East Lancashire Hospitals NHS Trust
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Clinical Radiology Referral Guidelines

Chest & Cardiovascular Referrals

Safe | Personal | Effective

June 2024 v2

EAST LANCASHIRE HOSPITALS NHS TRUST

CLINICAL RADIOLOGY REFERRAL GUIDELINES

These guidelines are intended to be used by all "referrers" requesting imaging at East Lancashire Hospitals NHS Trust. They are appropriate for both primary and secondary care clinicians and Non-Medical Referrers (NMR) to promote the best use of imaging and resources for the benefit of our patients.

The Ionising Radiation (Medical Exposure) Regulations (IR(ME)R) provide for the health protection of individuals undergoing medical exposures involving ionising radiation. All diagnostic tests should therefore be carefully considered prior to referral and should only be requested appropriately. Diagnostic tests which do not utilise Ionising Radiation (such as ultrasound and magnetic resonance imaging) carry their own potential risks and as such are as strictly governed in terms of justification. This not only serves to protect patients, but also to manage demand appropriately and keep waiting times to a minimum.

The aim for all examinations should be to obtain the maximum information with the minimum of radiation. This means that on occasions the imaging undertaken may not be what the referring clinician/NMR expects. Radiology has set examination protocols utilised for the legal authorisation and justification of requests.

Optimising radiation dose

The use of radiological investigations is an accepted part of medical practice justified in terms of clear clinical benefits to the patient, which should far outweigh the small radiation risks. However, even small radiation doses are not entirely without risk. A small fraction of the generic mutations and malignant diseases that occur in the population can be attributed to natural background radiation. Diagnostic medical exposures account for one-sixth of the total population dose.

The Ionising Radiation (Medical Exposure) Regulations (IR(ME)2017 require that the unnecessary exposure of patients to radiation is kept to a minimum and ELHT must comply with these regulations. This is achieved by avoiding undertaking investigations unnecessarily (especially repeat examinations) and the use of dose optimisation utilising locally set diagnostic reference levels (DRLs).

The effective dose for a radiological investigation is the weighted sum of the doses to a number of body tissues, where the weighting factor for each tissue depends on its relative sensitivity to radiation-induced cancer of severe hereditary effects. This provides a single dose estimate related to the total radiation risk, no matter how the radiation dose is distributed around the body (Table 1).

Typical effective doses for some common diagnostic radiology procedures range over a factor of about 1,000 from the equivalent 1-2 days of natural background radiation.

Table 1

Typical effective doses from diagnostic medical exposure			
Diagnostic Procedure	**Typical effective dose (mSv)**	**Equivalent number of chest x-rays**	**Approximate equivalent period of natural background radiation**
Radiographic examinations			
Limbs & joints (except hip)	<0.01	<0.5	<1.5 days
Chest (single PA film)	0.02	1	3 days
Skull	0.06	3	9 days
Thoracic spine	0.7	35	4 months
Lumbar spine	1.0	50	5 months
Hip	0.4	20	2 months
Pelvis	0.7	35	4 months
Abdomen	0.7	35	4 months
IVU	2.4	120	14 months
Barium swallow	1.5	75	8 months
Barium meal	2.6	130	15 months
Barium follow-through	3	150	16 months
Barium enema	7.2	360	3.2 years
CT Head	2	100	10 months
CT Chest	8	400	3.6 years
CT abdomen or pelvis	10	500	4.5 years
Radionuclide Studies			
Lung ventilation (Xe-133)	0.3	15	7 weeks
Lung perfusion (Tc-99m)	1	50	6 months
Kidney (Tc-99m)	1	5	6 months
Thyroid (Tc-99m)	1	50	6 months
Bone (Tc-99m)	4	200	1.8 years
Dynamic cardiac (Tc-99m)	6	300	2.7 years
PET head (F-18 FDG)	5	250	2.3 years
*UK average background radiation = 2.2 mSv per year: regional averages 1.5-7.5 mSv per year			

Please note that the doses from some CT examinations are particularly high and the demand for CT imaging continues to rise. **It is therefore particularly important that referrals for CT are thoroughly justified and that techniques that minimise dose while retaining essential diagnostic information are adopted.**

In these referral guidelines, the doses are grouped to support the referrer in understanding the order of magnitude of radiation doses of the various investigations (Table 2).

