require these clinical discussions to occur at a more informal level. An MDT for the care of complex patients with a PE occurred in only 22/167 (13.2%) hospitals and only 79/181 (43.6%) hospitals had a lead clinician for the pulmonary embolism service (Table 2.24).

Table 2.24 Multidisciplinary team management for patients with a PE

	Number of hospitals	%
Yes	22	13.2
No	145	86.8
Subtotal	**167**	
Unknown	2	
Total	**169**	

Patient education and follow-up

Dedicated information regarding PE was provided to patients in 112/167 (67.1%) hospitals. It was not provided in 55/167 (32.9%) and unknown in 22. Where information was provided, the timing of this is shown in Table 2.25. In 36/112 (32.1%) hospitals the information was provided both before discharge and at the patients' first clinic appointment.

Table 2.25 When patient information is provided

	Number of hospitals	%
Before discharge from hospital	61	54.5
Before discharge and at first clinic appointment	36	32.1
First clinic appointment	14	12.5
Other (specified)	1	0.9
Total	**112**	

The components of the patient information are shown in Table 2.26. Patients were most likely to receive an anticoagulation plan (93/111; 83.8%) and advice on managing the risks of anticoagulation (91/111; 82.0%). NICE specified that all patients receiving anticoagulation for VTE should be given verbal and written advice which included when to seek medical help, travel and dental treatment.

Table 2.26 Components of the patient information

	Number of hospitals	%
Anticoagulation plan tailored to each patient	93	83.8
Management of anticoagulation related risks (e.g. alcohol, missed dose)	91	82.0
When to seek help	80	72.1
Complications of PE	75	67.6
Need to assess risk factors	70	63.1
Future travel	60	54.1
Contraception	51	45.9
Impact of life	48	43.2
Future pregnancy	47	42.3
Future surgery	46	41.4
Written self-management plan	33	29.7
Other (specified)	12	10.8

Answers may be multiple; n=111

There was similar variation in the clinics or services where patients were routinely followed-up (Table 2.27)

Table 2.27 Services patients with a PE are routinely referred to/provided with following diagnosis

	Number of hospitals	%
Anticoagulation clinic	99	55.3
Venous thromboembolism clinic	85	47.5
Primary care follow-up	57	31.8
Respiratory clinic	26	14.5
Telephone follow-up	16	8.9
Medical clinic	14	7.8
Enhanced self-care	7	3.9
Other (specified)	12	6.7

Answers may be multiple; n=179

Outpatient follow-up was not routinely arranged following a PE diagnosis in 32/179 (17.9%) hospitals. Where routine outpatient follow-up was arranged it included a decision on the duration of anticoagulation in 138/147 (93.9%) hospitals and an assessment of whether the PE was provoked or unprovoked in 135/147 (91.8%). In 98/147 (66.7%) the follow-up was extended to 3 months (Table 2.28).

Table 2.28 Components of routine follow-up

	Number of hospitals	%
Duration of anticoagulation	138	93.9
Assessment of provoked or unprovoked VTE	135	91.8
Thrombophilia testing	104	70.7
Plan for further follow-up at 3 months	98	66.7
Other (specified)	25	17.0

Answers may be multiple; n=147

Testing for thrombophilia, including antiphospholipid antibodies, should be considered for patients with unprovoked PE or with a first degree relative who has had a PE or DVT when discontinuation of anticoagulation is planned.[5] Assessment of thrombophilia cannot be performed whilst taking anticoagulants. Additionally, the European Society of Cardiology recommend that the subset of PE survivors with persistent exercise-induced dyspnoea after 3 months of effective anticoagulation should be screened for chronic thromboembolic pulmonary hypertension (CTEPH).[32]

Governance and audit

Preventable thromboembolic events

Initiatives to reduce hospital related VTE morbidity and mortality have been introduced across the UK.[2,4,9,33] Furthermore NICE published CG92 'Venous Thromboembolism: reducing the risk for patients in hospital' and NICE Quality Standard QS3 for 'VTE prevention' in 2010.[34,35] In 2013 the NHS England CQUIN was amended to include 95% VTE risk assessment rates and a local system for investigating and reporting hospital-associated thromboses.[36] The VTE CQUIN 2013 recommended that a root cause analysis is carried out on all cases of hospital-associated VTE. This recommendation had been adopted by 124/145 (85.5%) hospitals in England and 134/163 (82.2%) hospitals overall in which there was a system for investigating preventable thromboembolic events, which included PE. In England VTE prevention remained in the CQUIN scheme for 4 years and is now a nationally mandated quality requirement in the National Health Service (NHS) Standard Contract. The most recently published guidance on VTE prevention was NICE NG89 Venous thromboembolism in over 16s: reducing the risk of hospital acquired deep venous thrombosis or pulmonary embolism which was published in March 2018,[37] after the case selection period for this study.

The common clinical scenarios for investigating preventable thromboembolic events are shown in Table 2.29. There was no consistency but a new PE when an inpatient for another condition (111/129; 86.0%) and a PE within 3 months of a hospital admission (112/129; 86.8%) were the most common.

Table 2.29 Clinical scenarios for investigating preventable thromboembolic events

	Number of hospitals	%
Inpatient within the last 3 months	112	86.8
PE in an inpatient admitted for another condition	111	86.0
PE in patients receiving chemotherapy as an outpatient or day case	41	31.8
PE in patients receiving radiotherapy as an outpatient or day case	31	24.0
Other (specified)	14	10.9

Answers may be multiple; n=129

Details on which aspects of care are included in the investigation of avoidable thromboembolic events is shown in Table 2.30. Omitted VTE assessment, omitted VTE prescription, omitted VTE administration and the failure to prescribe anti-embolism stockings were included. Non application of anti-embolism stockings and the use of intermittent mechanical compression devices was less commonly included. No hospital described a comprehensive investigation policy which included all elements with many having multilevel omissions.

Table 2.30 Aspects of care included in the investigation of avoidable thromboembolic events

	Number of hospitals	%
Omitted VTE assessment	124	93.2
Omitted VTE prescription	126	94.7
Omitted VTE administration	124	93.2
Prescription of anti-embolism stocking	105	78.9
Application of anti-embolism stocking	95	71.4
Use of mechanical intermittent compression devices (e.g. Flotrons)	79	59.4
Other (specified)	7	5.3

Answers may be multiple; n=133

Organisational reflection

Completing data returns for this study offered an opportunity to identify a service gap or deficiencies including those they were in the process of addressing. It was of note that gaps were identified by 117/158 (74.1%) hospitals in their PE service. Of those with a gap identified 68/94 (72.3%) had plans in place to correct the deficiencies. The areas where hospitals had plans to improve their services are summarised in Table 2.31 for 62 hospitals that provided specific information about this.

Table 2.31 Areas of improvement identified in hospital PE services

Ambulatory care		PE service		Discharge/follow-up	
Number of hospitals		Number of hospitals		Number of hospitals	
PE pathway	7	Guideline revisions	8	Patient information	18
Audit	6	Lead clinician/ formalisation of service	6	VTE clinics	6
		Risk assessment	3		
		Audit and tracking	4		

Key Findings

1. An ambulatory care centre was present in 157/189 (83.1%) hospitals and a further 19 without a designated centre had an ambulatory care pathway that operated separately from a specific centre, raising the total number of hospitals with ambulatory care to 176/189 (93.1%)
2. A guideline/protocol for the care of patients with PE was provided at 165/181 (91.2%) hospitals. The majority of the guidelines/protocols were modified versions of national guidelines (112/154; 72.7%)
3. A policy/guideline for the assessment of the severity of PE was provided at 144/179 (80.4%) hospitals. In 128/142 (90.1%) hospitals severity assessment was based on a validated scoring system such as PESI
4. A guideline/protocol for the diagnosis and care of patients with massive PE was not provided in 29/180 (16.1%) hospitals. The corresponding figure for sub-massive PE diagnosis and management was 65/176 (36.9%)
5. On-site formal (cardiology) transthoracic echocardiography was available at 179/182 (98.4%) hospitals. The service was available 24/7 in 40/180 (22.2%)
6. CT pulmonary angiography (CTPA) was widely available as a 24 hours/day, 7 days/week service in 156/169 (92.3%) hospitals with only 13/169 (7.7%) declaring incomplete access across the day or week
7. Proformas or other structured reporting systems for CTPA were only used in 22/156 (14.1%) hospitals
8. A radiology report alteration alert system had been implemented in 132/169 (78.1%) hospitals
9. A protocol for the use of IV thrombolysis was available in 146/163 (89.6%) hospitals that offered this on-site service
10. Catheter directed thrombolysis was unavailable on-site or off-site in 60/168 (35.7%) hospitals. In 80/156 (51.3%) hospitals and 60/166 (36.1%) hospitals, mechanical thrombectomy and surgical embolectomy were not treatment options
11. Surgical embolectomy for PE was available on-site in 24/174 (13.8%) hospitals with a further 90/174 (51.7%) having off-site access to this treatment
12. In those hospitals with off-site access to surgical embolectomy this was formalised in a service agreement or a formal network in 16 hospitals (16/75; 21.3%). The most common situation was for this to be an ad-hoc arrangement (42/81; 51.9%)
13. For hospitals with an IR department only 63/118 (53.3%) could identify how many temporary IVC filters were placed in 2017 and 66/118 (55.9%) for permanent filters
14. Ambulatory care centres were open 7 days/week at 81/157 (51.6%) hospitals whilst 55/157 (35.0%) were only open on weekdays
15. Ambulatory care pathways/processes operated in 167/177 (94.4%) hospitals
16. A lack of capacity in ambulatory care that sometimes resulted in patients being admitted was reported from 24/142 (16.9%) hospitals with a PE ambulatory care pathway
17. Specific information/education regarding PE was not routinely provided to patients at 55/167 (32.9%) hospitals
18. Outpatient follow-up was not routinely arranged following a PE diagnosis in 32/179 (17.9%) hospitals. Where routine outpatient follow-up was arranged it included a decision on the duration of anticoagulation in 138/147 (93.9%) hospitals and an assessment of whether the PE was provoked or unprovoked in 135/147 (91.8%).

3

Study population

The targeted sampling method in this study, described in Chapter 1 means that the clinical data presented here is not representative of an unselected PE population.

Study sample demographics

The patient age distribution in this study sample was 20-100 years with a median age of 69 years and a mode decile age range of 71-80 years. Females and males were represented in the same ratio as the general population (females 266/526; 50.6%) (Figure 3.1).

Documentation of risk factors for venous thromboembolism (VTE)

Correct categorisation of the PE as provoked (with risk factors) or unprovoked (no associated risk factors) requires full knowledge of the risk factors. The optimum time to record these is at the time of first presentation. The case reviewers identified a failure to record all risk factors in 50/476 (10.5%) (Table 3.1).

Table 3.1 All risk factors for VTE were appropriately documented

	Number of patients	%
Yes	404	84.9
Not all documented	50	10.5
None documented	16	3.4
Not clearly documented	6	1.3
Subtotal	**476**	
Insufficient data	50	
Total	**526**	

Case reviewer data

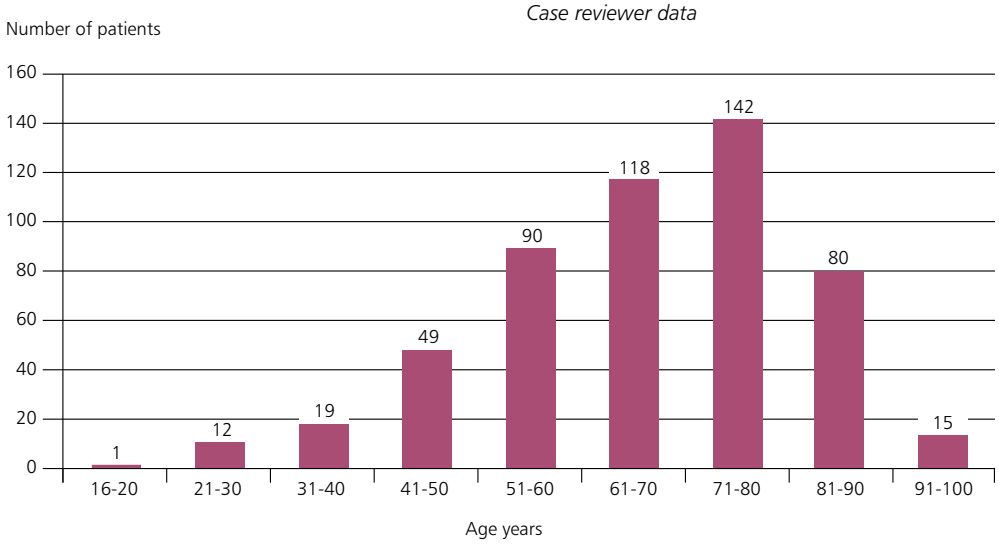

Figure 3.1 Age distribution of the study sample population

Table 3.2 shows the prevalence of other comorbidities and risk factors for PE. Active cancer, prior VTE, hospitalisation within the previous 6 weeks, obesity and chronic lung disease were the five most common. In the sampled population the prevalence of "generic" risk factors for VTE was much higher than specific haematological risk factors.

Table 3.2 Comorbidities and risk factors for PE

	Number of patients	%
Active cancer (treatment ongoing or palliative)	173	26.7
History of VTE	131	20.2
Hospitalisation within 6 weeks	123	19.0
BMI > 30	109	16.8
Chronic lung disease	88	13.6
Diabetes mellitus	75	11.6
Travel/immobility for longer than 4 hours	62	9.6
Major surgery within 12 weeks	54	8.3
Bedridden for 3 days or more in last 4 weeks	47	7.3
Heart failure	43	6.6
Chronic kidney disease	42	6.5
Trauma or fracture	36	5.6
Chronic inflammatory disease	29	4.5
Nursing care home resident	25	3.9
Other hyper-coagulable state	22	3.4
Family history of VTE	22	3.4
Orthopaedic limb immobilisation	21	3.2
Autoimmune disorder	18	2.8
Oestrogen therapy	17	2.6
Paresis or paralysis	11	1.7
Central line or pacemaker placement	8	1.2
Chronic liver disease/cirrhosis	7	1.1
IV drug abuse	6	<1
Pregnancy/puerperium (6 weeks post-partum)	<5	<1
Factor V Leiden	<5	<1
Antiphospholipid syndrome	<5	<1
Heparin induced thrombocytopaenia	<5	<1
Other	34	5.3

Answers may be multiple; n=647. Clinician questionnaire data

Previous venous thromboembolic episode

In 95/517 (18.4%) patients the current presentation with PE was not their first VTE episode. A previous episode of PE was more common than DVT (11.1% vs 8.4%; Table 3.3).

Table 3.3 Previous diagnosis of VTE

	Number of patients	%
Yes - deep vein thrombosis	38	7.4
Yes - pulmonary embolism	52	10.1
Yes - deep vein thrombosis & pulmonary embolism	5	1.0
Neither	422	81.6
Subtotal	**517**	
Unknown	9	
Total	**526**	

Case reviewer data

The time elapsed since the prior VTE diagnosis is shown in Table 3.4. In 65/82 (79.3%) patients the previous episode was more than 12 months prior to the current episode. In 12/82 (14.6%) patients the previous episode was less than 3 months prior. Nine of these 12 patients were documented as being on anticoagulants when they presented with the current episode of PE. No issues were raised by the case reviewers with respect to the dosing or duration of anticoagulation for these patients.

Table 3.4 Last episode of VTE

	Number of patients	%
≤3 months	12	14.6
>3-6 months	2	2.4
>6-9 months	1	1.2
>9-12 months	2	2.4
>12 months	65	79.3
Subtotal	**82**	
Unknown	13	
Total	**95**	

Case reviewer data

The large majority of patients who had a prior diagnosis of VTE had experienced a single prior episode (73/82; 89% (data not shown)). Where it could be determined, there was a near equal split of provoked and unprovoked episodes for the previous VTE. However, the more common finding was that the case reviewer could not determine if the previous VTE episode was provoked or unprovoked (Table 3.5). This finding was similar from clinicians reporting on the patients they cared for (42/132; 31.8% (data not shown)) cases. In the majority of cases it is possible to determine if a PE is provoked or unprovoked. This informs the duration of anticoagulation, as described in NICE Guideline CG144.[5]

Table 3.5 Previous VTE was provoked or unprovoked

	Number of patients	%
Provoked	28	29.5
Unprovoked	23	24.2
Not recorded	44	46.3
Total	**95**	

Case reviewer data

Anticoagulation at the time of this PE presentation

There were 79/494 (16%) patients on anticoagulation medication at the time of inclusion into the study. Prophylactic anticoagulation (48/494; 9.7%) was more common than therapeutic (31/494; 6.3%). The majority of patients (58/79; 73.4%) had not had a previous VTE episode (data not shown). The indications for anticoagulation in these patients was not recorded in the questionnaires.

Patients admitted for another condition (PE whilst an inpatient)

Patients admitted to hospital for another condition should be assessed for their risk of VTE during their initial clerking. Those assessed to be at risk of developing VTE should be started on appropriate prophylaxis either with anticoagulants or mechanical measures. In 20/47 (42.6%) cases reviewed the patient was not receiving anticoagulation and in 24 cases the case reviewers could not make a determination. Where a determination could be made the majority (25/47; 53.2%) were prescribed LMWH prophylactic dose anticoagulation with two receiving a therapeutic dose of an anticoagulant (Table 3.6).

Table 3.6 The patient was on anticoagulation prior to this episode (inpatient PE)

	Number of patients	%
Prophylactic	25	53.2
Therapeutic	2	4.3
Neither	20	42.6
Subtotal	**47**	
Unknown	24	
Total	**71**	

Case reviewer data

Patients presenting with symptoms of PE

Patients presenting with a new PE were prescribed ongoing anticoagulants at the time of their presentation in 42/396 (10.6%) cases reviewed, most commonly at a therapeutic dose (27/396; 6.8%)(Table 3.7). No assessment of whether outpatients were complying with their medication or inpatients received their anticoagulant could be made by the case reviewers.

