1 Introduction and Who Guideline applies to

Pulmonary embolus has a significant morbidity and mortality and all suspected patients should be thoroughly investigated. These guidelines are based on the British Thoracic Society (BTS) guidelines.

This guideline applies to all clinicians with responsibility for the management of patients who are at risk of developing Venous Thromboembolism (VTE) and specifically Pulmonary Embolism (PE).

2. Recommendations, Standards and Procedural Statements

2.1 Use of Imaging Examinations

2.1.1 All patients with possible PE should have clinical probability assessed and documented.

2.1.2 A negative D-dimer test (0.5µg/ml Fibrinogen Equivalent Units [FEU]) reliably excludes PE in patients with low clinical probability; such patients *do not* require imaging for VTE.

2.1.3 An age adjusted d-dimer algorithm is currently being employed at University Hospitals of Leicester, in which <1.0 µg/ml FEU is considered unlikely PE.

2.1.4 Patients with a good quality negative Computed Tomography Pulmonary Angiogram (CTPA) do not require further investigation or treatment for PE.

2.1.5 Since the introduction of Ventilation/Perfusion Single Photon Emission Tomography (VQ SPECT) at UHL, the specificity and sensitivity of Isotope lung scanning has improved considerably, and VQ SPECT should be considered as the initial imaging investigation in younger patients providing:

1. Facilities are available on site, *and*
2. Chest radiograph (CXR) is normal or near normal
3. PE is sought as the primary differential diagnosis with low suspicion of alternative pathology, *and*
4. Absence of significant concurrent cardiopulmonary disease.

In patients with a non-diagnostic VQ SPECT, a CTPA should still be considered.

VQ SPECT-CT can also be selectively performed if there are specific contra-indications to CTPA including contrast allergy and renal failure.

2.1.6 In patients with coexisting clinical DVT, leg ultrasound as the initial imaging test is often sufficient to confirm VTE.

A single normal leg ultrasound should not be relied on for exclusion of subclinical DVT, and should be followed up with a repeat ultrasound in 7-10 days if leg swelling persists and/or progresses with no reasonable alternative diagnosis.

2.1.7 CTPA or echocardiography will reliably diagnose clinically massive PE. Imaging should be performed within 1 hour in massive PE, and ideally within 24 hours in non-massive PE.

2.1.8 Investigations for occult cancer are only indicated in idiopathic VTE when it is suspected clinically, on CXR, or on routine blood tests.

2.1.9 For pregnant patients refer to the local guideline – Investigation and Management of VTE in Pregnancy and Puerperium Trust ref C5/2001

Pregnancy associated 'YEARS' algorithm for suspected pulmonary embolism is being considered for adoption based on a recent publication (Van der Hulle et al, NEJM 2019) and still undergoing an internal audit process, before it can be considered for protocol implementation.

YEARS algorithm:

- Haemoptysis *and/or*
- Clinical signs of DVT *and/or*
- PE most likely diagnosis clinically.

Any one of 3, with a raised D-dimer(>1.0 µg/ml FEU) is considered for further investigation for suspected PE in pregnancy.

2.1.10 The BTS Score of Clinical Probability is no longer used for risk stratification of pulmonary embolism. In accordance with the updated BTS guidelines from July 2018, the simplified Pulmonary Embolism Severity Index (sPESI) is used for risk stratification (Jimenez et al).

2.2 On Call Scans

2.2.1 The majority of investigations can be performed in core hours, (i.e. 09:00 – 17:00 Monday to Sunday). At present there is no VQ SPECT imaging available out of hours.

2.2.2 The following are indications for an urgent out of hours CTPA:

- Haemodynamic instability requiring thrombolysis.
- Relative contra-indication to prophylactic anticoagulation, where a benefit risk decision is required out of hours.

2.2.3. In hours, request for CTPA's are vetted by the inpatient hub team and all requests are performed and reported within 24 hours.

The creation of the inpatient reporting hub has meant that within working hours of Monday to Sunday, an inpatient CTPA can be facilitated between 9:00am – 17:00 pm

If the scan needs to be facilitated more urgently outside of core hours, it may be performed after discussion with the on-call Radiology Registrar (extension 6969) or via switch.