Table 2 **Typical effective doses of ionising radiation from common imaging procedures**		
Symbol	Typical effective dose (mSv)	Examples
None	0	Ultrasound (US), Magnetic Resonance Imaging (MRI)
☢	<1	Chest, limbs & pelvis X-ray, mammography
☢ ☢	1-5	Lumbar spine X-ray, Nuclear Medicine (NM) (e.g., bone), Computed tomography (CT) head and neck
☢ ☢ ☢	5-10	CT chest or abdomen, NM (e.g., cardiac)
☢ ☢ ☢ ☢	>10	Extensive CT studies, some NM studies (e.g., some Position Emission Tomography co-registered with CT (PET-CT)
The average annual background dose in most parts of Europe falls within the 1-5 mSv range ☢ ☢		

Pregnancy and Protection of the foetus

Irradiation of a foetus should be avoided whenever possible. This includes situations in which the woman herself does not suspect pregnancy. The prime responsibility for identifying such patients lies with the referring clinician. Radiology also checks the pregnancy status of patients when they attend for examination.

Persons of childbearing potential presenting for an examination in which the primary beam irradiates the pelvic area (essentially, any ionising irradiation between the diaphragm and the knees), directly or by scatter, or for a procedure involving radioactive isotopes, will be asked whether they are or may be pregnant.

If the patient can exclude the possibility of pregnancy, the examination can proceed. If the patient is definitely pregnant, or if pregnancy cannot be excluded, the justification for the proposed examination should be reviewed by the radiologist and the referring clinician/NMR, with a decision taken on whether to defer the investigation until after delivery. However, a procedure of clinical benefit to the parent may also be of indirect benefit to the unborn child and a delay in an essential procedure may increase the risk to the foetus as well as the parent. This consideration is especially relevant in an emergency situation and all decisions must be documented.

Guidelines Key

The pages of each section are composed five columns:

Clinical/diagnostic problem	Situation for requesting an examination
Investigation	Possible imaging techniques
Dose	Level of exposure to radiation ☢
Recommendation	Recommendation on appropriateness of the investigation
Comment	Explanatory notes

Chest and Cardiovascular System

Clinical/diagnostic problem	Investigation	Dose	Recommendation	Comment
Acute chest pain: ST elevation myocardial infarction (STEMI) and subsequent assessment	CXR	☢	Indicated	Should not delay acute revascularisation. Especially useful when an alternative diagnosis such as aortic dissection or associated pulmonary oedema is suspected.
	Catheter coronary angiography /intervention	☢ ☢ ☢	Indicated	Coronary angiography followed by primary percutaneous intervention is indicated in centres with access to primary angioplasty service or rescue angioplasty following thrombolysis.
	Echo-cardiography (Echo)	None	Indicated only in specific circumstances	Echo is indicated when acute aortic dissection is suspected or to clarify the diagnosis of STEMI when confounded with left bundle branch block or suspected posterior myocardial infarction. Useful in assessment of mechanical complications after myocardial infarction.
	CT Chest	☢ ☢	Indicated only in specific circumstances	CT of the chest is indicated when coronary arteries are normal and alternative diagnoses – such as aortic dissection, pulmonary embolism, pericarditis etc need to be excluded
	NM (myocardial perfusion imaging)	☢ ☢	Indicated only in specific circumstances	NM is indicated for risk assessment in haemodynamically stable patients after successful thrombolysis before discharge. Also helpful in the assessment of significance of a moderate stenosis after coronary angiography.
	MRI Heart	None	Indicated only in specific circumstances	MRI can be used post revascularisation in haemodynamically stable patients to assess ventricular function, degree of infarction and its transmural extent, and this to predict improvement in function. It can be used to investigate alternative cause of chest pain (myocarditis, pericarditis etc) in patients with normal coronary arteries but increased troponin concentrations.

Acute chest pain: non-STEMI and unstable angina	Echo-cardiography (Echo)	None	Indicated only in specific circumstances	Echo is used to assist in the diagnosis of ongoing ischemia, in assessment of left ventricular function for prognosis, and in identification of other underlying abnormalities such as aortic stenosis or hypertrophic cardiomyopathy.
	NM (myocardial perfusion imaging)	☢ ☢	Specialised investigation	Gated SPECT scintigraphy is indicated for diagnosis and prognosis in patients with intermediate probability and low or negative cardiac enzymes. It is also indicated for assessment of lesions on coronary angiography.
	CT coronary angiography (CTA)	☢ ☢	Specialised investigation	CTA may be indicated in patients with low or intermediate probability to exclude any significant CAD due to its high negative predictive value. It is also useful in the identification of other causes such as aortic dissection, pulmonary embolism, pericarditis, pulmonary infection etc. Absence of coronary artery calcification by itself has been shown to be of good prognostic value.
	MRI	None	Specialised investigation	ECG gated MRI of the heart with rest perfusion and/or pharmacological stress, ventricular function and delayed enhancement imaging can be used to assess the significant CAD and other causes of chest pain in patients with low to intermediate probability and who are haemodynamically stable.
	Catheter coronary angiography	☢ ☢ ☢	Specialised investigation	Catheter coronary angiography is indicated in patients who have recurrent symptoms or ischemia despite adequate medical therapy or are at high risk.
Acute aortic syndrome / suspected aortic dissection	CXR	☢	Indicated	CXR is used mainly to exclude other causes and is rarely diagnostic.
	CT	☢ ☢ ☢	Indicated	CT is the most reliable and practical technique. Initial unenhanced images may be helpful in the detection of acute intramural haematoma.
	TOE	None	Specialised investigation [B]	TOE is as useful and accurate technique for exclusion of type A dissections and intramural haematomas, and to