Table 3.7 Patient was on anticoagulation prior to this episode (patients presenting with PE)

	Number of patients	%
Prophylactic	15	3.8
Therapeutic	27	6.8
Neither	354	89.4
Subtotal	**396**	
Unknown	24	
Total	**420**	

Case reviewer data

Case reviewers were of the opinion that ten patients were not on anticoagulation who should have been and that the dose of anticoagulation was incorrect in two patients.

Frailty scoring

The Rockwood Clinical Frailty Scale was originally validated in the assessment of frailty in those aged 65 years or older.[38] When used in this study population 214/521 (41.1%) patients with a PE diagnosis were under 65 years of age and of those 151/214 (70.6%) were managing well, were well or very fit. In those 65 years or older 144/307 (46.9%) were managing well, were well or very fit. In the sampled population, the majority of patients diagnosed with a PE had no or minimal functional impairment (Figure 3.2).

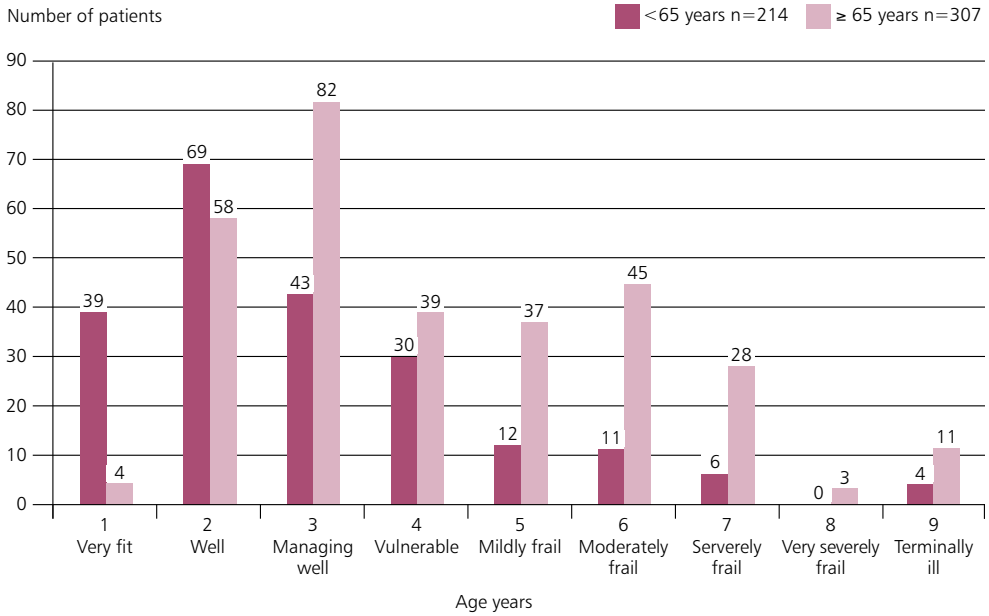

Figure 3.2 Rockwood clinical frailty score
Case reviewer data

Key Findings

19. The patient age distribution in this study sample was 20-100 years with a median of 69 years and a mode decile age range of 71-80 years
20. Active cancer (173/647; 26.7%), prior VTE (131/647; 20.2%), hospitalisation within the previous 6 weeks (123/647; 19.0%), obesity (109/647; 16.8%) and chronic lung disease (88/647; 13.6%) were the five most common comorbidities/risk factors for PE
21. In 95/517 (18.4 %) patients the current presentation with PE was not their first VTE episode
22. Overall a Rockwood Frailty score of 1-3 was recorded in 295/521 (56.5%) patients, meaning that in the sampled population, the majority of patients diagnosed with a PE had no or minimal functional impairment.

4

Presentation to hospital and initial assessment

The majority of patients (420/526; 79.8%) were a new admission to hospital with symptoms of pulmonary embolism (PE). The remaining group comprised 52/526 (9.9%) patients who had a PE as a complication of an admission for another condition and 54/526 (10.3%) patients whose PE was an incidental finding on imaging. Seventy-one patients who presented to hospital with symptoms of PE had a recent hospitalisation.

New admissions with a symptomatic PE

Prior to their admission 147/372 (39.5%) patients who presented with a symptomatic PE were known to have sought medical advice for their symptoms. For those where the question could be answered this included a General Practitioner (100/134; 74.6%). A further 28/134 (20.9%) patients had attended an emergency department previously and 14/134 (10.4%) had attended a deep vein thrombosis (DVT) clinic (Table 4.1).

Some patients had been seen twice before, underscoring the issue that PE can be hard to diagnose. Patients may have mild or non-specific symptoms and a high degree of clinical suspicion should be maintained.

Table 4.1 Prior medical advice sought for symptoms

	Number of patients	%
General practitioner	89	66.4
Emergency department	21	15.7
Deep vein thrombosis clinic	10	7.5
General practitioner/emergency department	7	5.2
General practitioner/deep vein thrombosis clinic	4	3.0
NHS 24/7 services	3	2.2
Subtotal	**134**	
Not answered	13	
Total	**147**	

Case reviewer data

Figure 4.1 shows that there was a daily demand on the service and Figure 4.2 overleaf, shows that patients were more likely to present in working hours irrespective of the day of the week.

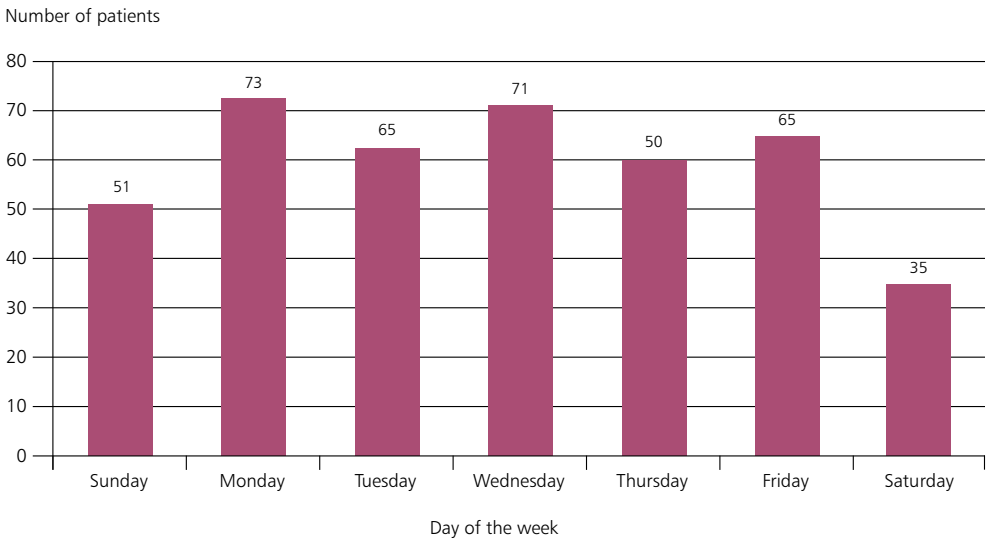

Figure 4.1 Day of the week of presentation (n=418)
Case reviewer data

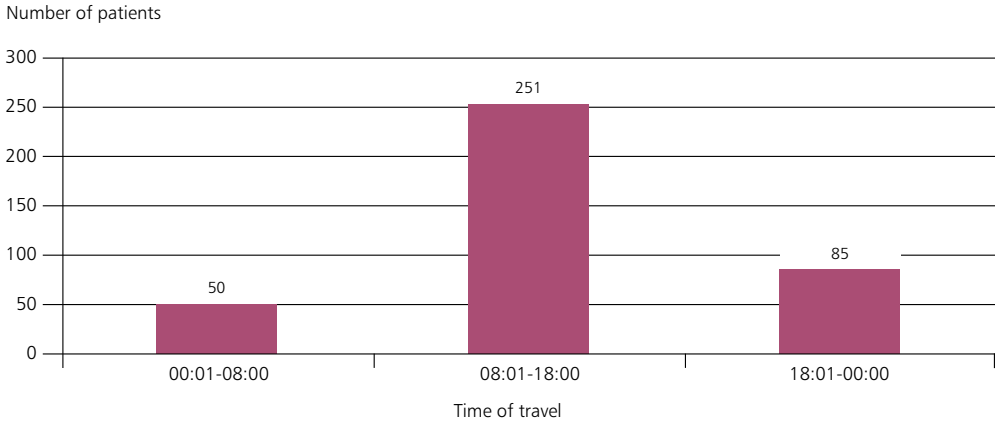

Figure 4.2 Time of day of presentation (n=386)
Case reviewer data

The case reviewers considered there was an avoidable delay in the patient presenting to the hospital in 91/335 (27.2%) patients with new symptoms of a PE. Despite the high rates of previous contact with medical services, in only 14/91 (15.4%) did the case reviewers identify a healthcare cause for the delay and the most common reason was the patient not going to the GP or the emergency department (61/91; 67.0%) (Table 4.2). Public awareness initiatives may help reduce the identified delays but as symptoms of PE are non-specific this may be more challenging than with similar initiatives such as those for myocardial infarction and stroke.

Table 4.2 An avoidable delay in presentation to hospital

	Number of patients	%
Yes	91	27.2
No	244	72.8
Subtotal	**335**	
Unknown	85	
Total	**420**	

Case reviewer data

The majority (251/415; 60.5%) of patients with symptoms of a PE self-presented and 108/415 (26%) were referred by their general practitioner (Table 4.3).

Table 4.3 Mode of presentation

	Number of patients	%
Self-presented	251	60.5
GP referral	108	26.0
Referred from outpatient clinic	23	5.5
Referred by radiology	11	2.7
Directly seen in ambulatory care	5	1.2
Other	17	4.1
Subtotal	**415**	
Unknown	5	
Total	**420**	

Case reviewer data

Hospital-related PE

A PE complicated an admission for another clinical condition in 83/621 (13.4%) patients (clinician questionnaire, data not shown). In 72/77 (93.5%) there was evidence in the medical or nursing records that a risk assessment for VTE was performed at admission.

The most common interventions to prevent PE in this group was a prophylactic dose of low molecular weight heparin (LMWH) in 57/72 (79.2%) patients and antithrombotic stockings in 23/72 (31.9%) patients. In five patients who

developed a PE during the same admission the clinical team stated that thromboprophylaxis was not indicated (Table 4.4). In two patients the intervention was not actioned as intended with one patient not receiving antithrombotic stockings and one missing a dose of LMWH.

Table 4.4 Intervention given

	Number of patients	%
Low molecular weight heparin	57	79.2
Anti-embolism stockings	23	31.9
Intermittent pneumatic compression	6	8.3
No thromboprohylaxis	5	6.9
IV heparin	2	2.8
Rivaroxaban	2	2.8
Fondaparinux sodium	1	1.4
Unknown	5	
Total	**420**	

Answers may be multiple; n=72. Clinician questionnaire data

Assessment and diagnostics

Symptoms

Shortness of breath and/or chest pain was a presenting symptom in 452/508 (89%) patients. Syncope or a fainting episode was a presenting feature in 54/508 (10.6%) and haemoptysis in 30/508 (5.9%) (Table 4.5).

Table 4.5 Presenting clinical symptoms

	Number of patients	%
Shortness of breath	390	76.8
Chest pain	234	46.1
Leg pain and/or swelling	103	20.3
Cough	70	13.8
Syncope/fainting	54	10.6
Haemoptysis	30	5.9
Panic /anxiety	15	3.0
Arm pain and/or swelling	4	0.8
Other	115	22.6

Answers may be multiple; n=508. Case reviewer data

The case reviewers identified delays in recognising the symptoms suggestive of PE in 79/509 (15.5%) patients.

The duration of the delay between the patient presenting to hospital and when their symptoms were recognised as possibly being due to a PE could be determined in 69/79 (87.3%) patients. The mean delay was 28.6 hours with a mode of 24 hours. In 22/69 (31.9%) patients the delay was longer than 24 hours (data not shown). A more likely alternative diagnosis was the reason given for the delay to diagnosis in 26/79 (32.9%) patients and five patients had atypical presentations. In 48/79 (60.8%) patients the case reviewers considered that an earlier diagnosis of PE should have been reached. In 37/79 (46.8%) patients symptoms or signs suggestive of PE were overlooked with this being attributed to review by a junior doctor (<ST3) in only 7. In 11/79 (13.9%) patients the combination of shortness of breath and an elevated troponin was attributed to acute coronary syndrome.

CASE STUDY 2

A middle-aged patient, who had a prior myocardial infarction, presented with chest pain. The patient was presumed to have an acute coronary syndrome (ACS) and received two ACS doses of fondaparinux (lower doses than are used in PE) but no further anticoagulation. No consultant review was recorded. Four days post admission the patient had a CT pulmonary angiogram which reported large pulmonary emboli and right heart strain. A decision was made to defer anticoagulation for 30 hours as the patient had received antiplatelet medication.

The case reviewers recognised an avoidable delay to diagnosis. They noted the absence of documented consultant-led care and the inconsistent and confused pharmacological management.

Clinical probability scores

(See Appendix 1 for descriptions)

For patients who present with a suspected PE, NICE CG144 recommends the use of a two level Wells PE score, supplemented by D-dimer testing in patients with an unlikely score.[5] The Geneva score and the revised Geneva score have also been validated as clinical probability scores for PE.[39] The YEARS algorithm, which is intended to reduce the number of CTPA examinations, was published after data collection for this study was underway.[40]

Despite the established NICE guidance, a PE clinical probability score could be identified in the notes in only 80/407 (19.7%) of the reviewed cases of patients presenting with symptoms of PE. Chapter 2 showed that 90.6% of hospitals described having a PE guideline which was the same as, or a modified version of, national guideline. In severely unwell patients calculation of a clinical probability score may be redundant because expedited imaging assessment is already planned, but this would not be sufficient to account for the 327/407 (80.3%) symptomatic patients who did not have a clinical probability score recorded (Table 4.6). Clinicians are largely not adhering to their organisational guidance in terms of the use or recording of a clinical probability score for PE.

Table 4.6 Documented clinical probability score for PE

	Number of patients	%
Yes	80	19.7
No	327	80.3
Subtotal	**407**	
Unknown	13	
Total	**420**	

Case reviewer data

Case reviewers retrospectively calculated a Wells PE Score for the 420 patients who presented to an emergency department with symptoms of a PE. The modified Wells criteria can be interpreted using a two-tier model (0-4 points PE unlikely, >4 points PE likely) or a three-tier model (low-risk of PE <2 points, moderate risk 2-6 points, high-risk >6 points) (Figure 4.3) The Wells score classified 177/387 (45.7%) patients who had a symptomatic PE as being unlikely to have a PE and requiring D-dimer testing using the NICE recommended interpretation. Case reviewers could see evidence that 108/169 (63.9%) (data not shown) of these patients had a D-dimer test requested. The D-dimer value was not recorded in the questionnaires.

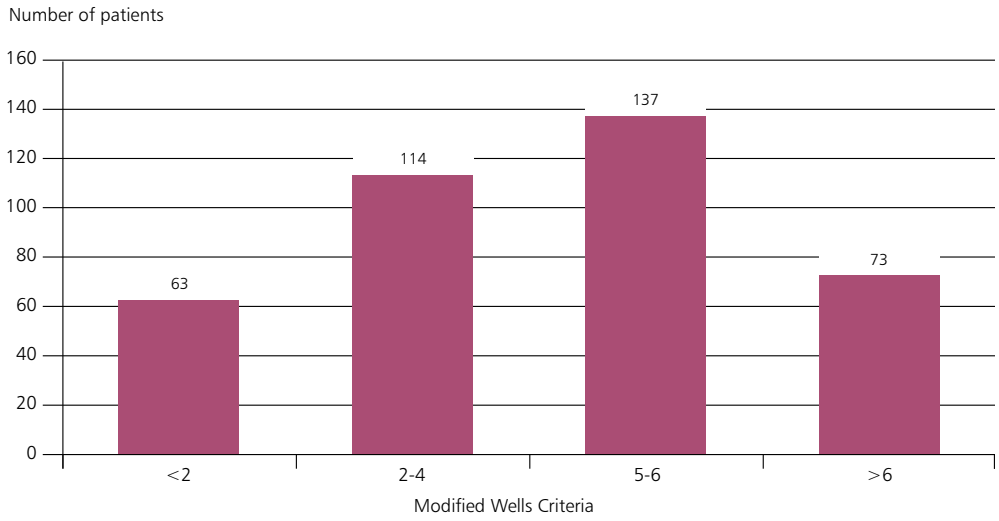

Figure 4.3 Modified Wells Criteria (n=387)

Case reviewer data

In the three-tier model the most common score was a moderate risk of PE score (251/387; 64.9%). In the three-tier model a D-dimer test would have been applied to 314/387 (81.1%) patients with 73/387 (18.9%) recommended for an immediate CTPA. There were 45/722 (6.2%) of the high-risk patients who had an unnecessary D-dimer test (data not shown) as it would not have altered their assessment or care.

A clinical probability score was more likely to be recorded in those at higher risk of PE with the highest rate of 29.2% (Figure 4.4).

CASE STUDY 3

An elderly patient with metastatic cancer presented following 3 days of breathlessness. An ECG showed right heart strain, a blood gas hypoxia and a D-dimer was >1000. A pulmonary embolism (PE) probability score was not recorded despite the D-dimer being requested. The only documented assessment was by a junior doctor who suspected pneumonia. PE was considered more likely at a delayed senior review. A dose of LMWH was prescribed but no patient weight was recorded to adjust the dose. A CTPA, which showed large central PEs, was performed 12 hours post admission. The patient arrested in the CT scanner and resuscitation was unsuccessful.

The case reviewers considered death at this time may have been avoided if senior review had been triggered by the initial findings. D-dimer assays should not be used in isolation as a screening test.