2.2.4 If it is possible to safely discharge a patient on therapeutic LMWH, it may be reasonable to refer the patient to the ambulatory care pathway on ICE, for further assessment and imaging as appropriate in the working week.

2.3 VQ SPECT

2.3.1 VQ SPECT has significantly lower radiation dose (1.2mSv) compared with CTPA(4-6mSv). VQ SPECT has a high sensitivity (96%) and specificity(97%) for diagnosing

pulmonary embolism with low technical failure **(** Eur J Nucl Med Mol Imaging 2019 - see reference number 10 at end of document)

2.3.2 Please see Figure 1 for comparative summary between VQ SPECT and CTPA.

2.3.3 A VQ SPECT can be considered for primary investigation 'in hours' for,

- Younger patients (<50y), particularly young female patients of child bearing age.
- PE is the primary differential with low suspicion of alternative pathology.
- Normal/near normal chest x-ray (CXR).
- Absence of significant concurrent cardiopulmonary disease or malignancy.
- Pregnancy/Breastfeeding.
- Patient is compliant and able to follow instructions.
- Imaging facilities are available on site (including camera time and sufficient isotope).

2.3.4 VQ SPECT with a non-contrast CT (VQ SPECT-CT) can be selectively performed for patients (of any age) in which CTPA is contra-indicated such as renal failure or contrast allergy.

2.3.5 VQ SPECT can also be performed if a prior performed CTPA is non-diagnostic and there are no extensive or severe lung parenchymal findings on CT.

2.3.6 Please see Figure 2 for additional summary reference guide for the appropriate use of VQ SPECT.

A summary of the comparison between computed tomography pulmonary angiography (CTPA) and planar ventilation–perfusion (V/Q) single-photon-emission computed tomography (SPECT).

	V/Q SPECT	CTPA
Radiation exposure	+	−
Possible allergic reaction	+	−
Risk of contrast nephropathy	+	−
Use in renal impairment	+	−
Provides other diagnoses	−	+
Incidental findings requiring follow-up	+	−
Availability out of hours	−	+
Specificity	−	+
Sensitivity	+	−
Accuracy with abnormal chest radiograph	−	+
Performance in pregnancy	+	−
Accuracy in COPD	−	+
Use for follow-up	+	−
Technical failure rate	+	−

+ indicates advantage, − disadvantage.
COPD, chronic obstructive pulmonary disease.

Figure 1: Comparative summary of VQ SPECT and CTPA

2.4 Requesting a VQ SPECT

2.4.1 Nuclear Medicine VQ SPECT services are available at the Glenfield Hospital and Leicester Royal Infirmary only during core hours 09:00-17:00 Monday-Friday.

2.4.2 To obtain a VQ SPECT, a request should be sent via ICE and the Nuclear medicine department should also be contacted (Glenfield ext. 3850/2932, LRI ext. 5627/6067).

2.4.3 For non-pregnant inpatients at the Leicester General Hospital or other sites, in which a VQ SPECT is the preferred imaging modality, discussion should be made with Nuclear Medicine regarding the clinical risks of transportation to LRI/GH for a VQ scan vs the additional radiation/contrast risk from a CTPA.

2.4.42.4.4
If a scan is critically urgent, discharge dependent, or the patient cannot be safely discharged and brought back for a VQ scan, a CTPA may be more appropriate.

