Guide for STP Trainees : Imaging with Non- Ionising Radiation - Specialism

DOPS / OCE

Note: E=easy, M=medium, D = difficult

	DOPS / OCE		Examples of evidence which may relate to this DOPS / OCE	Competencies which may share evidence with this DOPS / OCE
INIR DOPS	INIR1	Carry out scanner quality control tests based on recommended guidance. M	Observation of QA & QA report	INIR-6-1
		Carry out probe quality control tests based on recommended guidance. M	QA report	INIR-6-1
		Use a phantom to assess the effect of different machine parameters, settings and modes on ultrasound images. D	QA report	INIR-1-2
		Use a flow/string phantom to investigate Doppler ultrasound measurement. D	Phantom measurement report	INIR-1-5
	INIR2	Measure head and body coil SNR. E	QA report	INIR-6-1
		Investigate 2D and 3D slice profiles. M	QA report	INIR-6-1
		Check geometric accuracy. M	QA report	INIR-6-1
		Check body coil uniformity. M	QA report	INIR-6-1
		Check spatial resolution. M	QA report	INIR-6-1
		Use gauss meter to measure 3mT and 0.5mT contours. M	QA report	INIR-6-1
		Use a sound level meter to measure the acoustic noise of a range of pulse sequences. M	QA report	INIR-6-1
	INIR3	Use a force balance to measure acoustic intensity. E	QA report	INIR-4-6
		Use a force balance to measure acoustic power. E	QA report	INIR-4-7
		Use a hydrophone to measure acoustic pressure. M	QA report	INIR-4-8
		Use a hydrophone to measure the mechanical index of an ultrasound beam. D	QA report	INIR-4-8
	INIR4	Participate in commissioning of a new ultrasound scanner, including electrical safety testing. E	QA report	INIR-6-1
		Participate in baseline/acceptance testing of a new ultrasound scanner. E	QA report	INIR-6-1
		Investigate the limitations of thermal index models e.g. probe heating. M	Lit review	INIR-4-8
		Investigate how probe damage may D affect the mechanical index. M	Lit review	INIR-4-8
		Investigate how probe damage affects probe heating. M	Lit review	

	INIR5	Participate in acceptance/baseline testing of a new ultrasound scanner. E	Acceptance report	
		Participate in commissioning of a new ultrasound scanner. E	Acceptance report	
		Carry out routine scanner quality control tests based on recommended guidance. E	QA report	INIR-6-1
		Carry out routine probe quality control tests based on recommended guidance. E	QA report	INIR-6-1
		Investigate the performance of ultrasound equipment that is not performing optimally and suggest a solution. M	QA report (if probe has fault, and recommend solution)	INIR-6-1
		Investigate the effect that damage to components of the ultrasound scanning system has on the image quality of the system. D	QA report (if probe has fault, and recommend solution)	INIR-6-1
	INIR6	Critically evaluate emerging techniques and technologies in the application of clinical ultrasound. M	Lit review	INIR-6-1
		Compare the performance of an emerging technique/technology between scanner manufacturers. M	Lit review	
		Carry out measurements to assess the implications of emerging technologies/techniques with regard to safety guidelines. D	Lit review of measurements?	
	INIR7	Develop a software application to support image acquisition. D	QA protocol review	INIR-8-4
		Develop a software application to support image analysis. D	QA protocol review	INIR-8-4
		Design a system to analyse quality control results. M	QA protocol review	INIR-8-4
		Develop a program to plot the acoustic pressure profile of an ultrasound beam using a hydrophone. D	Report showcasing the 3D plots of the pressure measurements	Use a hydrophone to measure acoustic pressure. M
INIR OCE	INIR1	Observe the use of B-mode ultrasound during a patient scan. E	Clinical Observation Portfolio	
		Observe several different clinical applications of ultrasound imaging e.g. vascular, obstetric, small parts, musculoskeletal, cardiac. E	Clinical Observation Portfolio	
		Observe the use of Doppler ultrasound techniques during a patient scan. M	Clinical Observation Portfolio	
		Discuss and analyse the information gained from a range of clinical ultrasound investigations e.g. vascular, cardiac. M	Clinical Observation Portfolio	
		Observe the use of image enhancing functions and techniques e.g. tissue harmonic imaging, compound imaging, contrast agents during a patient scan. M	Clinical Observation Portfolio	

		Obtain images of volunteers using ultrasound scanners. Measure kidney length, aorta diameter and common carotid artery peak systolic velocities in five volunteers, make three measurements of each. Consider and discuss the precision obtained and accuracy of these measurements. Investigate how probe position and ultrasound control manipulation alter these measurements. D	Clinical Observation Portfolio/ measurements on volunteer/member of staff	