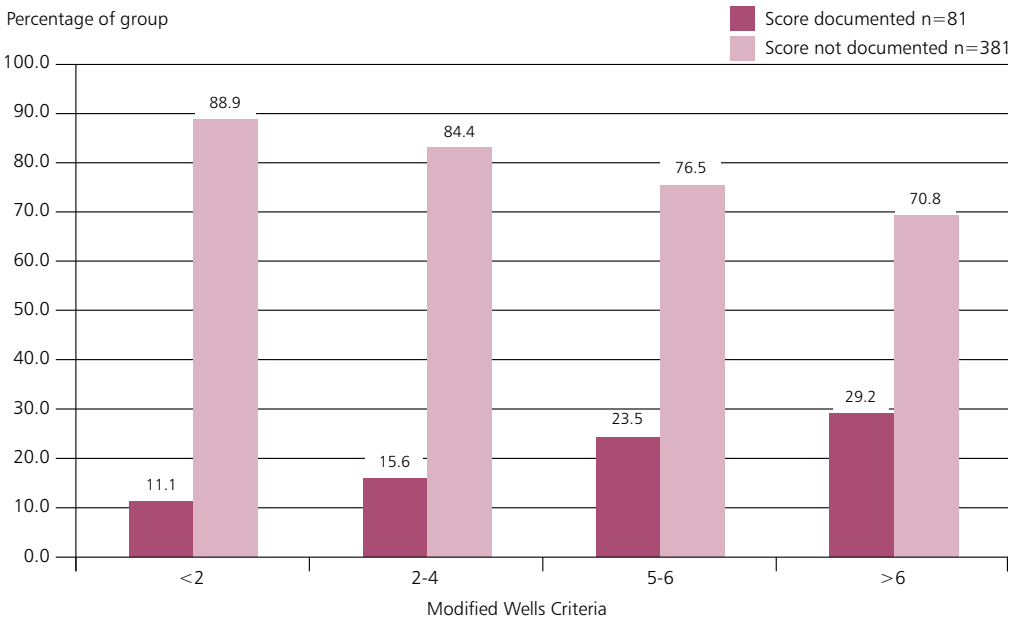

Figure 4.4 Documentation of the modified Wells criteria. (<2 n=63, 2-4 n=109, 5-6 n=132, >6 n=72)
Case reviewer data

Observations at presentation

As the patient sampling was not random in this study, the intentional selection of approximately a third of patients who died or required critical care could result in an over representation of those with haemodynamic impact (see Chapter 1). The patient's heart rate on the first set of observations at the time of presentation are shown in Figure 4.5. In 105/481 (21.8%) the heart rate was greater than 110bpm and in 185/481 (38.5%) greater than 100bpm.

Hypotension fulfilling one of the diagnostic criteria for massive PE (BP <90mmHg) was noted at presentation in 14/470 (3.0%) patients. A systolic blood pressure of less than 100mmHg was recorded in 40/470 (8.5%) patients (Figure 4.6).

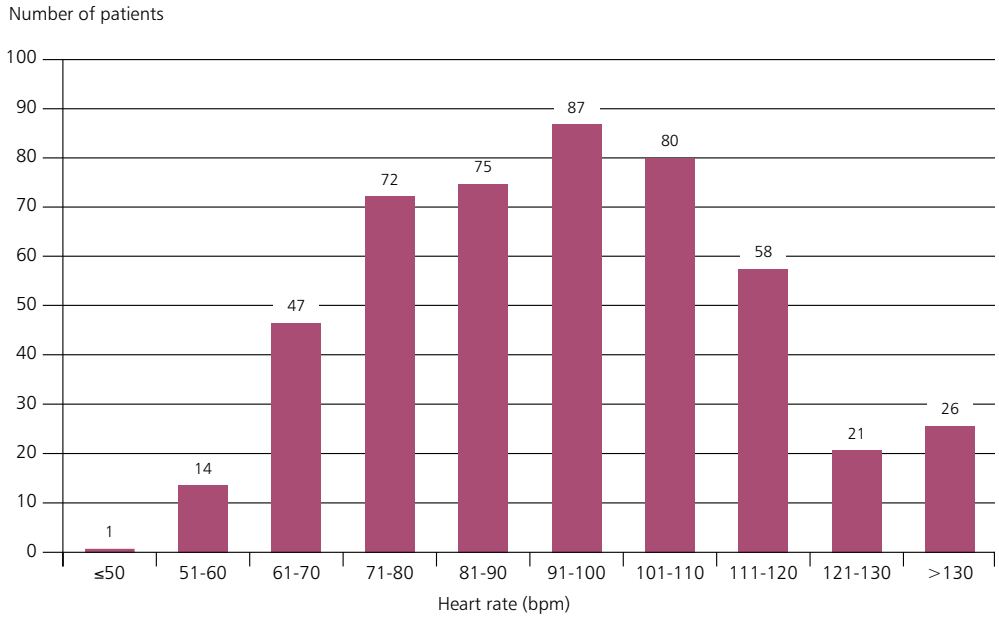

Figure 4.5 Heart rate at presentation (n=481)
Case reviewer data

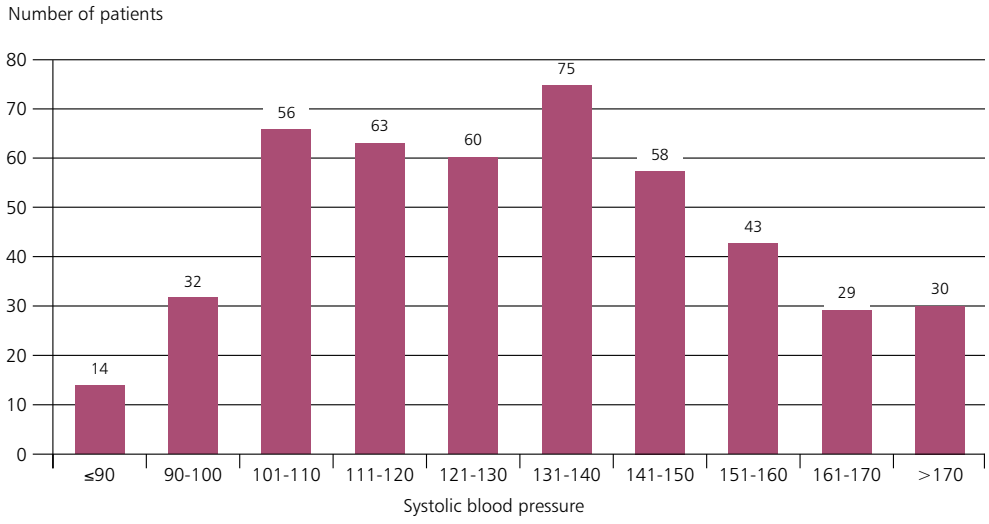

Figure 4.6 Systolic blood pressure at presentation (n=526)
Case reviewer data

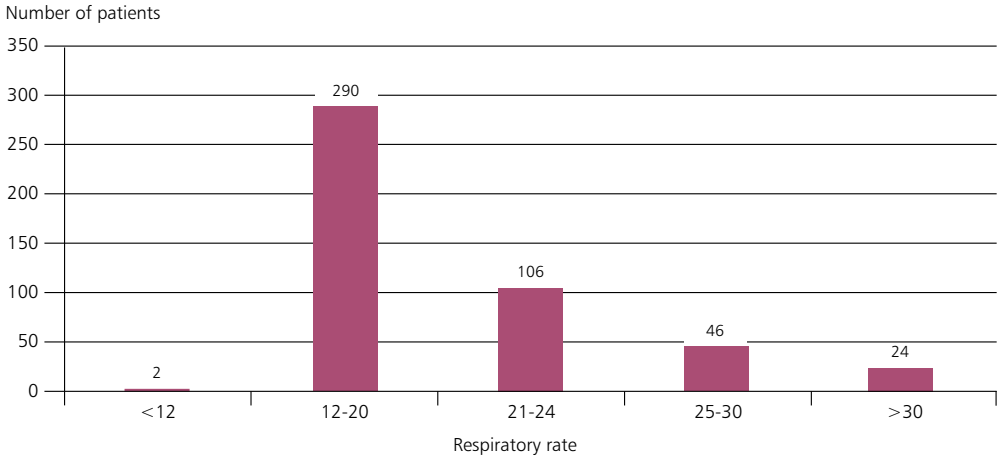

Figure 4.7 Respiratory rate at presentation (n=526)
Case reviewer data

Elevated respiratory rate (>20/minute) was present in 176/468 (37.6%) patients (Figure 4.7). A respiratory rate of 30/min or higher, which is one of the 11 scoring criteria in the Pulmonary Embolism Severity Index (PESI) was recorded in 24/468 (5.1%) patients (see Chapter 2).

Assessment

The appropriate specialities were involved for the individual patient's clinical presentation assessment and initial care in 413/450 (91.8%) in the view of the case reviewers. They were not involved in 37/450 (8.2%) and it was unknown in 76. Where speciality inputs were missing this was most commonly a respiratory or haematology review.

Initial Investigations

The investigations performed at the time of presentation with symptoms or incidental imaging diagnosis are shown in Table 4.7. A D-dimer was performed in 317/504 (62.9%) patients. This figure rose to 276/409 (67.5%) when just the symptomatic patients were considered.

Table 4.7 Investigations undertaken

	All patients n=504		Patients who presented with symptoms of PE n=409	
	Number of patients	%	Number of patients	%
Full blood count	425	84.3	358	87.5
Urea and electrolytes	422	83.7	356	87.0
ECG	406	80.6	342	83.6
Chest x-ray	387	76.8	322	78.7
D-dimer	317	62.9	276	67.5
Clotting screen	271	53.8	232	56.7
Blood gases	230	45.6	187	45.7
Troponin	204	40.5	175	42.8
Point of care ultrasound	37	7.3	29	7.1
Brain naturietic peptide /NT-proBNP	21	4.2	18	4.4
C-reactive protein	21	4.2	18	4.4
Lung function tests	18	3.6	15	3.7
Other	40	7.9	35	8.6

Case reviewer data

Table 4.8 Omission of initial investigations that should have been undertaken

	Case reviewer opinion		Clinician opinion	
	Number of patients	%	Number of patients	%
Yes	143	29.4	119	17.3
No	343	70.6	570	82.7
Subtotal	**486**		**689**	
Unknown	40		46	
Total	**526**		**735**	

A chest x-ray was performed in 387/504 (76.8%) patients. A chest x-ray is not mandatory when an immediate CTPA is planned based on clinical assessment and/or PE probability scoring. In that clinical context it adds no additional diagnostic information.

Initial investigations which might have altered management were not performed in 143/486 (29.4%) patients in the opinion of the case reviewers and in 119/689 (17.3%) patients in the view of the clinicians at the hospital (Table 4.8).

An arterial blood gas was the most common (49) single inappropriate omission that would have altered management in the opinion of the case reviewers (Table 4.9). Investigations which are usually used to diagnose sub-massive PE (point of care echocardiography 11) or assess the risk of sub-massive PE patients dying (troponin 41, BNP/NT-pro-BNP 15) were the next most common group.

Table 4.9 Investigations that were omitted

	n=
Blood gases	49
Troponin	43
Clotting screen	34
D-dimer	31
ECG	20
Chest x-ray	16
Brain naturietic peptide /NT-pro-BNP	15
Point of care ultrasound	11
Urea and electrolytes	6
Full blood count	5

Case reviewer data

Key Findings

23. 420/526 (79.8%) patients were a new admission to hospital with symptoms of PE
24. 147/420 (35%) of the patients who presented with symptomatic PE were known to have sought medical advice for their symptoms prior to the admission. In 100/134 (74.6%) this was solely, or included, a GP
25. The case reviewers considered there was an avoidable delay in the patient presenting to hospital in 91/335 (27.2%) patients with a symptomatic PE
26. The most common identified reason for delayed presentations was most common reason was the patient not going to the GP or the emergency department (61/91; 67.0%) although patients presented throughout the week
27. Shortness of breath and/or chest pain was a presenting symptom in 452/508 (89%) patients
28. Syncope or a fainting episode was a presenting feature in 54/508 (10.6%) and haemoptysis in 30/508 (5.9%) patients
29. The case reviewers identified delays in recognising the patient had symptoms suggestive of PE in 79/509 (15.5%) cases reviewed
30. A PE clinical probability score was documented in the notes for only 80/407 (19.7%) cases where the patient presented with symptoms of PE
31. Initial investigations which might have altered management were not performed in 143/486 (29.4%) patients in the opinion of the case reviewers and in 119/689 (17.3%) patients in the view of the clinicians at the hospital
32. In the opinion of the case reviewers, investigations which are usually used to diagnose sub-massive PE (point of care echocardiography) or assess the risk of sub-massive PE patients dying (troponin, BNP/NT-pro-BNP) were inappropriately omitted in 11/486 (2.3%), 41/486 (8.4%) and 15/486 (3.1%) patients.

5

Imaging

Imaging undertaken

NICE CG144 recommends an immediate CT pulmonary angiogram (CTPA) for a likely two-level Wells PE score or an unlikely Wells score with a positive D-dimer test. It recommends assessing the suitability of V/Q SPECT, or V/Q planar if not available, for patients with iodinated contrast allergy, who have renal impairment or whose risk from irradiation is high.[5] These direct tests for PE were performed in the majority of hospitals with CTPA the dominant test (430/484; 88.8%) and V/Q planar or V/Q SPECT in 12/484 (2.5%) (Table 5.1). NICE recommends imaging for either PE or DVT if patients have symptoms of both.

Table 5.1 Imaging undertaken

	Number of patients	%
CT pulmonary angiogram	430	88.8
Formal transthoracic echocardiogram	88	18.2
CT other	62	12.8
Ultrasound of the lower limb veins	40	8.3
Focussed (point of care) echocardiogram	27	5.6
V/Q planar/V/Q SPECT	12	2.5
Magnetic resonance imaging/ venography	2	0.4
Transoesophageal echocardiogram	4	0.8
Ultrasound of the upper limb veins	2	0.4

Answers may be multiple; n=484. Case reviewer data

The case reviewers identified investigations which should have been undertaken but were omitted in 48/453 (10.6%) patients (Table 5.2). Formal echocardiography accounted for 24/48 (50%) with some form of echocardiography in 33/48 (68.8%) patients. On-site formal transthoracic echocardiography was available in 166/169 (98.2%) hospitals. However this was only available 24 hours a day, 7 days a week in 37/166 (22.3%) hospitals. The omission of echocardiography may be due to failure to consider it or lack of access to on-site services when required.

Table 5.2 Omitted investigations

	Number of patients
Formal transthoracic echocardiogram	24
CT pulmonary angiogram	7
Ultrasound of the lower limb veins	6
Focused echocardiogram	7
Other	3

Case reviewer data

There were delays in carrying out investigations once PE was suspected in 86/505 (17%) patients (Figure 5.1). In 40% of patients the delay was more than 24 hours. The majority of delays related to the time it took for a CTPA scan to be undertaken (70/79; data not shown).

In 27/496 (5.4%) patients the case reviewers considered there was evidence of over-investigation; most commonly due to CT scanning of the abdomen/pelvis (ten patients; data not shown).

CT pulmonary angiogram report

The case reviewers had formal CTPA reports in the case notes of 349/430 (81.2%) patients. The site of pulmonary thrombus detailed in the reports are shown in Figure 5.2. The radiology report did not specify the site of thrombus in 11/344 (3.2%) patients. A central thrombus was reported in 87/333 (26.1%) patients.

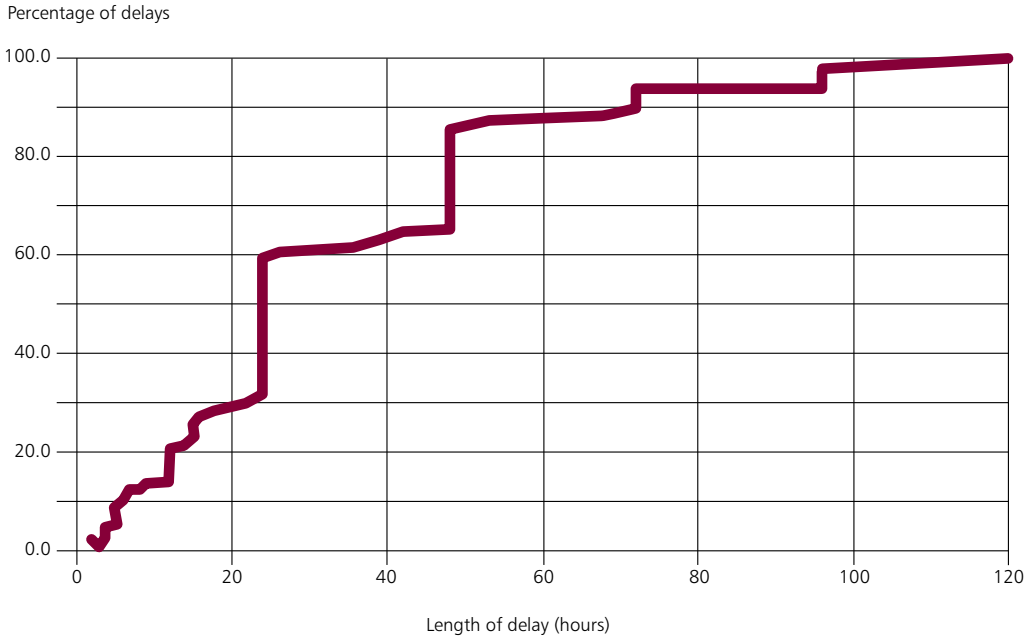

Figure 5.1 Delays to investigations
Case reviewer data

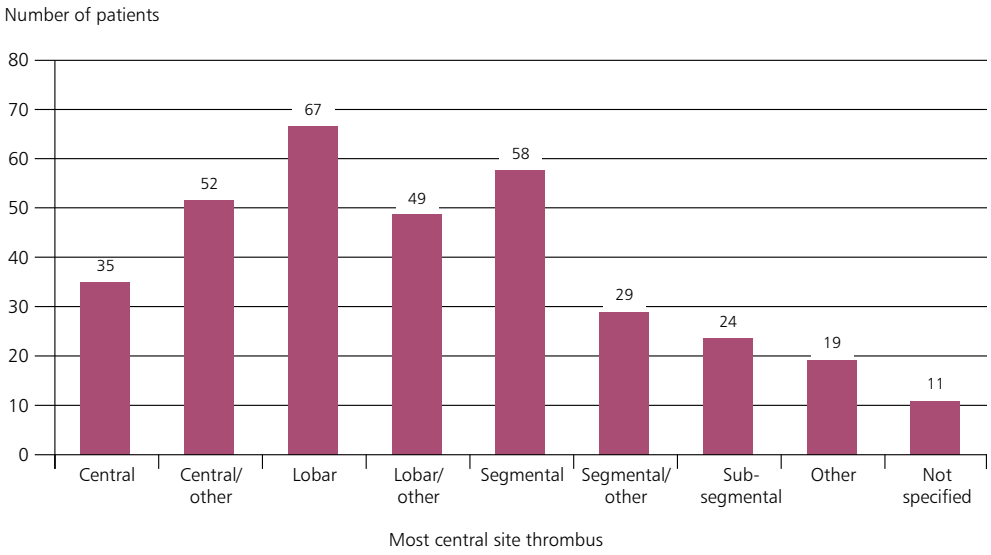

Figure 5.2 Most central site of thrombus (n=344)
Case reviewer data

The clinical significance of single or multiple emboli in the smaller segments of the lungs (sub-segmental emboli) is unclear. The 2016 American College of Chest Physicians Guideline suggests clinical surveillance in preference over anticoagulation for sub-segmental PEs and no evidence of proximal deep vein thrombosis (DVT) with a low-risk of recurrent VTE and anticoagulation in preference over clinical surveillance with a high risk of recurrent VTE.[13] In this study 24/333 (7.2%) patients were reported as having isolated sub-segmental thrombus.