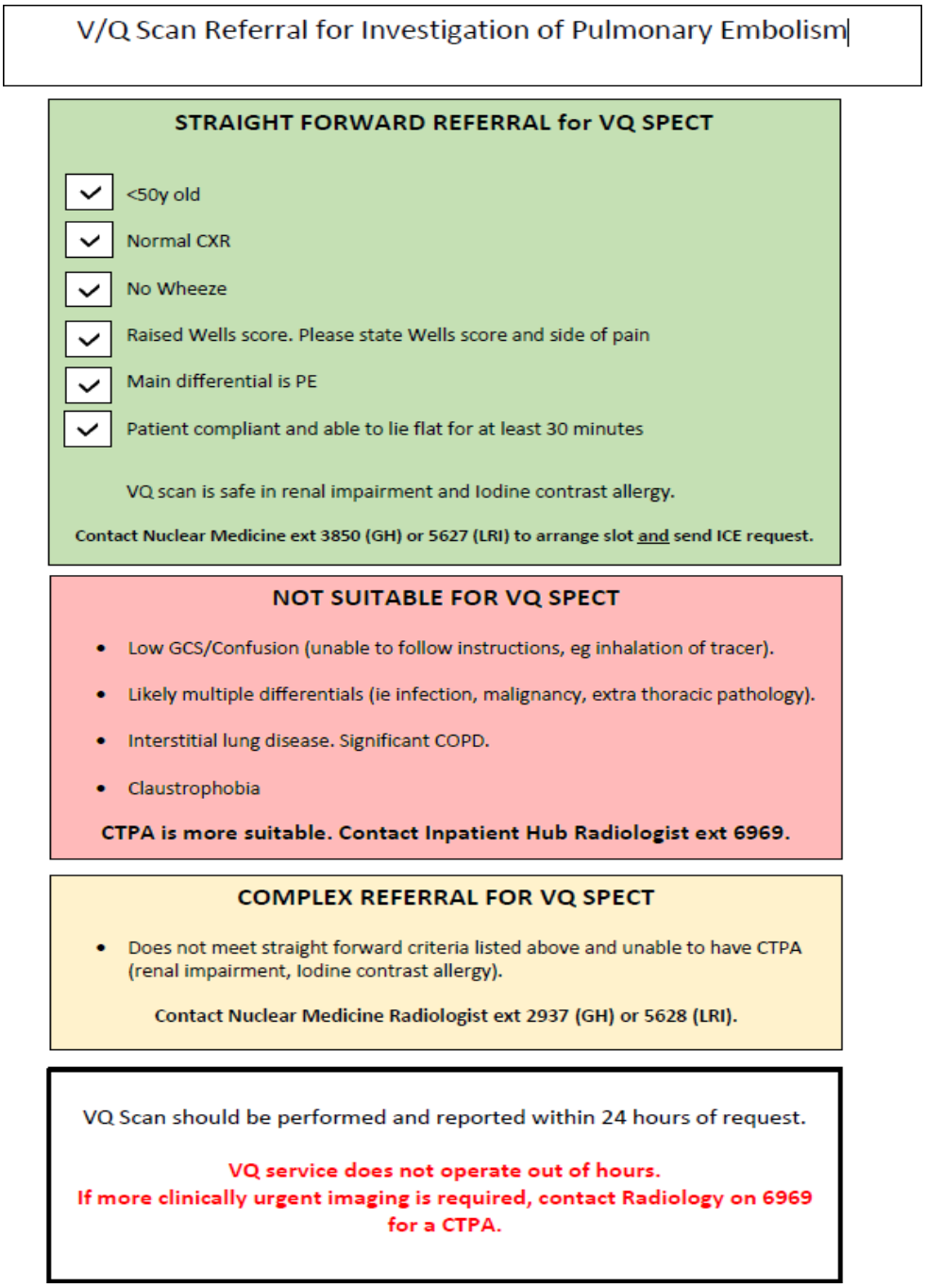

Figure 2: Summary Reference Guide for the Appropriate Use of VQ SPECT

2.5 Diagnosis of suspected PE in Pregnancy

2.5.1 Where there is clinical suspicion of acute PE a CXR should be performed. CXR may identify other pulmonary disease such as pneumonia, pneumothorax or lobar collapse Compression duplex Doppler should be performed only where there are symptoms to suggest Deep Vein Thrombosis (DVT)

2.5.2 A VQ SPECT is the preferred first-line modality in patients who are pregnant at UHL (rather than a Q scan only). This is because the lactating breast remains very radio-sensitive and VQ SPECT is considerably less radiation.

2.5.3 The mother should be appropriately counselled by the obstetric team (Consultant or Senior Registrar) about the risk and benefits between VQ SPECT and CTPA (see Figure 3).

2.5.4 If there are difficulties with the availability of a VQ SPECT scan out of hours, then a CTPA could be performed.

2.5.5 All scans in pregnancy should be discussed with the duty Radiologist in hours (ext. 6969), and on-call Radiology Registrar out of hours.