				establish the involvement of aortic root and acute aortic regurgitation. Choice between CT and TOE will depend on local expertise and availability.
	MRI	None	Specialised investigation	MRI may be difficult to undertake in an acute situation. However, it is useful for sequential follow-up and for aortic valve function assessment. Consider MRI or TOE if there are absolute contraindications to iodinated contrast medium.
Suspected pulmonary embolism				It is important that local agreed protocols for the systematic investigation of suspected pulmonary embolism are developed. Lower limb venous US can be useful for providing supporting evidence of thromboembolism in equivocal cases.
	CXR	☢	Indicated	CXR should be the preliminary investigation to demonstrate consolidation and pleural effusion, but a normal CXR does not exclude a pulmonary embolus.
	CT pulmonary angiography (CTPA)	☢ ☢ ☢	Indicated	CTPA is the investigation of choice in patients with high clinical suspicion of pulmonary embolus and in those with pre-existing pulmonary disease.
	NM (Ventilation – perfusion scintigraphy)	☢ ☢	Indicated	Ventilation-perfusion scintigraphy is an alternative to CTPA in patients with no pre-0exisitng cardio-pulmonary disease when the CXR is normal. A normal perfusion scintigram excludes clinically significant pulmonary emboli.
Suspected pericarditis or pericardial effusion	Echo-cardiography (Echo)	None	Indicated	Echo is the first investigation for suspected pericardial effusion, cardia tamponade and constriction and is useful for guiding pericardiocentesis.
	CXR	☢	Indicated	CXR may reveal as massive pericardia effusion, calcification in the pericardium, associated lesions in the lung, and pleural effusion. Normal CXR does not exclude the diagnosis.
	CT	☢ ☢ ☢	Specialised investigation	CT will show pericardial thickening, presence of calcification and associated pericardial and pleural effusions. CT may also suggest the cause.

	MRI	None	Specialised investigation	Where available, cardiac MRI will show pericardial thickening associated pericardial and pleural effusions and functional sequelae of pericardial disease but will not show calcification. With late enhancement, MRI can show underlying associated myocarditis.
Chronic stable angina	CXR	☢	Indicated	CXR is useful in the assessment of heart size, ventricular aneurysms, status of pulmonary vasculature (such as congestion), aortic aneurysms, and calcification in the pericardium, etc. It may also show any non-cardiac cause of chest pain such as pneumonia and other lung disease.
	Echo-cardiography (echo)	None	Indicated	Rest echo is indicated of on clinical examination there is murmur to suggest aortic stenosis, hypertrophic cardiomyopathy, or mitral regurgitation. It can assess any regional wall motion abnormality if done during or within 30 min of chest pain. Stress echo with dobutamine or exercise is more helpful in identifying ischaemia in patients with intermediate probability of CAD.
	CT	☢ ☢ ☢	Specialised investigation	CT coronary calcification alone has been shown to have equal predictive accuracy to exercise ECG in patients with intermediate probability of CAD. Significant obstructive luminal disease is highly unlikely in the absence of calcification. CT coronary angiogram has been shown to have an excellent negative predictive value in symptomatic patients undergoing coronary catheterisations. The precise indication for CT coronary angiography is still being developed but is most likely to be beneficial in those with low to intermediate risk. It is also useful for the assessment of bypass graft obstruction. Use of such examinations will depend on local expertise and the availability of at least a 16-detector MDCT.