The size of thrombus was much less consistently described. There is no consensus on how to assess and communicate the extent and impact of the blockage caused by the embolus/emboli in the pulmonary circulation or its relevance to clinical management. In 177/349 (50.7%) patients no comment was made on the thrombus burden. A comment on the size of PE was most likely to be made (84/147; 57.1%) in those where it was categorised as large (Figure 5.3).

In this study, which had a selection bias to include patients with more severe PEs, right heart strain (RHS) was identified in 93/333 (27.9%) patients (Table 5.3).

Table 5.3 Right heart strain

	Number of patients	%
Yes	93	27.9
No	115	34.5
No comment made	125	37.5
Subtotal	**333**	
Not answered	16	
Total	**349**	

Case reviewer data

There is no national guidance on what positive findings or pertinent negatives should be included in a CTPA report. It may be argued that those without a comment on the right heart were all small peripheral emboli unlikely to cause right heart strain or it is only relevant to report when right heart strain is present. The CT reports were reviewed to determine if this was the case.

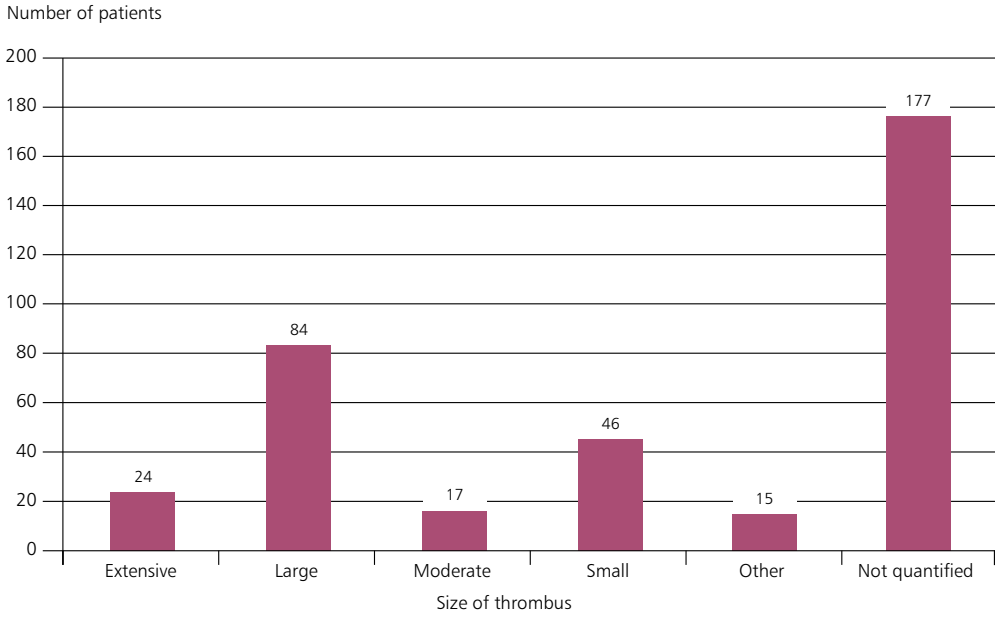

Figure 5.3 Size of thrombus (n=363)
Case reviewer data

There was a small increase in the presence of a comment on right heart strain in the CTPA report with more central PEs (Table 5.4).

Table 5.5 shows the size of thrombus vs evidence of right heart strain and whether a comment was made. When the PE was reported as 'large' a comment on the presence or absence of RHS was made in 42/58 (72.4%) reports. This was similar when the term extensive was used in the CTPA report. Reporters were more likely to comment on RHS signs (98/160; 61.3%) when no comment on thrombus size was made than when it was moderate or small.

The other chest findings on the CTPA included malignancy in 56/430 (13.0%) patients (ten patients had a new diagnosis of malignancy) and chronic lung disease in 27/430 (6.3%) patients (Table 5.6). In 33/430 (7.7%) the PE resulted in pulmonary parenchymal infarction which is more common in younger patients and is associated with a presentation with chest pain.[41]

The CTPA reported showed that the lungs were normal in three patients. Incidental findings requiring further assessment were reported in 35/349 (10.0%).

Table 5.4 Site of thrombus vs evidence of right heart strain and whether a comment was made

	Evidence of right heart strain (RHS)				
Site of thrombus	**Yes**	**No**	**No comment made**	**Total**	**% comment on RHS**
Central	36	20	24	80	70.0
Lobar	26	35	45	106	57.5
Segmental	16	34	30	80	62.5
Sub-segmental	2	9	8	19	57.9

Case reviewer data

Table 5.5 Size of thrombus vs evidence of right heart strain and whether a comment was made

	Evidence of right heart strain (RHS)					
Size of thrombus	**Yes**	**No**	**Subtotal**	**No comment made**	**Total**	**% comment on RHS**
Extensive	10	8	18	6	24	75.0
Large	42	16	58	20	78	74.4
Moderate	2	4	6	8	14	42.9
Small	3	15	18	26	44	40.9
Other	1	3	4	2	6	66.6
Not quantified	32	66	98	62	160	61.3
Total	**90**	**112**	**202**	**124**	**326**	

Case reviewer data

Table 5.6 Other chest findings on CTPA

	n=
Malignancy	63
Pulmonary parenchymal infarction	33
Infection	48
Chronic lung disease/bronchiectasis	44
Pleural effusion	37
Collapsed lung	35
Other	48

Answers may be multiple; n=430. Case reviewer data

Review of the quality of CTPA reports demonstrate inconsistency in how the findings were described. Case reviewers considered 179/346 (51.7%) to be less than good, including 33/346 (9.5%) which were graded as poor; most commonly due to the lack of comment on the right heart (30/33; 90.9%) including ten patients reported to have central or large PEs (Table 5.7).

Where a report was only rated as adequate and a reason was given (99/146; 67.8%) the most common concerns were a failure to comment on the right ventricle in 55/99 (55.6%) (including 16 patients with large PEs), no quantification of the size of PE in 32/99 (32.3%) and no comment on the site(s) of emboli in 22/99 (22.2%) (Figure 5.4). The reviewers considered that beyond the diagnosis of PE, a CTPA report should reliably guide the clinical management and trigger any additional indicated diagnostic tests, including further assessment of right heart strain.

Table 5.7 Assessment of the information provided in the CTPA report

	Number of patients	%
Good	167	48.3
Adequate	146	42.2
Poor	33	9.5
Subtotal	**346**	
Unknown	3	
Total	**349**	

Case reviewer data

The CTPA reports from the 15 hospitals in which a CTPA report proforma was used were less frequently categorised as poor (2/43; 4.7%: vs. 22/230; 9.6%) (data not shown).

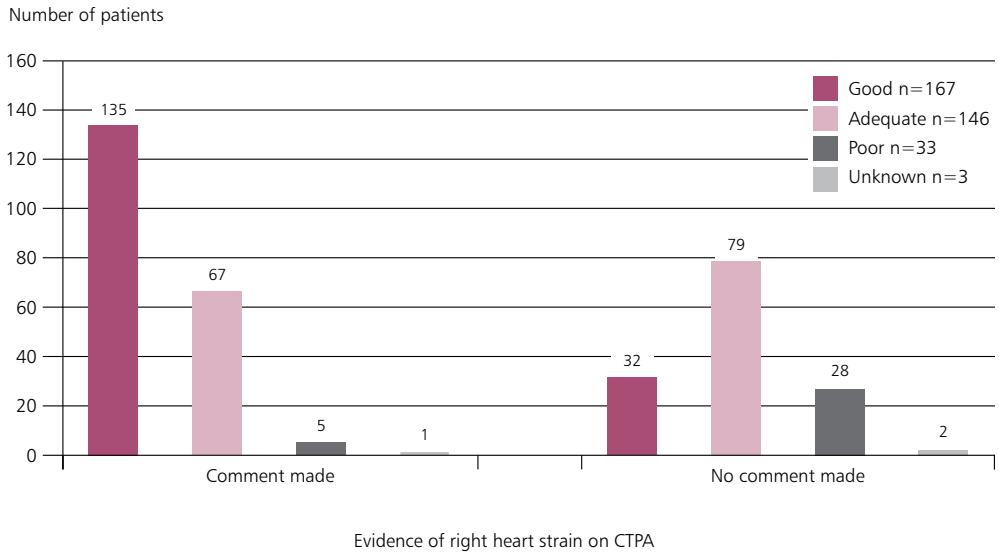

Figure 5.4 Case reviewer rating of the CTPA reports

Key Findings

33. The case reviewers identified omitted investigations which should have been undertaken in 48/453 (10.6%) patients. Formal echocardiography accounted for 24/48 (50%) of these with some form of echocardiography in 33/48 (68.8%)
34. There were delays in carrying out investigations once PE was suspected in 86/505 (17%) patients
35. The large majority of delays to investigations related to the time it took for a CTPA scan to be undertaken 70/79 (88.6%)
36. The radiology report did not specify the site of thrombus in 17/344 (4.9%) patients. A central thrombus was reported in 87/333 (26.1%) patients
37. In 177/349 (50.7%) CTPA reports no comment was made on the thrombus burden
38. Right heart strain was identified in 93/333 (27.9%) and 115/333 (34.5%) of reports commented on its absence. In 125/333 (37.5%) no comment was made on the right ventricle
39. There was a small increase in the presence of a comment on right heart strain in the CTPA report with more central PEs. The highest rate was 56/80 (70.0%) for those with central PEs
40. Case reviewers considered half of CTPA reports to be less than good (179/346; 51.7%), including 33/346 (9.5%) which were graded as poor; most commonly due to the lack of comment on the right heart (30/33; 90.9%)
41. Where a CTPA report was only rated as adequate and a reason was given (99/146; 67.8%) the most common concerns were a failure to comment on the right ventricle in 55/99 (55.6%).

6

Ambulatory care of the patient with pulmonary embolism

According to the Ambulatory Emergency Care (AEC) network ambulatory care is emerging as a pathway for the assessment and care of patients with suspected pulmonary embolism (PE). A new CQUIN emerging in England also supports this.[42] Patients are either cared for in a designated ambulatory care centre which can contribute to initial assessment, clinical probability scoring and diagnosis of PE or through an ambulatory pathway. The availability and use of PE severity and outcome prediction tools, used with clinical judgement after the confirmation of diagnosis, have helped in stratifying the risk of complications and death in patients diagnosed with acute PE, helping identify low-risk patients for ambulatory treatment. Those patients not suitable for ambulatory care would be admitted. The availability of newer oral anticoagulants, that do not require such close monitoring, has aided the use of ambulatory care pathways.

In this study 52/526 (9.9%) patients developed PE while they were inpatients in hospital for other reasons. Of the remaining patients who presented to hospital with clinical suspicion or incidental imaging diagnosis of PE, 77/461 (16.7%) were cared for on an ambulatory care pathway for all or part of their patient journey (Table 6.1).

Table 6.1 Ambulatory care pathway for all or part of this admission

	Number of patients	%
Yes	77	16.7
No	384	83.3
Subtotal	**461**	
Unknown	13	
Total	**474**	

Case reviewer data

Using the general principles of ambulatory care, based on the evidence available at the time of case identification (prior to the BTS guidelines), case reviewers were of the opinion that a further 43/366 (11.7%) patients could have benefitted from an ambulatory pathway (Table 6.2). Since this study was designed to select patients who had hospital stays of more than 3 days or who were escalated to higher care, it under-represented patients, relative to their coding prevalence, who were admitted for up to 3 days.

Table 6.2 The patient could have been on an ambulatory care pathway, if they were not already

	Number of patients	%
Yes	43	11.7
No	323	88.3
Subtotal	**366**	
Unknown	18	
Total	**384**	

Case reviewer data

Of the patients who should have been on an ambulatory care pathway 20/43 (46.5%) patients were clinically stable and 8/43 (18.6%) had a low PESI score and would have been suitable for ambulatory care. Reasons for not pursuing an ambulatory service included the lack of a service available (8/43), patients presenting outside of working hours (2/43) or refusing ambulatory care (1/43).

Of the 77 patients who were treated on an ambulatory pathway, 18/56 (32.1%), where it was answered, had evidence in the case notes that a formal method was used to select patients for ambulatory care. In 21 patients it was unknown. Furthermore case notes did not have details of the grade or specialty or the person accepting ambulatory referral in 30/78 (38.5%) patients. Where it was recorded it was most commonly a consultant or senior trainee (28/48; 58.3%) and the most common specialty was acute medicine (31/48; 64.6%).

CASE STUDY 4

A middle aged patient was called back to hospital after an incidental pulmonary embolism was diagnosed on CT scan of chest. On clinical assessment the patient was asymptomatic with normal examination but was admitted to hospital. The retrospectively calculated PESI score was 65, indicating very low-risk (class I) for morbidity and mortality.

Case reviewers were of the opinion that such an incidental PE should have been investigated and managed as an out-patient on an ambulatory pathway.

CASE STUDY 5

An elderly patient consulted their GP in a remote rural area for right sided chest pain and shortness of breath. The GP found both C-reactive protein and D-dimer to be elevated. The patient was prescribed antibiotics and administered a first dose of low molecular weight heparin. In ambulatory care the patient was assessed, a CT pulmonary angiogram was performed and reported and the patient discharged on a well-documented care pathway within 2 hours.

The case reviewers considered this to be an example of good, well-integrated primary and secondary care.

An initial set of observations should be recorded for all patients soon after they arrive in the ambulatory area. Table 6.3 shows that in 16/61 (26.2%) patients an early warning score was not documented.

Frail patients may not be suitable for ambulatory care even if their PE is determined to be low-risk. Of the 70 patients cared for on an ambulatory care pathway 14 had the higher Rockwood Frailty scores of 4-9 (Table 6.4).

Table 6.3 Documented early warning score (e.g. NEWS) on arrival in the ambulatory area/unit

	Number of patients	%
Yes	45	73.8
No	16	26.2
Subtotal	**61**	
Unknown	17	
Total	**78**	

Case reviewer data

Table 6.4 Rockwood Clinical Frailty score

Rockwood	Ambulatory	Inpatient	% Ambulatory
1-3	56	190	22.8
4-6	13	112	10.4
7-9	**1**	**36**	**2.7**
Total	**70**	**338**	**17.2**

Case reviewer data

Key Findings

42. 77/461 (16.7%) patients who presented to hospital with clinical suspicion of PE, were cared for on an ambulatory care pathway for all or part of their patient journey
43. Case reviewers were of the opinion that a further 43/366 (11.7%) patients could have benefitted from an ambulatory pathway
44. 18/56 (32.1%) patients had evidence that a formal method was used to select them for ambulatory care.

7

Severity of the pulmonary embolism

To estimate the risk of complications or death following a confirmed diagnosis of a pulmonary embolism (PE) it is important to assess the severity of the PE. The Pulmonary Embolism Severity Index (PESI), a simplified version (sPESI) and the Hestia criteria are some of the commonly used scoring tools (See Appendix 1). Using the PESI, low-risk patients can be considered for ambulatory care and high-risk patients should be admitted. Intermediate risk patients should be reviewed by a senior clinician because they may require a short stay in hospital. Patients recommended for ambulatory care following assessment using the scoring systems still remain at risk of adverse outcomes.

Assessment of severity

Case reviewers found no evidence of a formal assessment of PE severity in the majority of case notes reviewed (436/483; 90.3%) (Table 7.1). Similarly PE severity was not recorded in 456/559 (81.6%) patients in the view of the clinicians caring for the patient. This was despite organisational data reporting an available policy/guideline to assess the severity of PE in 144/179 (80.4%) hospitals.