	INIR2	Perform a patient/volunteer safety screening. E		
		Setup a volunteer for cardiac gating. M		
		Set up a subject for a research study. M		
		Investigate a fault/image quality issue by questioning the operator. M		
		Scan a normal volunteer. M		
		Explain sequence or technique principles to another healthcare professional. D		
	INIR3	Use a thermal camera or thermal test object to measure the temperature of ultrasound probe surfaces prior to and post clinical examination/use on a volunteer. M	Bring in a thermal camera and take images in clinical environment.	
		Measure the mechanical properties of ultrasound beams applied for different clinical applications and compare to	Report	
		Measure the thermal properties of ultrasound beams applied for different clinical applications and compare to current standards. M	Thermal index was measured in first year rotations. Report is evidence	
		Following from clinical observation, use a hydrophone to measure and compare the acoustic properties of the ultrasound beams in the laboratory setting which are representative of clinical output.. D	3D plots of acoustic pressure	
	INIR4	Record clinical mechanical and thermal indices for different applications and compare to current limits. E	These were measured in the first year, report is evidence	
		Carry out risk assessments of different clinical ultrasound applications taking into account specific bio-effects e.g. use of contrast agents and measurement of mechanical index. M	Generate risk assessment	
		Carry out measurements to evaluate thermal index values for different clinical applications and different types of patient using a phantom or volunteer. D	These were measured in the first year, report is evidence	
		Carry out measurements to evaluate mechanical index for different clinical applications and different types of patient/volunteer using appropriate equipment. D	These were measured in the first year, report is evidence	
		Carry out measurements to investigate probe heating for different clinical applications and. D	Using a thermal camera would achieve this, or using a themoresistor on the probe itself.	
		Discuss a safety issue with another healthcare professional (e.g. radiologist / radiographer).		
		Provide a MRI safety lecture / tutorial to staff members.		
IR OCE		Observe parameters used during clinical scans and investigate optimisation of user selectable settings. E	Clinical observation portfolio	
		Investigate how damage to components in the imaging chain may affect clinical measurements. M	QA report with a damaged probe	

N	INIR5	Investigate how damage to components in the ultrasound imaging chain may affect clinical image quality using phantoms. M	QA report with a damaged probe	
		Compare the performance of a portable scanner against a high end scanner using an ultrasound phantom and volunteer. D	QA report comparison of both scanners	
		Establish an action plan for MRI protocol improvements with another healthcare professional (e.g. radiologist / radiographer). D	QA report comparison of both scanners	
		Assist a radiographer to acquire images on a volunteer / research subject. M	Assist by varying the user selectable settings or help in setting up DICOM link	
		Discuss the results of a service review with a Manufacturer Engineer. M		
	INIR6	Observe clinical ultrasound scans using emerging techniques. E	May need to travel to another institution	
		Observe Abdominal Aortic Aneurysm screening. E	Clinical observations	
		Discuss how emerging technologies and techniques compare to existing clinical practice. M	Literature review/PowerPoint presentation	
		Carry out a risk assessment considering the clinical application of an emerging technique/technology. M	Risk assessment	
		Consider the clinical safety considerations of an emerging technique/technology and take measurements to compare safety parameters. D	Literature review	
	INIR7	For a range of scanners across various departments, record the range and values of minimum and maximum gain and mean gain, minimum to maximum colour gain and mean colour gain. Comment on these readings and the clinical implications of your findings. E	Compare QA reports	
		Observe a clinical scan and investigate differences in image quality between those images viewed on a scanner and images transferred via PACS. M	Screen shots may have to suffice	
		Draw up a list of ultrasound scanners used in various departments including information on: Manufacturer, model, date of purchase, software revisions, purchase costs (where available) and probe types. What commonality is there between different departments? Does this reflect optimal clinical practice? D	Looking at the QA reports generated, a list can be made from this (database)	
		Demonstrate how to perform a post processing task to another healthcare professional and/or train another healthcare professional in the task.	Performing a task may be as simple as clicking 'go'	

CbD

	Examples of possible subjects for CbD. Note that these are not prescribed within the Learning Guide		Examples of possible evidence	Competencies which may share evidence with this CbD
INIR CbD	1	Developing a QA protocol (MRI/Ultrasound)	QA report	
	2	Discussion on emerging technology	Reporting back from a scientific meeting e.g. PowerPoint presentation/group meeting	
	3	Discussion on test objects & how they relate to parameters being measured (MRI/Ultrasound)	QA report	
	4	Discussion of Ultrasound output measurements & how this relate to bio effects and patient safety	Written report on output measurements	