	Effects on Foetus	Effects on mother
CTPA Lower radiation dose to the foetus **BUT** high radiation to mother's thorax and breast tissue	Foetal exposure ranges from 0.01-0.66mGy Risk of fatal cancer to the age of 15years <1/1,000,000 after in utero exposure	Delivery of 10mGy of radiation increases the lifetime risk of developing breast cancer. CTPA ~12-44mGy The estimated increased risk of breast cancer has been quoted as 13.6% (background 1/200)(RCOG)
VQ SPECT	Foetal dose ranges from 0.1-0.5mGy. This equates to a risk of approximately 1/100,000 risk of malignancy/teratogenesis. The natural background risk to a foetus is 1:500. A single foetal exposure of less than 50mGy should be considered negligible	Maternal breast dose from radioisotope low dose Q scans is in the order of 0.2mGy (~60x LESS radiation than CTPA)

Figure 3: Associated Foetal Risk and Maternal Risk of CTPA and VQ SPECT

2.6 Ambulatory PE Pathway

2.6.1 There is a now an Ambulatory PE pathway based at Glenfield Hospital, which runs from Monday to Friday 09:00-17:00. There is a separate guideline and referral pro-forma for the pathway on ICE. Further information can be found in Assessment & treatment of patients with suspected or confirmed pulmonary embolism (PE).