Table 7.1 An assessment of the PE severity was undertaken

	Case reviewers		Clinicians	
	Number of patients	%	Number of patients	%
Yes	47	9.7	103	18.4
No	436	90.3	456	81.6
Subtotal	**483**		**559**	
Unknown	43		207	
Total	**526**		**766**	

Table 7.2 How the decision was made to admit the patient

	Number of patients	%
Clinical assessment	365	91.5
National Early Warning Score (NEWS)	48	12.0
Pulmonary Embolism Severity Index (PESI)	17	4.3
Simplified Pulmonary Embolism Severity Index (sPESI)	4	1.0
Hestia criteria	3	<1.0
Other	18	4.5
Subtotal	**399**	
Unknown	75	
Total	**474**	

Answers may be multiple; n=399 Case reviewer data

Decision to admit patient with a new presentation of a PE

In the 474 patients who had inpatient or ambulatory care (not including the 52 patients who developed a PE in hospital) it was found that clinical judgement was used for the basis of the decision to admit in 365/399 (91.5%) patients (Table 7.2). Risk assessment tools were used in 24/399 (6.0%) patients, with PESI being most frequently used (17/399; 4.3%). This conflicted with the organisational data in which it was reported that 94/144 (65.3%) hospitals listed a PESI score as being included in the guidance on PE management. The National Early Warning Score (NEWS) is a tool for early identification of clinical deterioration, with little evidence for its use to risk-stratify patients with acute PE yet it was used in 48/399 (12%) patients, usually with clinical assessment.

Retrospective PE severity calculation

Case reviewers retrospectively assessed the severity of PE in each case reviewed by calculating the PESI score, details of which are in Figure 7.1. There were 193 patients in the PESI low-risk groups (Class I and II), 133 patients in the intermediate-risk group (Class III) and 162 patients in the high-risk groups (Class IV and V).

Patients who developed an acute PE whilst in hospital had higher severity scores than those who presented to hospital with a PE (Figure 7.2), possibly due to the medical condition that resulted in their initial hospitalisation, or due to additional comorbidities and complications.

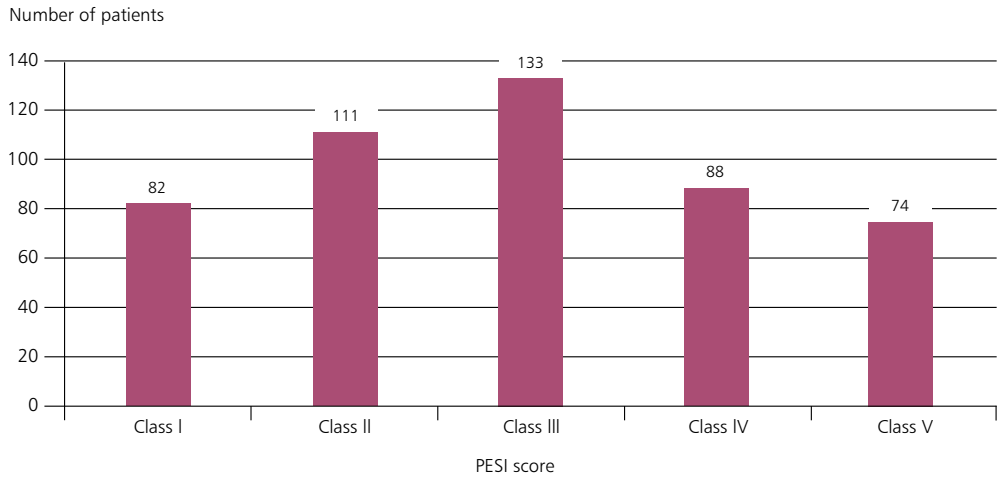

Figure 7.1 PESI score calculated by the case reviewers during peer review
Case reviewer data

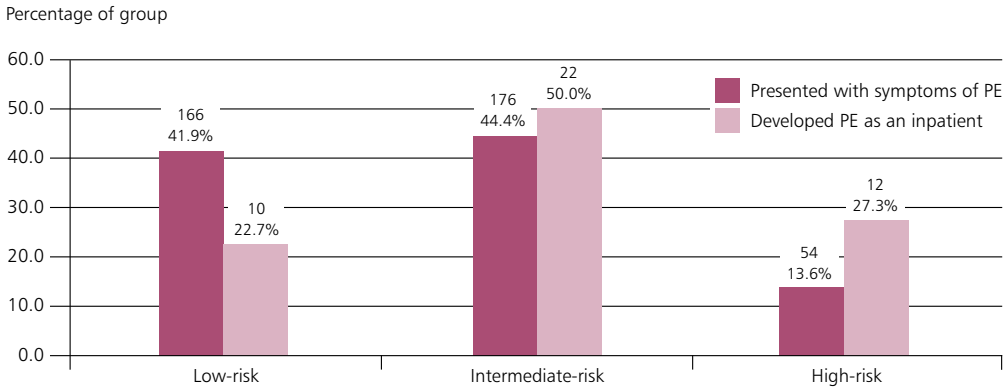

Figure 7.2 PESI score severity score by admission with or development of a PE in hospital
Case reviewer data

PE severity and location of care for patients admitted with a new PE

Based on retrospective PESI scoring in those patients who presented with symptoms of PE, 43/73 (58.9%) patients who were selected for ambulatory care were in the PESI low-risk group. However, 24/73 (32.9%) intermediate-risk and 6/73 (8.2%) high-risk patients, who should not have been recommended for ambulatory care, also received care on this pathway (Figure 7.3).

When considering the total number of patients who presented to hospital with a PE in the context of their retrospective PESI scores, 43/188 (22.9%) low-risk patients were treated on an ambulatory pathway, suggesting potential missed opportunities for the remaining 145/188 (77.1%) low-risk patients. Conversely, 24/214 (11.2%) patients with intermediate-risk and 6/74 (8.1%) with high-risk scores were ambulated, suggesting excessive risk-taking. It is possible that in some patients this decision was appropriate (for example, palliative or end of life care) but such a rationale was not documented, nor was there evidence of risk scoring using PESI or another system to justify the chosen pathway.

CASE STUDY 6

A young patient was referred by their GP with suspicion of pulmonary embolism. CT pulmonary angiogram (CTPA) was scheduled for the day after presentation, but anticoagulant therapy was not started until 12 hours after the CTPA report was received. There was no documentation of timing senior review or management plan.

Case reviewers were of the opinion that a clear investigation and management plan should have been documented and first dose of anticoagulant given promptly.

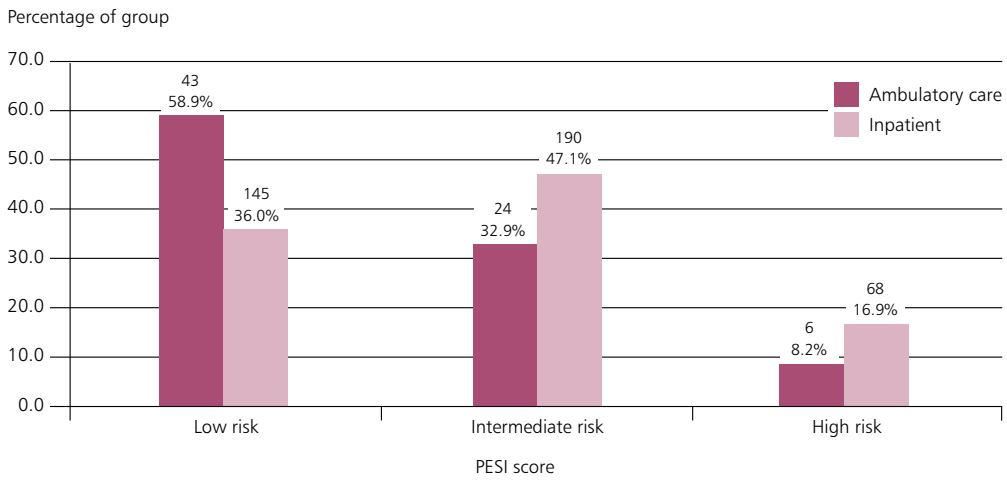

Figure 7.3 PESI severity score by ambulatory care pathway or inpatient admission
Case reviewer data

PE severity and outcome

As the study sample is not representative of the general PE population it is not possible to compare absolute mortality rates in each PESI class with those from epidemiological studies. However, a similar pattern of increasing mortality rates with increasing risk of severity was seen in this selected study population (7/193 (3.6%) in low-risk, 16/221 (7.2%) in intermediate-risk and 25/74 (33.8%) in high-risk patients) as is known to occur across patients with a Class I to Class V PESI score (Figure 7.4).

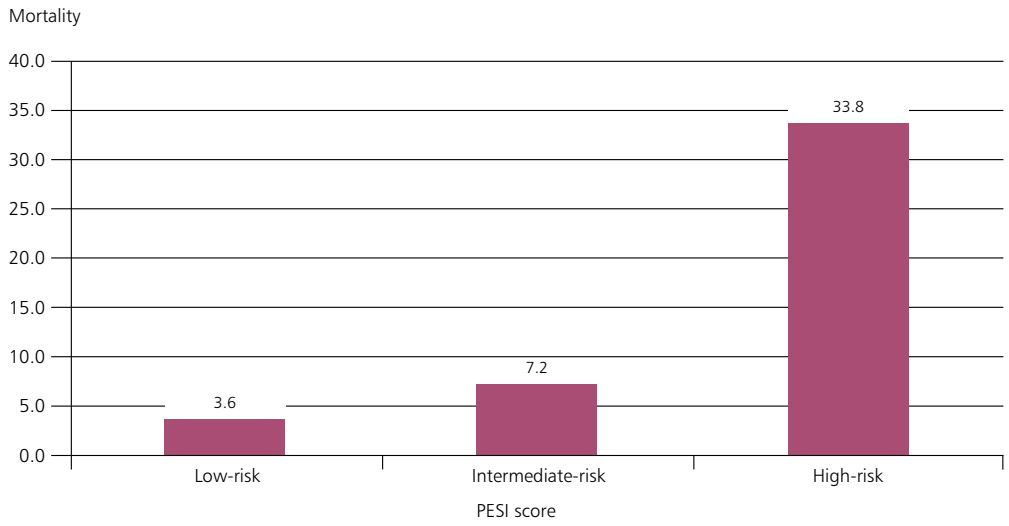

Figure 7.4 PESI score and mortality
Case reviewer data

Key Findings

45. Case reviewers found no evidence of a formal assessment of PE severity in 436/483 (90.3%) cases reviewed
46. Data from clinician questionnaires revealed that PE severity was not recorded in 456/559 (81.6%) patients
47. Retrospective calculation of PE severity by the case reviewers identified 194 patients in the PESI low-risk groups (Class I and II), 133 patients in the intermediate risk group (Class III) and 162 patients in the higher risk groups (Class IV and V)
48. 43/188 (22.9%) low-risk patients were treated on an ambulatory pathway, suggesting potential missed opportunities for the remaining 145/188 (77.1%) low-risk patients
49. 24/214 (11.2%) with intermediate risk and 6/74 (8.1%) with high-risk scores were ambulated, suggesting excessive risk-taking.

8

Treatment and escalation decisions

Acute pulmonary embolism (PE) is treated with anticoagulation, unless contraindicated. Weight adjusted low molecular weight heparin (LMWH) or a direct oral anticoagulant (DOAC) like rivaroxaban or apixaban are selected for their convenience, although unfractionated heparin (UFH) or fondaparinux are also used. Intravenous UFH is recommended in patients with advanced renal disease (glomerular filtration rate <30ml per minute) or if thrombolysis is being considered. Thereafter, ongoing treatment for PE is usually required for 3-6 months.

Historically, warfarin was the most commonly used anticoagulant used, but its efficacy can vary between patients and within the same patient depending on multiple factors such as diet, medications, alcohol and comorbidity. The dose of warfarin has to be titrated to achieve its optimal anticoagulant effect, which is assessed by measuring Prothrombin Time (PT) and expressed as International Normalised Ratio (INR). NICE guideline CG144 (June 2012) recommends a target INR of 2.5 (range 2.0 – 3.0).[5] Warfarin normally takes a few days to achieve its therapeutic effect, consequently patients with an acute PE require initiation of additional treatment with a rapidly acting anticoagulant to cover the time until warfarin is effective as described above.

Newer DOACs have become popular because they have a predictable anticoagulant effect and do not require regular monitoring. Except for edoxaban and dabigatran, they achieve therapeutic levels rapidly thus mitigating the need for bridging therapy with intravenous or LMWH. As DOACs are taken orally without monitoring patients are able to manage their medication and if considered suitable for ambulatory care, do not require admission to hospital. The British Thoracic Society outpatient guideline recommends the use of DOACs (with or without LMWH) over warfarin, if there are no contraindications.[6]

The majority of patients in this study were initially prescribed LMWH (446/517; 86.3%). Direct oral anticoagulants (DOAC) were the second most frequently prescribed initial anticoagulant (89/517; 17.2%) with oral apixaban (n=40) or rivaroxaban (n=37) being preferred. Warfarin was prescribed in 22/517 (4.3%) patients (Table 8.1).

Table 8.1 Initial anticoagulation given

	Number of patients	%
Low molecular weight heparin (LMWH)	446	86.3
Intravenous unfractionated heparin (UFH)	25	4.8
Direct oral anticoagulant (DOAC)	89	17.2
Warfarin	22	4.3
Fondaparinux	15	2.9

Answers may be multiple; n=517 Case reviewer data

Case reviewers were of the opinion that 36/468 (7.7%) patients received either an inappropriate dose (n=22) or an inappropriate anticoagulant (n=13) (Table 8.2).

Table 8.2 Correct treatments/doses of treatment were prescribed to this patient

	Number of patients	%
Yes	432	92.3
No	36	7.7
Subtotal	**468**	
Unknown	58	
Total	**526**	

Case reviewer data

The most common issue with anticoagulant dose arose because patients were not weighed before prescribing an anticoagulant like LMWH. The second issue with dosing was prescription of only a prophylactic dose of anticoagulant, which is significantly less than a treatment dose. There were also patients who were initially suspected to have acute coronary syndrome and prescribed an anticoagulant like fondaparinux, the dose of which is about a third of its dose for PE.

Analysis of comments regarding choice of anticoagulant revealed a lack of consideration of related illness or associated liver or kidney failure, where certain anticoagulants are not advised. The other concern was for patients with active cancer who were not administered heparin when acute PE was confirmed (data not shown). While there is some evidence to support use of DOACs in patients with active cancer, current guidelines recommend heparin as the anticoagulant of choice.

Treatment delays

Anticoagulation should be commenced as soon as possible after diagnosing acute PE and NICE QS29 recommends that the first dose of anticoagulation should be given to patients suspected to have acute PE if delay in confirmation of diagnosis is anticipated.[8] In this study, case reviewers were of the opinion that there was an avoidable delay in commencing treatment in 90/481 (18.7%) patients (Table 8.3).

Table 8.3 Avoidable delay in commencing treatment

	Number of patients	%
Yes	90	18.7
No	391	81.3
Subtotal	**481**	
Unknown	45	
Total	**526**	

Case reviewer data

More than half the cases of avoidable delay were either because an anticoagulant was not prescribed (44/90; 48.9%) and/or not administered (5/90; 5.6%) in this potentially life threatening condition (Table 8.4).

Table 8.4 Reasons for avoidable delay

	Number of patients	%
Delay in confirmatory scan or reporting	10	11.1
First dose anticoagulant not prescribed	44	48.9
Top up dose not added to anticoagulant prophylaxis	12	13.3
Anticoagulant prescribed but not administered	5	5.5
Alternative diagnosis considered	3	3.3
Awaiting senior review of report	4	4.4
Patient not attending GP or emergency department	2	2.2

Answers may be multiple: n=90 Case reviewer data

CASE STUDY 7

A middle aged patient was admitted early in the day with acute onset breathlessness. A CT pulmonary angiogram was requested after clinical assessment but the report confirming PE was not reviewed for the next 2 hours nor was the first dose of anticoagulation given, apparently awaiting senior review. The patient deteriorated over the next few hours and suffered a cardiac arrest from which they could not be resuscitated.

Case reviewers were of the opinion that the patient should have received their first dose of anticoagulation at initial assessment or at least soon after confirmation of diagnosis.

Table 8.5 Delays to treatment by pathway of care

	Avoidable delays to commencing any of the treatments			
	Yes	%	No	%
Ambulatory care	7	9.7	65	18.4
Inpatient	66	18.6	289	81.6

Case reviewer data

Avoidable delays were less common in the ambulatory care setting (9.7% vs 18.6%) (Table 8.5).

Treatment changes

Following confirmation of diagnosis of PE, 295/504 (58.5%) patients required a change of anticoagulant. Most patients changed from LMWH to DOACs (204/295; 69.2%) or warfarin (27/295; 9.2%) (Figure 8.1). LMWH was prescribed in 49/295 (16.6%) patients and UFH in 11/295 (3.7%) patients. This is indicated in sub-massive or massive PE (in anticipation of thrombolysis or another intervention), comorbid conditions like advanced renal failure, bleeding risk or the presence of active cancer.

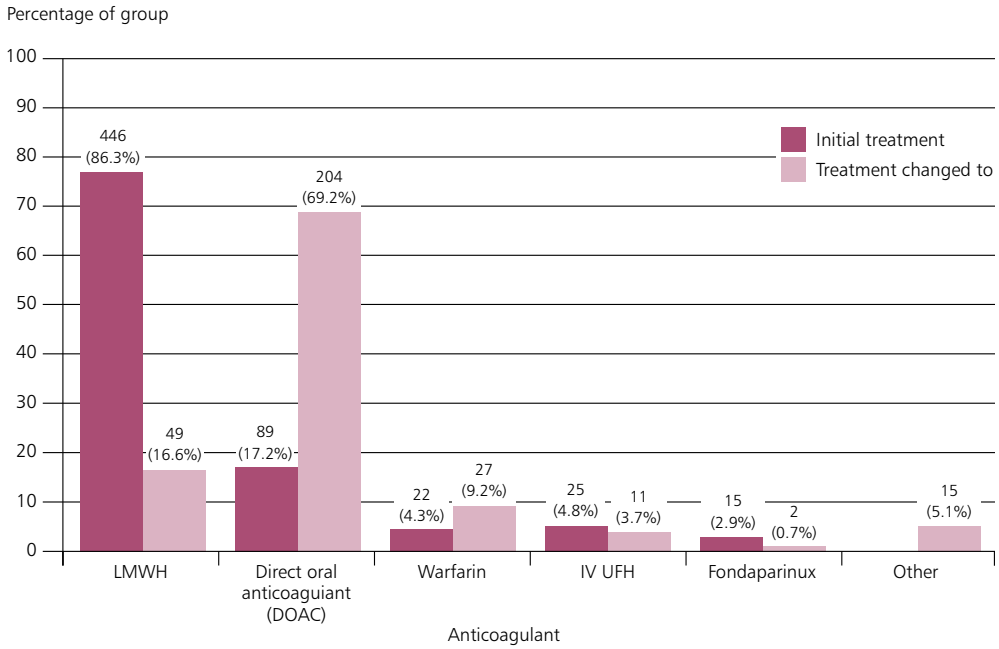

Figure 8.1 Anticoagulants prescribed initially and following a change. Initial treatment n=517 Changed to n=295

Case reviewer data

Treatment changes were required in five patients due to adverse effects (Table 8.6).