Competencies

Learning Outcome Subject	Code	Competency	Examples of evidence	Other competencies which may be demonstrated by this evidence
Ultrasound Imaging	INIR-1-1	Analyse the requirements for the optimal acquisition, processing and display of clinical images.	Log or write-up of case studies from attendance at US clinics to observe clinical scanning for a range of applications (e.g. general, obstetrics & gynaecology, MSK, breast, echocardiography, vascular) including information on probes, user -settings (gain, Dynamic range, depth, focal points), processing, Doppler/harmonic imaging, and normal ranges for clinical measurements such as in obstetrics -measurement of sac diameter, foetal heartbeat, crown rump length, NT, biparietal diameter, head circumference, abdominal circumference or arterial vascular normal/abnormal diameters for upper and lower limb peripheral, aortic or extra cranial vessels).	
	INIR-1-2	Make recommendations on optimal acquisition, processing and display parameters for clinical images.	Attend application specialist training days. Write a standard of practice (SOP) for operating a new scanner for a particular clinical application (e.g. vascular, MSK, obstetrics etc.)	
	INIR-1-3	Use image analysis software to extract quantitative information from ultrasound images.	Formal written report documenting software used (manual or automated) to obtain quantitative information from ultrasound images (e.g. low contrast penetration depth, sensitivity, cyst detectability, contrast target visibility).	
	INIR-1-4	Explain the cause and effect of artefacts and equipment performance limitations on the interpretation of clinical images.	Examples of artefacts (anonymous clinical images/test objects) to include: a discussion on their cause, use of the scanner controls to minimise/ overcome them (where possible, and explain why not if not possible) and examples where artefacts can aid diagnosis (aliasing to draw the eye to a stenosis, shadowing to identify gallstones, foreign bodies etc.)	
	INIR-1-5	Use Doppler techniques to provide quantitative information relating to blood flow.	Formal written report of vascular studies clinical placement/case studies/measurements on volunteer/patients. E.g. for arterial vascular, normal/pathological velocities for upper and lower limb peripheral, aortic, extra cranial especially ICA stenosis or the S/D ratio of umbilical artery.	

	INIR-1-6	Interpret advanced techniques such as elastography, harmonic imaging and contrast enhancement.	Formal written report of clinical placements where elastography (e.g. breast, liver), harmonic imaging, contrast enhancement (echocardiography) are used.	
	INIR-1-7	Analyse the technical requirements, including transducers, for a range of clinical uses of ultrasound equipment.	Clinical observations (e.g.. Vascular, obstetrics & gynaecology, general ultrasound, MSK, Paediatric, echocardiography), data-base of probes used for clinical applications and details of pre-sets.	
	INIR-1-8	Make recommendations on optimal equipment selection for each of these clinical uses.	Presentation to clinical scientists/clinical users.	
Magnetic Resonance Imaging	INIR-2-1	Safely operate an MR system to obtain a selection of images using different MR pulse sequences and test objects in order to obtain images demonstrating the main characteristics of the sequence.	Formal written report on MR acceptance testing and QC.	
	INIR-2-2	Optimise imaging protocols for specified clinical applications.	Sequence optimisation: work on a current clinical project to recommend optimal MR protocol & write-up as a report to the user.	
	INIR-2-3	Use image analysis software to obtain quantitative results from appropriate images, e.g. measure T2.	Formal written report documenting software used (manual or automated) to obtain quantitative information from MR images (e.g. T1, T2).	
	INIR-2-4	Summarise the principles and applications of a range of advanced/specialist MR examinations, including patient set up and coil selection.	Log or write-up of case studies from attendance at MRI clinical observations for a range of applications (e.g. cardiac, neuro).	
	INIR-2-5	Explain the cause and effect of artefacts and equipment performance limitations on the interpretation of clinical images.	Examples of the appearance and cause of common MRI artefacts (sources of information: Text books/literature search ,MRI courses, home-made test objects , clinical observations, MR QC) and where they may aid diagnosis.	
Exposure Measurement	INIR-4-1	Design and conduct a study to evaluate occupational exposure to static magnetic fields.	Formal written report on measurements of static magnetic field using a gauss meter.	
	INIR-4-2	Advise on the importance of entering the correct patient height and/or weight for SAR calculation.	Presentation to MR users e.g. other clinical scientists, MR radiographers.	
	INIR-4-3	Measure the acoustic noise generated by a variety of MR pulse sequences and, if possible, different MR systems.	Formal written report on measurements using a sound meter (e.g. MR acceptance testing or typical clinical sequences).	
	INIR-4-4	Identify and use appropriate measuring equipment to investigate occupational and/or patient exposure levels.	Formal written report on measurements of static magnetic field using a gauss meter/ acoustic noise levels using a sound meter.	
	INIR-4-5	Assess the suitability of non-ionising radiation test equipment and phantoms.	Literature review/ MR and ultrasound QC measurements.	
	INIR-4-6	Measure total acoustic power from diagnostic and therapy ultrasound equipment (e.g. high-intensity focused ultrasound, lithotripsy).	Formal written report on Hydrophone/radiation force measurements.	
	INIR-4-7	Measure acoustic pressure and derived intensities from continuous and pulsed ultrasound systems.	Formal written report on Hydrophone/radiation force measurements with reference to US safety and US bio-effects.	
	INIR-4-8	Undertake measurements to determine thermal and mechanical indices associated with exposure to ultrasound.	Formal written report on Hydrophone/radiation force measurements with reference to US safety and US bio-effects.	
	INIR-4-9	Interpret and report on findings, providing advice on exposure and safe exposure levels.	Prepare information/presentation for FRCR students/ STP trainees/ clinical users.	