	MRI with vasodilator or inotropic stress	None	Specialised investigation	MRI myocardial perfusion in the detection of CAD with vasodilator stress has been shown to be as good as coronary angiography, PET, and nuclear SPECT. Dobutamine stress cardiac MRI can be superior to stress echo, especially in patients with a poor acoustic window. It is application in patients with no contraindication to MRI.
	NM (myocardial perfusion with stress)	☢ ☢	Specialised investigation	NM is useful in patients with intermediate probability of CAD for identifying areas of ischemia and risk assessment. It can be done with exercise or pharmacological agents such as adenosine and dipyridamole. Gated studies at rest also estimate left ventricular function and regional wall motion abnormalities.
	Coronary angiography	☢ ☢	Specialised investigation	Coronary angiography remains the gold standard for diagnosis of CAD. It is best used as the initial test in patients with high probability of angina and those with abnormal, equivocal, or inconclusive non-invasive tests.
Suspected valvular heart disease	Echo-cardiography (Echo)	None	Indicated	Echo is the current standard for detection and quantification of valvular heart disease. When the acoustic window is suboptimal, or in cases of suspected ineffective endocarditis, TOE may help.
	CXR	☢	Indicated	CXR is useful as a baseline to identify any valvular calcification, cardiomegaly, and pulmonary vascular congestion of oedema.
	MRI	None	Specialised investigation	MRI is complementary to echo when transthoracic acoustic windows are poot and a TOW approach is undesirable. It is also helpful when the results from echo and catheterisation conflict. MRI is valuable for assessment of the severity of regurgitant lesions and for quantification of the effects of valvular lesions on ventricular volumes, function, and myocardial mass. Most prosthetic heart valves are MRI safe unless severely dehisced.

	CT	☢ ☢ ☢	Specialised investigation	ECG gated CT of the heart can assess the aortic valve area in patients with suspected aortic valve stenosis. Calcification in the aortic valve has also been shown to be related to the severity of stenosis in degenerative valve disease.
Suspected heart failure and/or myocarditis	Echo-cardiography (Echo)	None	Indicated	Echo is the first-line investigation for establishing diagnosis and possible cause of heart failure/cardiomyopathy. Low dose dobutamine stress can be used to assess hibernation where ischaemic cardiomyopathy is suspected.
	CXR	☢	Indicated	CXR is a useful investigation for assessment of cardiac size any pulmonary congestion and associated pulmonary disease. Normal CXR does not exclude a failing heart. CXR forms a useful baseline.
	MRI	None	Specialised Investigation	MRI is complementary to echo in most instances, but is superior in quantifying ventricular volumes, ejection fraction and mass, and in differentiating ischaemic from non-ischaemic cardiomyopathy. It is helpful in identifying specific causes such as amyloidosis, iron overload and sarcoidosis. MRI has become the accepted technique to assess hibernation when combined with delayed enhancement and/or low dose dobutamine stress. It is also the technique of choice to show myocarditis. The technique used to study myocardial hibernation will depend on local availability and expertise.
	CT	☢ ☢ ☢	Specialised investigation	ECG gated CT can be used to quantify ventricular function in the same study performed assessing coronary arteries. There is increasing evidence that this technique correlates closely with 3D echo, MRI, and gated SPECT. Its role in assessing various cardiomyopathies is evolving.
Congenital heart disease	Echo-cardiography (Echo)	None	Indicated	Echo is the technique of choice for the diagnosis and evaluation of congenital heart disease. It can be supplemented with MRI and/or CT if required.

	CXR	☢	Indicated	CXR can suggest diagnosis and help in the assessment of pulmonary vascularity and cardiac situs.
	MRI	None	Indicated	MRI is an alternative to echo in new-born babies and young children and is used mainly if vascular rings or complex congenital heart disease is suspected. In adults, MRI is used for postoperative follow-up, for abnormality involving aorta and pulmonary arteries, and for shunt quantification. Most prosthetic heart valves are MRI-safe and can be checked against databases. It is contraindicated with some old ball-cage-socket type valves and suspected valve dehiscence.
	CT	☢ ☢ ☢	Specialised investigation	CT can be useful in defining complex cardiac morphology where MRI is not possible. It is also useful in defining abnormalities of aorta, pulmonary vasculature, and particularly coronary arteries. Limited functional information is currently available from CT
Assessment of asymptomatic patients for cardiovascular risk	US (carotid intima-medical thickness)	None	Indicated only in specific circumstances	Both US and CT can be useful for the assessment of cardiovascular risk in patients with unclear or intermediate risk on traditional risk assessment. There is no evidence to show that routine screening of asymptomatic people leads to improved clinical outcome. There may be a case to refine risk prediction in patients at intermediate cardiovascular risk in whom pharmacological risk modification will be considered.
	CT (coronary calcification)	☢ ☢ ☢	Indicated only in specific circumstances	
Abdominal aortic aneurysm	US	None	Indicated	US is useful in diagnosis, determination of maximal diameter, and follow-up. CT is preferable for suspected leak but should not delay urgent surgery.
	CT MRI	☢ ☢ ☢ None	Indicated	CT or MRI is used for renal iliac vessels. There is increasing demand for detailed anatomical information because of consideration of percutaneous stenting.
Deep vein thrombosis	US	None	Indicated	More sensitive with colour flow doppler. Most clinically significant thrombi are detected. There is increasing