Table 8.6 Reason for the change in treatment

	Number of patients	%
Planned switch to oral	244	87.8
Clinical deterioration	32	11.5
Adverse effects	5	1.8
Other	3	1.1
Unknown	17	

Case reviewer data

CASE STUDY 8

An elderly patient collapsed while walking. On admission to hospital the patient received neither anticoagulation nor echocardiography assessment during a 4 hour wait for CT pulmonary angiogram which showed large central PEs with right heart strain. The patient was thrombolysed but received no anticoagulation for 18 hours thereafter.

This example reflected many cases reviewed where a failure to administer a first dose of anticoagulation prior to CTPA was identified and an under use of echocardiography in patients suspected to have large PEs. Following thrombolysis patients should receive anticoagulation.

Treatment escalation decisions

Following a patient's admission to hospital the treating clinician should document the investigation and management plan. Treatment plans should also include advice on further action if the patient's condition deteriorates, including details on decisions regarding the appropriateness, or not, of cardiopulmonary resuscitation (CPR). Such decisions should be taken in collaboration with the patient, their family and carers. Well written and timely treatment escalation plans help avoid unnecessary procedures and ensure prompt escalation of care, especially if clinical deterioration occurs out of working hours when the admitting team may not be available in the hospital.

There was no evidence of a treatment escalation plan in 211/386 (54.7%) patients (Table 8.7).

Table 8.7 A treatment escalation plan was made

	Number of patients	%
Yes	175	45.3
No	211	54.7
Subtotal	**386**	
Unknown	62	
Total	**448**	

Case reviewer data

In cases where a plan was documented, there was no evidence that it was discussed with the patient in 38/121 (31.4%) cases reviewed (Table 8.8). Good clinical practice recommends that the reasons for not discussing with the patient (or carers) should be documented when a treatment escalation plan is not created in collaboration with them. The reason for not involving the patient was recorded in 20/38 of the case notes.

Table 8.8 Escalation of treatment was discussed with the patient

	Number of patients	%
Yes	83	68.6
No	38	31.4
Subtotal	**121**	
Unknown	54	
Total	**175**	

Case reviewer data

Further interventions

Some patients with acute PE require additional interventions. This may be due to evidence of haemodynamic instability (massive PE), right heart strain (RHS) on the CT pulmonary angiogram with elevated biomarkers like troponin or BNP (sub-massive PE). Systemic thrombolysis is indicated for patients with massive PE and may also be appropriate for some patients with sub-massive PE.

CASE STUDY 9

A young patient was diagnosed with acute pulmonary embolism. Their CT pulmonary angiogram report included evidence of right heart strain, however this was not taken into account in the patient's management plan for the next 48 hours, when the patient had persistent shortness of breath and hypoxemia.

Case reviewers were of the opinion that evidence of RHS should have prompted further investigations (including biomarkers like BNP and troponin) and escalation to a higher level of care appropriate for sub-massive PE.

Anticoagulation may be contraindicated in some patients with PE due to the increased risk of bleeding. Such patients should be considered for insertion of an inferior vena cava (IVC) filter to prevent the movement of blood clots from the large deep veins in the lower limb or pelvic veins to the pulmonary circulation. IVC filters are also considered in patients who develop PE despite receiving appropriate and effective doses of anticoagulant. The majority of filters are inserted with the intention of removing them when clinically appropriate (temporary filters) or may be inserted with the intention of leaving them in place for life (permanent filters). It is important to plan for the removal of a temporary filter once it is not required.

Additional interventions were performed in 25/494 (5.6%) patients. The most common intervention was thrombolysis, with 22 patients receiving systemic thrombolytic therapy and one patient receiving catheter directed thrombolysis (Table 8.9).

Table 8.9 Additional interventions were undertaken

	Number of patients	%
Yes	25	5.1
No	469	94.9
Subtotal	**494**	
Unknown	32	
Total	**526**	

Case reviewer data

The reasons for systemic thrombolysis are summarised in Table 8.10. This included patients with evidence of massive PE (shock or cardiac arrest) appropriately received thrombolysis. The remaining patients met the criteria for sub-massive PE (RHS and hypoxia).

Table 8.10 Reasons for thrombolysis

	Number of patients
Shock (with or without right heart strain and/or hypoxia)	14
Right heart strain	4
Cardiac arrest	3
Hypoxia	1
Total	**22**

Case reviewer data

IVC filters were inserted in two patients, one for preventing further PE and the other because anticoagulation was contraindicated. Neither of the filters were considered inappropriate by the case reviewers.

Case reviewers identified 23/417 (5.5%) patients who would have benefitted from further interventions (Table 8.11). In their opinion, this included four patients with massive PE (who had shock), and 6 with sub-massive PE who had RHS and other concerning features, where catheter directed thrombolysis should have been considered. Another five patients would have benefitted from IVC filter insertion to prevent further PE (n=3) or because of high risk of anticoagulation (n=2).

Table 8.11 Patient would have benefitted from further interventions

	Number of patients	%
Yes	23	5.5
No	394	94.5
Subtotal	**417**	
Unknown	52	
Total	**469**	

Case reviewer data

CASE STUDY 10

An elderly patient with chronic obstructive pulmonary disease (COPD) was admitted with rectal bleeding. Compression stockings were applied. A CT angiogram to find the site of bleeding identified new PEs. An inferior vena cava filter insertion needed to be abandoned because the patient could not lie flat. No consultant physician or anaesthetic input was recorded. The patient died from multi-organ failure.

The case reviewers considered that the inferior vena cava filter insertion with anaesthetic support should have been considered.

Critical care admission

Patients with an acute PE requiring organ support, as well as those who are assessed to have a risk of clinical deterioration require higher levels of monitoring and care, including patients with evidence of a massive PE and some patients with sub-massive PE. This level of care may also be required for another clinical reason not directly related to the acute PE.

There were 74 patients in the study who were referred for critical care, 7 for a specialist procedure and 3 had their care escalated to another hospital (Table 8.12).

Case reviewers identified another 12 patients who should have been considered for escalation of care. The reasons for this opinion included history of transient episode of hypotension, evidence of sub-massive PE and other factors such as bleeding risk or systemic comorbidity.

Table 8.12 Escalation of care

	Number of patients	%
Critical care	74	5.5
Specialist procedure	7	94.5
Escalation to other hospital	3	
Other	18	
Total	**469**	

Case reviewer data

Critical care admissions by severity score (PESI)

The association between the retrospectively calculated PESI score and admission to critical care is shown in Figure 8.2. The PESI high-risk group formed the majority of admissions at 21/74 (28.4%), compared with 39/221 (17.6%) from the intermediate-risk group and 19/193 (9.8%) from the low-risk group.

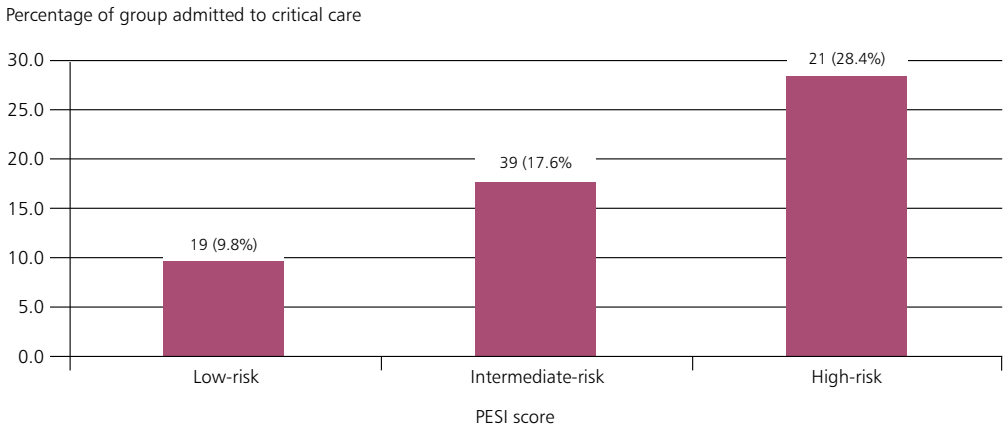

Figure 8.2 Admission to critical care by PESI score. Low risk n=193, intermediate risk n=221, high risk n=74
Case reviewer data

Critical care admissions by right heart strain on CT pulmonary angiography (CTPA)

Chapter 7 highlighted the importance of reporting the presence, or absence, of right heart strain (RHS) in CTPA reports positive for PE. In the 54 CTPA reports of patients admitted to critical care, the presence of RHS was reported in 28. Of the remaining 26 reports, 13 mentioned that RHS was not present and 13 made no comment on RHS. Conversely, 55 CTPA reports of the 242 patients not admitted to critical care had evidence of RHS (Figure 8.3). In the remaining cases 84 reported absence of RHS and 103 reports did not comment on it. This might reflect a lack of consideration of sub-massive PE by some radiologists and interpreting CTPA reports by some treating clinicians. Presence of RHS by itself does not require admission to critical care and some of the patients requiring escalation of care may have been for other reasons. Since sub-massive PE carries significant mortality and morbidity risk, this represents a missed opportunity.

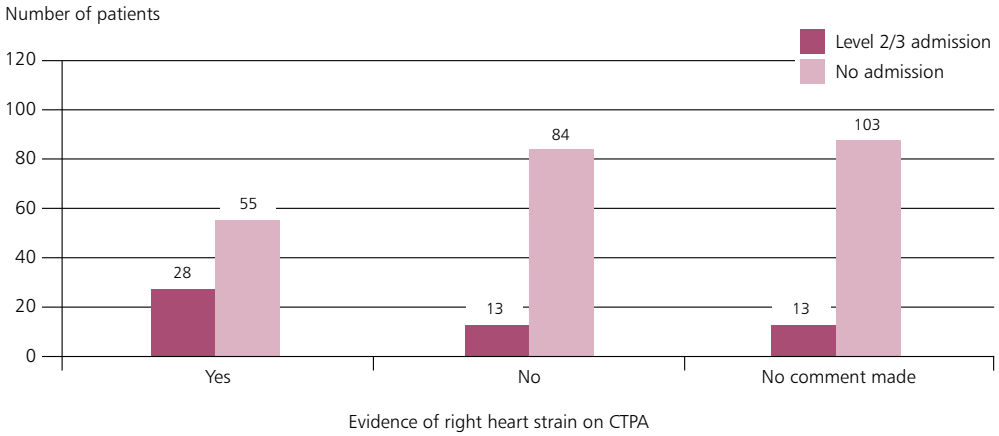

Figure 8.3 Critical care admission by evidence of right heart strain on the CTPA report
Case reviewer data

Key Findings

50. The majority of patients in this study were initially prescribed low molecular weight heparin (446/517; 86.3%)
51. Case reviewers were of the opinion that 36/468 (7.7%) patients received either an inappropriate dose (n=22) or an inappropriate anticoagulant (n=13)
52. Case reviewers were of the opinion that there was an avoidable delay in commencing treatment in 90/481 (18.7%) patients
53. More than half of the avoidable delays recorded were because an anticoagulant was not prescribed 44/90 (48.9%) and/or not administered 5/90 (5.6%)
54. Most patients were switched to direct oral anticoagulants (204/295; 69.2%) or warfarin (27/295; 9.2%)
55. There was no evidence of a treatment escalation plan for 211/386 (54.7%) patients
56. Additional interventions were performed in 25 patients. The most common intervention was thrombolysis, with 22 patients receiving systemic thrombolytic therapy and one patient receiving catheter directed thrombolysis
57. Case reviewers identified a further 23 patients (5.5%) who they felt would have benefitted from further interventions
58. 17.8% (80/449) inpatients were admitted to critical care. Case reviewers identified another 12 patients that should have been considered for escalation of care.

Clinical outcomes

Discharge destination

Most patients with acute PE respond to appropriate treatment and are fit for discharge from hospital in a few days. In this study population, 463/526 (88.0%) patients were discharged from hospital (Table 9.1).

The majority of patients were discharged home within a week, with 80/676 (11.8%) having a hospital stay of less than 24 hours (Figure 9.1).

Table 9.1 Discharge location

	Number of patients	%
Usual place of residence	433	82.3
Discharged to another hospital	17	3.2
Other residence e.g. family member	13	2.5
NA patient died in hospital	63	12.0
Total	**526**	

Case reviewer data

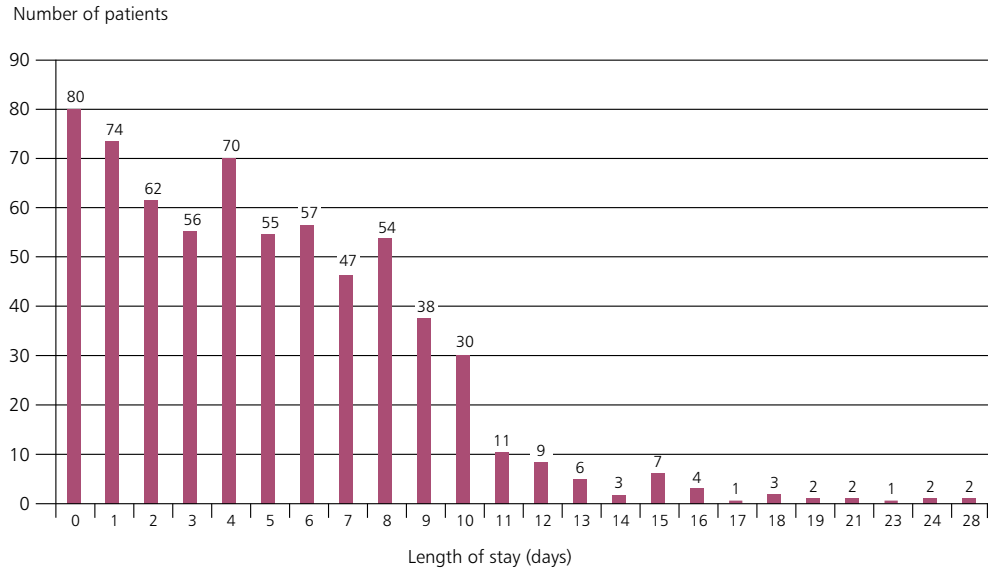

Figure 9.1 Length of hospital stay
Clinician questionnaire data

Discharge anticoagulation

The duration of anticoagulation after PE is dependent on the ongoing risk of PE recurrence. This needs to be balanced against the risk of bleeding and patient choice. The minimum duration of anticoagulation recommended by NICE and the British Thoracic Society is three months.[5,6] Patients should be reviewed at that stage to assess their ongoing and future risk of venous thromboembolism (VTE) and risk of bleeding. Those at higher risk require continuation of anticoagulation for another 3 months. Patients with unprovoked PE, recurrent PE or ongoing risk (for example active cancer) should be considered for lifelong anticoagulation.

Table 9.2 Discharge anticoagulation

	Number of patients	%
Direct oral anticoagulants (DOAC)	274	60.9
Low molecular weight heparin (LMWH)	124	27.6
Warfarin	33	7.3
Low molecular weight heparin/warfarin	8	1.8
Direct oral anticoagulants/other	<5	<1
Low molecular weight heparin/direct oral anticoagulant	<5	<1
Low molecular weight heparin/other	<5	<1
Other	<5	<1
None	<5	<1
Subtotal	**450**	
Unknown	13	
Total	**463**	

Case reviewer data

In this study 274/450 (60.9%) patients were discharged on direct oral anticoagulants (DOACs) and 33/450 (7.3%) on warfarin. The second largest group was patients on low molecular weight heparin (LMWH) (124/450; 27.6%). The remaining patients were discharged on combination therapy, usually with LMWH and warfarin or a DOAC (Table 9.2).

Case reviewers were of the opinion that the duration of anticoagulation was adequate in 343/380 (90.3%) patients, but not in 37/380 (9.7%) patients and unknown in 83 patients.

NICE CG144 recommends that patients receiving anticoagulation for VTE should be given verbal and written advice on discharge.[5] Organisational data showed that 112/167 (67.1%) hospitals provided specific information and education about PE, with 62 hospitals providing it at discharge. However, treating clinicians were unable to determine whether 336/600 (56.0%) patients were given this information. There was little difference between inpatients and ambulatory patients (Figure 9.2).