Risk, Safety and Bio effects	INIR-5-1	Critically evaluate a non-ionising radiation facility design.	Evaluate facility of a new/current MRI/US units.	
	INIR-5-2	Perform a comprehensive risk assessment of a non-ionising imaging facility or technique.	Risk assess new/current MRI/US scanners .	
	INIR-5-3	Identify and label equipment as MR safe, MR conditional or MR unsafe.	Carry out audit of labelling of new equipment at an MRI unit and label where appropriate.	
	INIR-5-4	Critically evaluate the safety for MR scanning of a range of inactive and active implants and foreign bodies.	Write a SOP on implants.	
	INIR-5-5	Provide recommendations on occupational exposure to non ionising radiation based on measurements and published recommendations.	Prepare information for FRCR St1 trainees. Produce advice on acceptable sequences for scanning MR conditional devices.	
	INIR-5-6	Advise on limitation or reduction of patient exposure consistent with clinical requirements.	Prepare information/presentation for FRCR students/STP trainees/clinical users. Mini lab based projects such as: Investigate the limitations of thermal index (US e.g. probe heating) or SAR models (MRI) , investigate how ultrasound probe damage may affect the mechanical index or investigate how ultrasound probe damage affects probe heating with project report/ PowerPoint slides from scientific presentation etc. as evidence for this.	
	INIR-5-7	Advise healthcare staff about non ionising radiation safety.	Prepare information/presentation for clinical users on MR/US safety and bio effects.	
	INIR-5-8	Interpret and apply current guidelines and standards in non-ionising radiation.	Carry out review of how the training centre adheres to new MHRA guidelines, risk assessments.	
Diagnostic Equipment Performance	INIR-6-1	Perform, and write a report based on the results from, acceptance testing of a non-ionising radiation imaging system.	Formal written acceptance testing report for a new MRI/US machine or existing machines using results obtained at acceptance.	
	INIR-6-2	Write a protocol for routine quality control and advise on appropriate testing frequencies.	Written QC protocol for MR/US.	
	INIR-6-3	Assess the relationship between underlying technical specifications and measured imaging performance.	Comparison of QC results from 1.5T and 3T scanners. Comparison of portable and ‘top end’ ultrasound scanners.	
	INIR-6-4	Investigate, report and provide recommendations to rectify poor or faulty equipment performance.	Contribute towards QC reports in MR and ultrasound including ‘action required’ section.	
	INIR-6-5	Critically evaluate the range of commercially available non-ionising imaging equipment available.	Written report evaluating a range of ultrasound /MR scanners.	
Emerging Technology	INIR-7-1	Write a critical evaluation of the new imaging technique/technology with particular emphasis on its potential future role in patient care.	Evaluate technology from a current research project at the training centre or from a literature review. Critically evaluate emerging techniques and technologies in the application of clinical ultrasound or MRI.	
	INIR-7-2	Design a study to evaluate the impact of the new technology/technique. Consider the ethical and Research and Development issues.	Ideally contribute to an on-going project/ retrospectively analyse results from an US/MRI project at the training centre/ design a study based on information obtained from a literature review. Or mini projects (clinical or phantom based) such as: Use of SMI in EVAR surveillance, ASQ for DVT diagnosis etc., with project report/ PowerPoint slides from scientific presentation etc. as evidence for this. Or comparing the performance of an emerging technique/technology between scanner manufacturers or carrying out measurements to assess the implications of emerging technologies/techniques with regard to safety guidelines.	

Information and Communication Technology	INIR-8-1	Critically review information governance policies in the trust with particular emphasis on those relevant to Radiology.	Formal written report.	
	INIR-8-2	Use or write software to manipulate Digital Imaging and Communications in Medicine (DICOM) headers. Anonymise DICOM images and use different software to verify the anonymisation.	Generating portfolio for clinical observations.	
	INIR-8-3	Describe the data flows involved between a patient being allocated an appointment and the images finally being reported by a radiologist.	Case study report from clinical observations.	
	INIR-8-4	Develop a software application to support either image acquisition or analysis. The software should be appropriately documented, commented, tested and, where possible, deployed.	Write code to automate QC (US or MRI) analysis.	