2.7 Investigation of Non- Massive PE

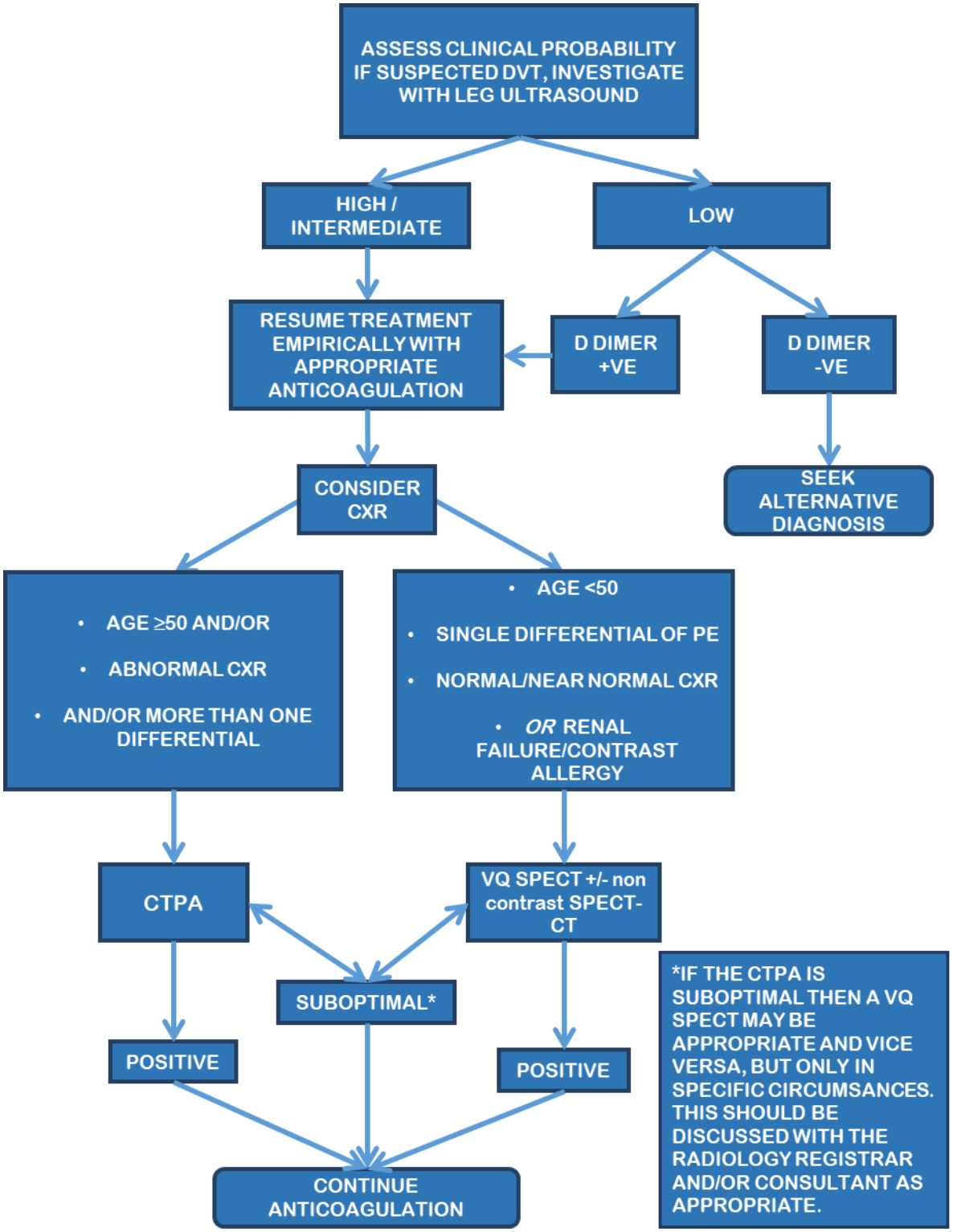

Figure 4: Clinical Considerations for Imaging of VTE

3 Education and Training

None

4 Monitoring and Audit Criteria

Key Performance Indicator	Method of Assessment	Frequency	Lead
Indeterminate VQ scan should have further imaging	Review of CRIS data	Annual	Dr Kamil Anver
Imaging should be performed within 24 hours of request receipt	Review of CRIS data	Annual	Dr Indrajeet Das
Patients should have a clinical probability documented in the notes and on any request form	Review of notes/EPR and CRIS data	Annual	Imaging Q&S lead

5. Supporting Documents and Key References

Please use these guidelines in conjunction with Assessment & treatment of patients with suspected or confirmed pulmonary embolism (PE) and Investigation and Management of VTE in Pregnancy and Puerperium Trust ref C5/2001

1. British Thoracic Society guidelines for the management of suspected acute pulmonary embolism Thorax (2018)

2. Winer-Muram *et al*. Pulmonary embolism in pregnant patients: fetal radiation dose with helical CT. Radiology. (2002) Aug;224(2):487-92

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5. Bajc M *et al,* EANM guidelines for ventilation/perfusion scintigraphy. Eur J Nucl Med Mol Imaging (2009);36:1356-705

6.I.J. Laurence et al. VQ/ SPECT imaging of acute pulmonary embolus – A practical perspective. Clinical Radiology 67 (2012) 941-948.

7.Nikki Tirada et al, Radiographics, Imaging Pregnant and Lactating Patients Oct (2015) https://doi.org/10.1148/rg.2015150031

8 Jiménez D, et al. Simplification of the Pulmonary Embolism Severity Index for Prognostication in Patients With Acute Symptomatic Pulmonary Embolism. Arch Intern Med (2010);170:1383–9

9. Nikki Tirada et al, Radiographics, Imaging Pregnant and Lactating Patients Oct (2015) https://doi.org/10.1148/rg.2015150031

10. EANM guideline for ventilation/perfusion single-photon emission computed tomography (SPECT) for diagnosis of pulmonary embolism Eur J Nucl Med Mol Imaging. 2019; 46(12): 2429–2451.

6 Key Words

Venous Thromboembolism (VTE)
Pulmonary Embolism (PE)
Deep Vein Thrombosis (DVT)
CTPA
VQ scan
VQ SPECT
D-Dimer
Imaging

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This table is used to track the development and approval and dissemination of the document and any changes made on revised / reviewed versions

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Reviewed by:	Imaging Q&S Board, CSI P&G Group.	
Approved by:	Policy and Guideline Committee	19.11.21

REVIEW RECORD			
Date	**Issue Number**	**Reviewed By**	**Description Of Changes (If Any)**
21/10/2020	2	Dr Indrajeet Das, Dr Anver Kamil, Dr Rajini Sudhir	Replace BTS Score of clinical Probability with sPESI, Outpatient investigations replaced with ambulatory PE Pathway, Additional detail regarding VQ SPECT, Changes to dose estimates based on new guidance, Renumbering and formatting.
14.11.2021	3	Dr Indrajeet Das, Dr Anver Kamil, Dr Rajini Sudhir	Addition of 2 additional statements (2.2.4 and 2.4.4) mainly for clarification regarding referral for CTPA and VQ SPECT.
19.11.21	Approved by PGC		

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Date	**Name**	**Dept**	**Received**