(See also CC04)				experience with US for calf vein thrombi. May show other lesions.
	Venography	☢ ☢	Indicated only in specific circumstances	The use of venography varies greatly according to US expertise and local therapeutic strategy.
Ischaemic leg	Angiography	☢ ☢ ☢	Specialised investigation	Local policy on angiography needs to be determined in agreement with vascular surgeons, especially with regard to therapeutic interventions. US is used in some centres as first investigation.
	CTA MRA	☢ ☢ ☢ None	Specialised investigation	CTA and MRA are increasingly used for diagnosis.
Ischaemic upper limb	Angiography	☢ ☢ ☢	Specialised investigation	Local policy on angiography needs to be determined in agreement with vascular surgeons, especially with regard to therapeutic intervention.
Non-specific (non-cardiac) chest pain	CXR	☢	Not indicated initially	Conditions such as Tietze's disease show no abnormality on CXR. Its main purpose is reassurance
Pre-employment or screening materials	CXR	☢	Indicated only in specific circumstances	CXR is not justified except in a few high-risk categories (e.g., at risk immigrants with no recent CXR). Some have to be done for occupation (e.g., driver) or emigration purposes.
Routine preoperative CXR	CXR	☢	Not indicated	Routine preoperative CXR is not indicated in patients aged<60 years old undergoing non-cardiothoracic surgery. The yield of abnormalities increases in patients >60 years but is still low if patients without known cardiorespiratory disease are excluded.
Upper respiratory tract infection	CXR	☢	Not indicated	There is no documented evidence of the effect of CXR on the management or outcome of upper respiratory tract infection.
Acute exacerbation of asthma	CXR	☢	Indicated only in specific circumstances	Patients presenting with asthma but without localising signs in the chest, pyrexia or leucocytosis do not require

				CXR, except when the asthma is life threatening or does not respond adequately to treatment.
Acute exacerbation of COPD	CXR	☢	Indicated only in specific circumstances	Patients with an exacerbation of COPD requiring referral to hospital should have a CXR.
Pneumonia	CXR	☢	Indicated	Most patients with community-acquired pneumonia will show radiological resolution at 4-6 weeks, but resolution may take longer in the elderly, smokers, and those with chronic airway disease.
Pneumonia: Follow-up	CXR	☢	Indicated only in specific circumstances	CXR need not be repeated before hospital discharge in those who have made a satisfactory clinical recovery from community-acquired pneumonia. CXR should be arranged after about 6 weeks for all patients who have persistent symptoms or physical signs of who are at higher risk of underlying malignancy (especially smokers and patients >50 years), whether they are admitted to hospital.
Pleural effusion suspected	CXR	☢	Indicated	Erect CXR may detect small quantities of pleural fluid.
	US	None	Indicated	US confirms the presence and characteristics of pleural fluid and is superior to CT in the detection of loculation and internal septation. US may detect pleural metastases and guide thoracentesis.
	CT	☢ ☢ ☢	Indicated only in specific circumstances	CT may help in the detection and characterisation of pleural fluid. CT may also identify underlying pleural disease.
Haemoptysis (Including massive haemoptysis)	CXR	☢	Indicated	All patients presenting with haemoptysis should have a CXR. If CXR is normal and the haemoptysis was significant and occurred without a concurrent chest infection, referral for further investigation should be considered.
	CT	☢ ☢ ☢	Specialised investigation	CT 9including CT angiography) may be used in conjunction with bronchoscopy to investigate patients with haemoptysis, CT may detect malignant and non-

				malignant disease (e.g., bronchiectasis) not identified on CXR on bronchoscopy. It is insensitive in detecting mucosal and submucosal disease.
	Bronchial angiography =/- embolisation	☢ ☢ ☢	Indicated only in specific circumstances	Catheter bronchial angiography (with or without embolisation) may be life saving in some patients with massive haemoptysis.
ITU/HDU patient	CXR	☢	Indicated	A CXR is helpful when there has been a change in symptoms or insertion of removal of a device. The value of the routine daily CXR is being increasingly questioned and there is no evidence to support it. CT is a useful adjunct to CXR for problem solving in critically ill patients.
Suspected diffuse/infiltrative lung disease	CT	☢ ☢ ☢	Specialised investigation	There is evidence to indicate that HRCT may be histospecific in some instances. Valuable information about disease reversibility and prognosis may be provided by HRCT.