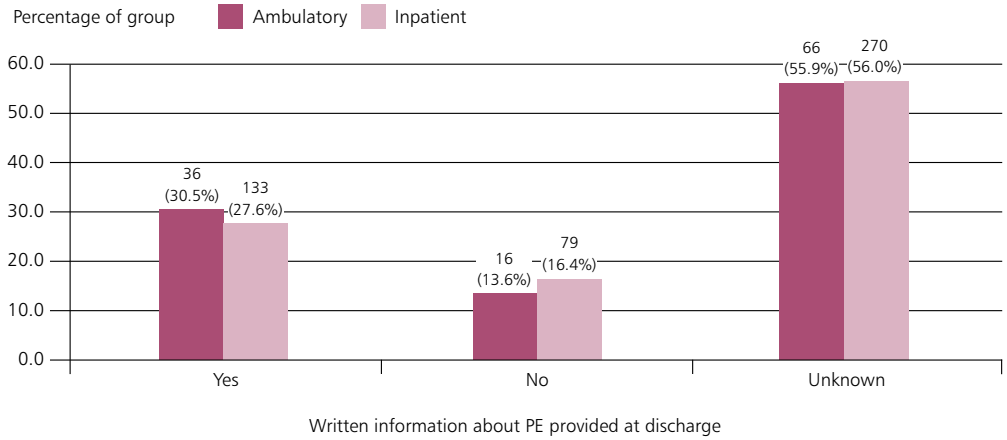

Figure 9.2 Written information about PE given to the patient at discharge
Clinician questionnaire data

Follow-up

After the acute episode of care for PE, patients are usually followed-up in a haematology or anticoagulation clinic. Patients may also be cared for by their GP or in the community by District Nurses, especially those on warfarin who need regular monitoring and dose adjustment. At discharge patients should have clear documentation that includes the likely cause of PE, dose of anticoagulant, target INR (if on warfarin) and intended duration of anticoagulation. It should also indicate if any further investigations are planned or required to be done by the GP.[5]

Follow-up was not organised for 56/399 (14.0%) patients (Table 9.3). Where case reviewers had adequate information to make an assessment they were of the opinion that follow-up was inadequate in 50/308 (16.2%) cases reviewed (Table 9.4).

The follow-up decision was assessed against the retrospective PESI scoring. Although the numbers are small there was no association between a follow-up appointment being offered to a patient and their PE severity (Table 9.5).

Table 9.3 Follow-up was arranged

	Number of patients	%
Yes	343	86.0
No	56	14.0
Subtotal	**399**	
Unknown	47	
Total	**446**	

Case reviewer data

Table 9.4 Follow-up arrangements were adequate

	Number of patients	%
Yes	258	83.8
No	50	16.2
Subtotal	**308**	
Unknown	101	
Total	**409**	

Case reviewer data

Table 9.5 Adequacy of follow-up vs PESI

	Adequate follow-up			
PESI	**Yes**	**No**	**% inadequate**	**Total**
Class I	45	10	18.2	**55**
Class II	59	8	11.9	**67**
Class III	78	13	14.3	**91**
Class IV	47	6	11.3	**53**
Class V	20	13	39.4	**33**

Case reviewer data

Case reviewers reported the most common reasons for inadequate follow-up were either lack of follow-up appointment (n=19) or it not being timely (n=11). The other reasons were lack of follow-up with haematology (n=16) or a relevant specialty (n=11) for further investigations relevant to the acute PE.

CASE STUDY 11

A young patient was admitted to hospital for treatment of traumatic fracture of their tibia and fibula following a road traffic accident. The patient developed a pulmonary embolism (PE) whilst in hospital and was started on a direct oral anticoagulant. The discharge letter outlined a plan for surgical follow-up but no follow-up for the PE. The letter did not provide any advice to the GP either.

Case reviewers were of the opinion that this discharge letter was inadequate as it should have had a follow-up plan in place for the treatment of the PE, including anticoagulation review.

Readmissions

There were 200/609 (32.8%) patients included in the study who were readmitted (Table 9.6). Where details of the cause of re-admission were available, PE related complications were responsible in 17/189 cases (9%), it was unknown for 11 patients.

Mortality

Data from clinician questionnaire revealed that 90 patients died following their presentation with acute PE. Their mortality in relation to length of hospital stay showed that 30/90 (33.3%) patients died in the first 72 hours, and 78/90 (86.7%) in the first 10 days (Figure 9.3).

Table 9.4 Follow-up arrangements were adequate

	Number of patients	%
Yes	258	83.8
No	50	16.2
Subtotal	**308**	
Unknown	101	
Total	**409**	

Case reviewer data

CASE STUDY 12

A middle aged patient with mental health issues on rivaroxaban for a first deep vein thrombosis (DVT) one week previously presented with shortness of breath having missed some anticoagulant doses. CT pulmonary angiogram showed pulmonary emboli without right heart strain. No family discussion or other strategies to improve compliance were documented. A third admission with DVT extension and a fourth with further PE followed.

The case reviewers were understanding of the challenges but considered that alternative treatment, such as family or nurse administered low molecular weight heparin, should have been considered and discussed with the patient.

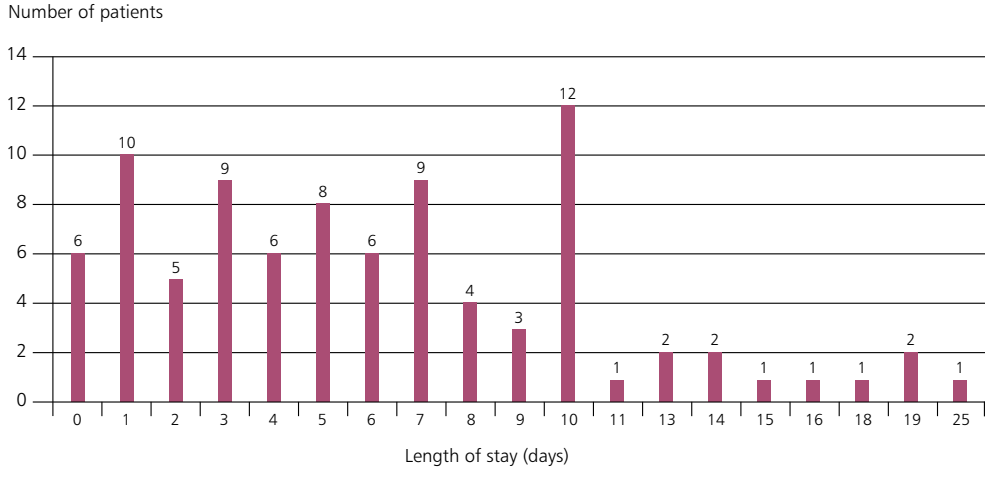

Figure 9.3 Length of hospital stay prior to death
Clinician questionnaire data

Data from the clinician questionnaires showed that PE was the primary cause of death in 40 patients. The second most frequent cause was metastatic cancer (14/90). Of the 40 patients where the cause of death was recorded as PE, 14 underwent thrombolysis and 19 were admitted to critical care (data not shown). This group also had 18 patients who did not go to critical care or undergo further interventions (such as thrombolysis).

Death was anticipated in 68/85 (80%) patients. Acute PE was the most common cause when death was not anticipated (10/17), the other causes being sepsis (n=2), metastatic cancer (n=2) and stroke (n=1).

Key Findings

59. Data from the clinician questionnaires showed that PE was the primary cause of death in 40 patients. The second most frequent cause was metastatic cancer (14/90)
60. Death was anticipated in 68/85 (80%) patients. Acute PE was the most common cause when death was not anticipated (10/17)
61. Case reviewers were of the opinion that the duration of discharge anticoagulation was adequate in 343/380 (90.3%) patients but not in 37 (9.7%) patients
62. Treating clinicians were unable to determine if patients were given verbal and written information regarding PE in 336/600 (56.0%) instances
63. Case reviewers were of the opinion that follow-up was inadequate for 50/308 (16.2%) patients where there was adequate information to make a determination
64. Analysis of data submitted within the clinician questionnaire showed that 200/609 (32.8%) patients were readmitted
65. Where details of the cause of readmission were available, PE-related complications were responsible in 17/189 (9%) cases reviewed.

Overall quality of care

Delays in the process of care

In the opinion of the case reviewers' 161/420 (38.3%) patients had one or more delays in their care and delays occurred at multiple stages for some patients (Figure 10.1). Analysis of the first delay was made with the assumption that patients had investigations before treatment, because a large number of patients had not received their first dose of anticoagulation prior to investigation. However, it is recognised that in patients with PE the need for early anticoagulation may take precedence over further investigation.

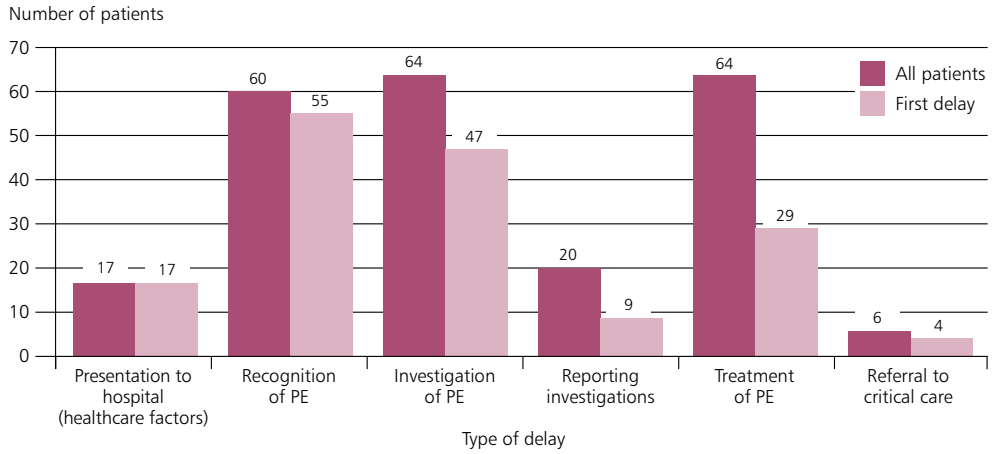

Figure 10.1 Type of delay (patient factors delaying presentation to hospital were not included)
Case reviewer data

Case reviewers assessed the overall quality of care as 'good practice' in 215/526 (40.9%) cases reviewed. There was room for improvement in clinical care in 257/526 (48.9%) cases and in the organisation of care in 15.4% (81/526).

The care provided was considered to have fallen below an acceptable standard in a number of areas (less than satisfactory) in 3.2% (17/526) cases. (Figure 10.2)

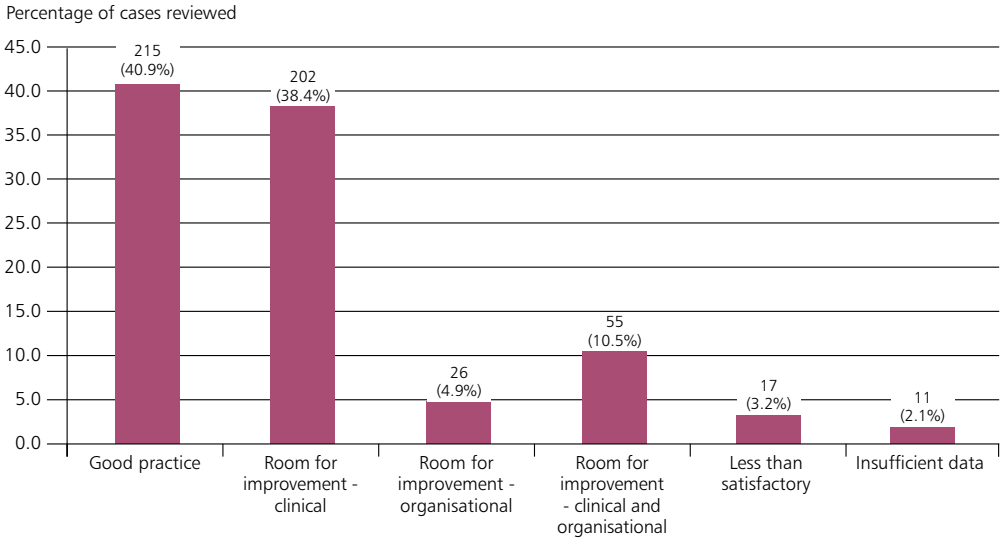

Figure 10.2 Overall quality of care
Case reviewer data

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Glossary

Term	Abbreviation	Definition
Commissioning for Quality and Innovation	CQUIN	This is a system introduced in 2009 to make a proportion of healthcare providers' income conditional on demonstrating improvements in quality and innovation in specified areas of care
AMB Score		If the Amb Score ≥ 5, it has a sensitivity of 92% in predicting discharge within 12 hours of assessment
Ambulatory care		Ambulatory care or outpatient care is medical care provided on an outpatient basis, including diagnosis, observation, consultation, treatment, intervention, and rehabilitation services. This care can include advanced medical technology and procedures even when provided outside of hospitals
Anticoagulants		Anticoagulants are medicines that help prevent blood clots
Apixaban		A type of anticoagulant
Brain-type natriuretic peptide	BNP/NTProBNP	Also known as B-type natriuretic peptide, is a hormone secreted in the heart ventricles in response to stretching caused by increased ventricular blood volume
Cardiogenic shock		This is a condition in which the heart suddenly can't pump enough blood to meet the body's needs. The condition is most often caused by a severe heart attack
Catheter directed treatments	CDT	This is a nonsurgical treatment for acute deep vein thrombosis (DVT) that dissolves blood clots
Clinical pulmonary embolism rule-out criteria	PERC	This rules out PE if no criteria are present and pre-test probability is ≤15%. The PERC rule can be applied to patients where the diagnosis of PE is being considered, but the patient is deemed low-risk – see Appendix 1
Clotting screen		This is a bundle of tests used to assess bleeding risk and monitor bleeding conditions
C-reactive protein	CRP	This is a marker for inflammation in the body. CRP is produced in the liver and its level is measured by testing the blood
CT pulmonary angiography/ angiogram	CTPA	This is a medical diagnostic test that uses computed tomography (CT) to obtain an image of the pulmonary arteries. CTPA was introduced in the 1990s as an alternative to V/Q SPECT ventilation/perfusion scanning (see below)

Term	Abbreviation	Definition
D-dimer		This is a small protein fragment present in the blood after a blood clot has broken down
Deep vein thrombosis	DVT	This is a blood clot that develops within a deep vein in the body, usually in the leg. DVT usually occurs in a deep leg vein, a larger vein that runs through the muscles of the calf and the thigh. It can cause pain and swelling in the leg and may lead to complications such as pulmonary embolism
Direct oral anticoagulant	DOAC	These are an alternative choice for blood clot treatment in appropriately selected patients. Unlike warfarin, DOACs do not require regular laboratory monitoring and are not affected by food or alcohol. However, DOACs tend to be more expensive than warfarin and are shorter acting, making it important not to miss any doses, as this can quickly expose patients to inadequate protection against blood clot formation. In addition, some DOACs require twice-daily dosing that, when compared to warfarin's once-per-day administration, may lead to more missed doses
Echocardiography/ echocardiogram		Often referred to as a cardiac echo or simply an echo, it is an ultrasound scan of the heart
Edaxoban		A type of anticoagulant
Embolism		This is the lodging of an embolus, a blockage-causing piece of material, inside a blood vessel. The embolus may be a blood clot (thrombus), a fat globule (fat embolism), a bubble of air or other gas (gas embolism), or foreign material
Fondaparinux		A type of anticoagulant
Geneva score		The Geneva score is a clinical prediction rule used in determining the pre-test probability of pulmonary embolism (PE) based on a patient's risk factors – see Appendix 1
Gestalt		A school of thought that believes all objects and scenes can be observed in their simplest forms. Sometimes referred to as the 'Law of Simplicity,' the theory proposes that the whole of an object or scene is more important than its individual parts
Hestia criteria		The Hestia Criteria for VTE evaluates a patient for recurrent VTE and suitability for outpatient treatment – see Appendix 1
Hypokinesis		Abnormally reduced muscular function or mobility
Inferior vena cava filters	IVC filters	These are designed to trap emboli from the leg or pelvic veins and stop them moving to the lung and causing a PE. IVC filters have been shown to reduce the mortality in massive PE. They are usually inserted via a groin or neck vein under local anaesthesia. Modern filters are generally of a design that are safe to leave in permanently but can be removed in a similar manner to their insertion if they are no longer required. IVC filters carry a small risk of IVC occlusion, inferior cava wall perforation or metallic fracture and embolisation which increases over time

Term	Abbreviation	Definition
Low molecular weight heparin	LMWH	This is a blood thinner derived from Unfractionated Heparin and is used to treat & prevent blood clots
MBRRACE-UK	MBRRACE-UK	MBRRACE-UK is national collaborative programme of work involving the surveillance and investigation of maternal deaths, stillbirths and infant deaths **https://www.npeu.ox.ac.uk/mbrrace-uk**
Mechanical thromectomy		This is a type of minimally-invasive procedure in which an interventional radiologist uses specialised equipment to remove a clot from a patient's artery
Myocardial necrosis		Death of heart tissue, following a myocardial infarction
National early warning score	NEWS	Now NEWS 2 is a tool developed by the Royal College of Physicians of London which improves the detection and response to clinical deterioration in adult patients
Point of care ultrasound	POCUS	This refers to the use of portable ultrasonography at a patient's bedside for diagnostic and therapeutic purposes
Prothrombin time	PT	This is a blood test that measures how long it takes blood to clot. A prothrombin time test can be used to check for bleeding problems. PT is also used to check whether medicine to prevent blood clots is working. A PT test may also be called an INR test
Pulmonary embolism	PE	This occurs when a blood clot gets lodged in an artery in the lung, blocking blood flow to part of the lung. Blood clots most often originate in the legs and travel up through the right side of the heart and into the lungs
Pulmonary embolism severity index	PESI/sPESI	This is a risk stratification tool that has been externally validated to determine the mortality and outcome of patients with newly diagnosed pulmonary embolism (PE). The PESI score determines clinical severity and can influence treatment setting for management of PE - see Appendix 1
Right heart strain	RHS	This is a medical finding of right ventricular dysfunction where the heart muscle of the right ventricle (RV) is deformed (see below)
Right ventricular dysfunction	RV	The muscle of the right ventricle is not pumping as efficiently as it should be
Shock		An altered level of consciousness, oliguria, or cool, clammy extremities
Surgical embolectomy		A type of surgery to remove a blood clot from inside an artery or vein
Systemic hypotension		Systolic pressure < 90 mmHg or a drop in systolic pressure of at least 40 mmHg for at least 15 min which is not caused by new onset arrhythmias

Term	Abbreviation	Definition
Thrombolysis/ Intravenous systemic thrombolysis		This is also known as thrombolytic therapy, is a treatment to dissolve dangerous clots in blood vessels, improve blood flow, and prevent damage to tissues and organs
Thromboprophylaxis		Prevention of a blood clot forming
Thrombus		A blood clot
Troponin		These are proteins in muscle fibres that help to regulate muscle contraction. There are three different troponins: skeletal muscle troponin and two heart muscle troponins. When there is damage to heart muscle, the heart muscle troponins are released into the blood
Venous thromboembolism/ thromboembolic disease	VTE	This is a condition in which a blood clot forms most often in the deep veins of the leg, groin or arm (known as deep vein thrombosis (DVT) and travels in the circulation, lodging in the lungs causing a pulmonary embolism
Single photon emission computed tomography ventilation/perfusion	(V/Q) planar	This is a blood test that measures how long it takes blood to clot. A prothrombin time test can be used to check for bleeding problems. PT is also used to check whether medicine to prevent blood clots is working. A PT test may also be called an INR test

Appendices

Appendix 1 – Tools for prognostic severity scoring of acute pulmonary embolism

Pulmonary Embolism Severity Index (PESI)

Predictor variable	Points
Age	Years
Male sex	+ 10
History of cancer	+ 30
History of heart failure	+ 10
History of chronic lung disease	+ 10
Pulse ≥ 110 beats/min	+ 20
Systolic blood pressure < 100 mm Hg	+ 30
Respiratory rate ≥ 30 breaths/min	+ 20
Temperature < 36 °C	+ 20
Altered mental status	+ 60
Arterial oxy-haemoglobin saturation (SaO2) < 90%	+ 20

A total point score for a given patient is obtained by summing the patient's age in years and the points for each predictor variable when present. The score corresponds with the following risk classes: ≤ 65 class I; 66–85 class II; 86–105 class III; 106–125 class IV; and > 125 class V. Patients in risk classes I and II are defined as low-risk.

Pulmonary Embolism Severity Index (PESI)

PESI Score	Class	Risk 30 day Mortality
0-65	I	0.0-1.6%
76-85	II	1.7-3.5%
86-105	III	3.2-7.1%
106-125	IV	4.0-11.4%
≥125	V	10-24.5%

Aujesky D, Obrosky DS, Stone RA, et al. Derivation and validation of a prognostic model for pulmonary embolism. Am J Respir Crit Care Med. 2005;172:1041–1046.

Simplified Pulmonary Embolism Severity Index (sPESI)

Variable	Points
Age > 80 years	1
History of cancer	1
History of chronic cardiopulmonary disease	1
Pulse ≥ 110 beats/min	1
Systolic blood pressure < 100 mm Hg	1
Arterial oxy-haemoglobin saturation (SaO2) < 90%	1

Sum the variable points to produce the total point score. The score corresponds with the following risk classes: 0, low-risk; ≥ 1, high-risk.

Jiménez D, Aujesky D, Moores L, et al. Simplification of the pulmonary embolism severity index for prognostication in patients with acute symptomatic pulmonary embolism. Arch Intern Med. 2010;170(15):1383–1389.

Hestia criteria

Variable
Hemodynamically unstable? (a)
Thrombolysis or embolectomy necessary?
Active bleeding or high risk of bleeding? (b)
Oxygen supply to maintain oxygen saturation > 90% for > 24 h?
Pulmonary embolism diagnosed during anticoagulant treatment?
Intravenous pain medication > 24 h?
Medical or social reason for treatment in the hospital > 24 h?
Creatinine clearance of < 30 mL/min? (c)
Severe liver impairment? (d)
Pregnant?
Documented history of heparin-induced thrombocytopenia?

If one of the questions is answered with YES, the patient cannot be treated at home.

(a) - Include the following criteria, but are left to the discretion of the investigator: systolic blood pressure < 100 mm Hg with heart rate > 100 beats per minute; condition requiring admission to an intensive care unit

(b) - Gastrointestinal bleeding in the preceding 14 days, recent stroke (< 4 weeks ago), recent operation (< 2 weeks ago), bleeding disorder or thrombocytopenia (platelet count < 75 × 109/L), uncontrolled hypertension (systolic blood pressure > 180 mm Hg or diastolic blood pressure > 110 mm Hg)

(c) - Calculated creatinine clearance according to the Cockcroft-Gault formula

(d) - Left to the discretion of the physician

Zondag W, Mos IC, Creemers-Schild D, et al. Outpatient treatment in patients with acute pulmonary embolism: the Hestia Study. J Thromb Haemost 2011; 9: 1500–1507.

PERC rule

The PERC rule is used to rule out pulmonary embolism in those patients where the clinical gestalt is that they are low-risk (ie <15% risk of pulmonary embolism).

Pulmonary embolism can be ruled out if none of the following features are identified:
Age ≥50 years
Heart rate ≥100 bpm
Oxygen saturation <95%
Hemoptysis
Estrogen use
Prior DVT or PE
Unilateral leg swelling
Surgery/trauma within the previous four weeks

In patients with a low pre-test probability of PE who meet any of these criteria, further testing could be considered to more definitely rule out pulmonary embolism.

Pauker SG, Kassirer JP. The threshold approach to clinical decision making. N Engl J Med. 1980;302:1109–17. doi: 10.1056/NEJM198005153022003.

Wells' Score

Clinical feature	Points
Active cancer (treatment ongoing, within 6 months, or palliative)	1
Paralysis, paresis or recent plaster immobilisation of the lower extremities	1
Recently bedridden for 3 days or more or major surgery within 12 weeks requiring general or regional anaesthesia	1
Localised tenderness along the distribution of the deep	+ 10
venous system	1
Entire leg swollen	1
Calf swelling at least 3 cm larger than asymptomatic side	1
Pitting oedema confined to the symptomatic leg	1
Collateral superficial veins (non-varicose)	1
Previously documented DVT	1
An alternative diagnosis is at least as likely as DVT	−2
Clinical probability simplified score	
DVT likely	2 points or more
DVT unlikely	1 point or less

Patient risk is determined to be "PE Unlikely" (0-4 points, 12.1% incidence of PE): consider high sensitivity D-dimer testing. If the dimer is negative consider stopping workup. If the dimer is positive consider CTA. Patient risk is determined to be "PE Likely" (>4 points, 37.1% incidence of PE): consider CTA testing.

Wells PS, Anderson DR, Bormanis J, et. al. Value of assessment of pretest probability of deep-vein thrombosis in clinical management. Lancet. 1997 Dec 20-27;350(9094):1795-8.

Appendix 2 – Participation

Trust/Health Board	No. of hospitals participating	No. of OQs received	No.of cases included	No. of CQs received	No. of sets of case notes received
Aintree Hospitals NHS Foundation Trust	1	1	6	6	6
Airedale NHS Foundation Trust	1	1	5	4	4
Aneurin Bevan University Health Board	3	0	13	7	3
Ashford & St Peter's Hospitals NHS Trust	2	2	7	7	7
Barking, Havering & Redbridge University Hospitals NHS Trust	2	2	7	7	7
Barnsley Hospital NHS Foundation Trust	1	1	3	2	1
Barts Health NHS Trust	4	4	21	2	1
Basildon & Thurrock University Hospitals NHS Foundation Trust	1	1	6	4	4
Bedford Hospital NHS Trust	1	1	6	4	3
Belfast Health and Social Care Trust	1	1	0	0	0
Betsi Cadwaladr University Local Health Board	3	3	16	5	3
Blackpool Teaching Hospitals NHS Foundation Trust	1	1	5	2	2
Bolton Hospital NHS Foundation Trust	1	1	5	5	5
Bradford Teaching Hospitals NHS Foundation Trust	1	1	3	3	3
Brighton and Sussex University Hospitals NHS Trust	2	2	12	12	12
Buckinghamshire Healthcare NHS Trust	1	1	5	4	5
Calderdale & Huddersfield NHS Foundation Trust	2	2	9	8	8
Cambridge University Hospitals NHS Foundation Trust	1	1	6	6	6
Cardiff and Vale University Health Board	2	2	10	7	10
Chelsea & Westminster NHS Foundation Trust	2	2	9	7	8
Chesterfield Royal Hospital NHS Foundation Trust	1	1	5	5	5
Countess of Chester Hospital NHS Foundation Trust	1	1	3	3	3
County Durham and Darlington NHS Foundation Trust	2	2	9	5	5
Croydon Health Services NHS Trust	1	1	5	5	5
Cwm Taf University Health Board	2	2	12	10	11
Doncaster and Bassetlaw Hospitals NHS Foundation Trust	2	1	11	10	8
Dorset County Hospital NHS Foundation Trust	1	1	6	6	6
East & North Hertfordshire NHS Trust	1	1	4	4	4
East Cheshire NHS Trust	1	0	1	0	0
East Kent Hospitals University NHS Foundation Trust	3	0	13	8	8
East Lancashire Hospitals NHS Trust	1	1	6	6	6
East Suffolk and North Essex NHS Foundation Trust (ESNEFT)	2	2	8	3	5
East Sussex Healthcare NHS Trust	2	2	10	10	10
Epsom and St Helier University Hospitals NHS Trust	2	0	11	3	1
Frimley Health NHS Foundation Trust	2	2	12	12	12
Gateshead Health NHS Foundation Trust	1	1	6	4	1
Gloucestershire Hospitals NHS Foundation Trust	2	2	11	5	5
Great Western Hospitals NHS Foundation Trust	1	1	6	6	6
Guy's & St Thomas' NHS Foundation Trust	2	2	10	8	10
Hampshire Hospitals NHS Foundation Trust	2	2	10	7	2
Harrogate and District NHS Foundation Trust	1	1	6	6	6
Hillingdon Hospitals NHS Foundation Trust	1	1	4	4	4

Trust/Health Board	No. of hospitals participating	No. of OQs received	No.of cases included	No. of CQs received	No. of sets of case notes received
Homerton University Hospital NHS Foundation Trust	1	1	0	0	0
Hull University Teaching Hospitals NHS Trust	2	2	10	10	10
Hywel Dda University Health Board	4	4	16	9	7
Imperial College Healthcare NHS Trust	3	3	15	10	10
Isle of Man Department of Health & Social Security	1	1	0	0	0
Isle of Wight NHS Trust	1	1	6	6	6
James Paget University Hospitals NHS Foundation Trust	1	1	6	6	0
Kettering General Hospital NHS Foundation Trust	1	1	4	2	2
King's College Hospital NHS Foundation Trust	2	2	10	8	8
Kingston Hospital NHS Foundation Trust	1	1	6	6	6
Lancashire Teaching Hospitals NHS Foundation Trust	2	0	10	4	3
Lewisham and Greenwich NHS Trust	1	1	0	0	0
Liverpool Heart and Chest Hospital NHS Trust	1	1	2	2	2
London North West University Healthcare NHS Trust	3	3	5	5	5
Luton and Dunstable Hospital NHS Foundation Trust	1	1	6	0	0
Maidstone and Tunbridge Wells NHS Trust	2	0	10	4	1
Manchester University NHS Foundation Trust	1	1	16	6	6
Medway NHS Foundation Trust	1	1	5	5	5
Mid Cheshire Hospitals NHS Foundation Trust	1	1	5	3	2
Mid Essex Hospitals NHS Trust	1	0	6	4	3
Mid Yorkshire Hospitals NHS Trust	1	1	12	5	12
Milton Keynes University Hospital NHS Foundation Trust	1	1	5	1	2
Newcastle upon Tyne Hospitals NHS Foundation Trust	2	2	6	3	5
NHS Grampian	2	2	6	2	NA
NHS Highland	2	0	7	2	1
NHS Lanarkshire	2	2	10	7	4
NHS Orkney	1	0	1	1	0
NHS Western Isles	1	0	2	2	1
Norfolk & Norwich University Hospital NHS Trust	1	1	6	5	6
North Bristol NHS Trust	1	1	6	5	6
North Cumbria University Hospitals NHS Trust	2	2	11	6	5
North Middlesex University Hospital NHS Trust	1	1	5	4	5
North Tees and Hartlepool NHS Foundation Trust	1	1	6	1	1
North West Anglia NHS Foundation Trust	2	2	11	9	10
Northampton General Hospital NHS Trust	1	1	6	6	6
Northern Devon Healthcare NHS Trust	1	1	6	6	6
Northern Lincolnshire & Goole NHS Foundation Trust	2	2	10	8	7
Northumbria Healthcare NHS Foundation Trust	1	1	13	7	4
Nottingham University Hospitals NHS Trust	1	1	10	8	8
Oxford University Hospitals NHS Foundation Trust	3	3	12	11	11
Papworth Hospital NHS Foundation Trust	1	1	0	0	0
Pennine Acute Hospitals NHS Trust	2	2	13	8	13
Poole Hospital NHS Foundation Trust	1	1	6	2	2

Trust/Health Board	No. of hospitals participating	No. of OQs received	No.of cases included	No. of CQs received	No. of sets of case notes received
Portsmouth Hospitals NHS Trust	1	1	6	2	2
Rotherham NHS Foundation Trust	1	1	4	4	4
Royal Berkshire NHS Foundation Trust	1	1	6	6	6
Royal Bournemouth and Christchurch Hospitals NHS Foundation Trust	1	1	5	5	5
Royal Cornwall Hospitals NHS Trust	1	1	2	1	1
Royal Devon and Exeter NHS Foundation Trust	1	1	6	6	6
Royal Free London NHS Foundation Trust	2	2	12	11	11
Royal Liverpool & Broadgreen University Hospitals NHS Trust	1	1	4	4	4
Royal Surrey County Hospital NHS Trust	1	1	6	5	6
Royal United Hospitals Bath NHS Foundation Trust	1	1	5	5	5
Salford Royal Hospitals NHS Foundation Trust	1	1	5	2	1
Salisbury NHS Foundation Trust	1	1	4	4	4
Sandwell and West Birmingham Hospitals NHS Trust	2	2	11	8	8
Sheffield Teaching Hospitals NHS Foundation Trust	2	2	10	9	10
Sherwood Forest Hospitals NHS Foundation Trust	1	1	6	6	6
Shrewsbury and Telford Hospitals NHS Trust	1	1	11	10	11
South Eastern Health & Social Care Trust	3	3	5	3	2
South Tees Hospitals NHS Foundation Trust	2	2	7	7	7
South Tyneside and Sunderland NHS Foundation Trust	2	2	10	9	9
South Warwickshire NHS Foundation Trust	1	1	4	4	4
Southend University Hospital NHS Foundation Trust	1	1	5	5	5
Southern Health & Social Care Trust	2	2	5	4	5
Southport & Ormskirk Hospitals NHS Trust	1	0	6	2	5
St George's University Hospitals NHS Foundation Trust	1	1	4	4	4
St Helens and Knowsley Teaching Hospitals NHS Trust	1	1	6	6	6
States of Guernsey Committee for Health & Social Care	1	1	2	2	1
States of Jersey Health & Social Services	1	1	4	3	3
Stockport NHS Foundation Trust	1	1	4	1	3
Surrey & Sussex Healthcare NHS Trust	1	0	6	6	6
Swansea Bay University Local Health Board	3	3	6	6	6
Tameside and Glossop Integrated Care NHS Foundation Trust	1	1	4	4	4
Taunton & Somerset NHS Foundation Trust	1	1	6	5	4
The Christie NHS Foundation Trust	1	0	6	3	1
The Clatterbridge Cancer Centre NHS Foundation Trust	1	0	3	3	3
The Dudley Group NHS Foundation Trust	1	1	6	5	5
The Leeds Teaching Hospitals NHS Trust	1	1	11	4	2
The Princess Alexandra Hospital NHS Trust	1	1	6	6	6
The Queen Elizabeth Hospital King's Lynn NHS Foundation Trust	1	0	6	2	0
The Royal Marsden NHS Foundation Trust	2	2	4	2	1
The Royal Wolverhampton Hospitals NHS Trust	1	1	6	2	6
The University Hospitals of the North Midlands NHS Trust	2	2	10	8	10
Torbay and South Devon NHS Foundation Trust	1	1	5	3	1
United Lincolnshire Hospitals NHS Trust	3	3	16	16	16

Trust/Health Board	No. of hospitals participating	No. of OQs received	No.of cases included	No. of CQs received	No. of sets of case notes received
University College London Hospitals NHS Foundation Trust	1	1	3	3	3
University Hospital Southampton NHS Foundation Trust	1	1	6	6	6
University Hospitals Birmingham NHS Foundation Trust	2	2	22	22	21
University Hospitals Coventry and Warwickshire NHS Trust	1	1	6	5	6
University Hospitals of Bristol NHS Foundation Trust	1	1	9	2	0
University Hospitals of Derby and Burton NHS Foundation Trust	2	2	11	11	11
University Hospitals of Leicester NHS Trust	3	1	16	9	10
University Hospitals of Morecambe Bay NHS Trust	2	2	11	9	9
University Hospitals Plymouth NHS Trust	1	1	6	5	6
Walsall Healthcare NHS Trust	1	1	4	3	3
Warrington & Halton Hospitals NHS Foundation Trust	1	1	3	3	3
West Hertfordshire Hospitals NHS Trust	1	1	3	3	3
West Suffolk NHS Foundation Trust	1	1	5	4	5
Western Health & Social Care Trust	1	1	4	1	1
Western Sussex Hospitals NHS Foundation Trust	2	2	9	9	9
Whittington Health NHS Trust	1	1	3	3	3
Worcestershire Acute Hospitals NHS Trust	2	2	12	12	12
Wrightington, Wigan & Leigh NHS Foundation Trust	1	1	4	3	4
Wye Valley NHS Trust	1	1	0	0	0
Yeovil District Hospital NHS Foundation Trust	1	1	3	3	3
York Teaching Hospital NHS Foundation Trust	1	1	12	8	7

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