MEDICAL IMAGING
# SAUDI BOARD

## MEDICAL IMAGING Curriculum

2015

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SECTION 1

1.1 Introduction

Medical Imaging is an ever-evolving and growing field that is advancing at an incredible rate, with not only an emergence of new subspecialties over the past few years but also a redefinition of existing specialties.

Therefore, the training course for radiologists must be comprehensive and dynamic in order to integrate established academic knowledge and practical proficiency with the ever-growing body of research that drives the field, thus encouraging trainees to invest in comprehension of research and its methodology. The Saudi Board of Radiology aims to not only produce competent radiologists who are capable of performing various diagnostic and therapeutic tasks but also build a culture of continued excellence and the drive to perform crucial and beneficial research, thus ensuring that the needs of the Kingdom are best served with a strong understanding of the cultural, ethical, and socioeconomic milieu of the region.
SECTION 2

2.1 Training Program
The training program is a 4-year, full-time residency in accredited institutions, with continuous and final evaluations by way of examinations. The program comprises training to acquire cognitive and technical skills and to understand how they relate to the physics, applied anatomy, pathology, and physiology of health and disease.

The training involves practical procedures and interpretation methods taught in a sequential and integrated manner through lectures, tutorials, seminars, and, above all, apprenticeship that provides hands-on experience.

2.1.1 Objectives
The Saudi Board of Radiology is built upon the foundation that the radiologist must be a Medical Expert, Communicator, Collaborator, Manager, Health Advocate, Scholar, and Professional. This ensures that each candidate can provide the optimum level of care and expertise to sustain and advance the profession. The objectives can be further broken down into general and radiology-specific requirements.


2.2 Structure of the Training Program

The program comprises 4 years of training structured into four levels (R1–R4). Each level facilitates the acquisition of basic, relevant, and appropriate academic knowledge, along with the integration and application of this knowledge as part of standard radiological practice.

Theoretical knowledge shall be acquired through lectures, tutorials, seminars, and assignments, while professional and practical radiological skills will be acquired through on-the-job experience and apprenticeship. On-call duties are compulsory.

2.2.2 Contents of Training

First Year (R1)

The first year begins with month-long introductory rotations in general CT, ultrasound, chest, emergency radiology, and fluoroscopy. These rotations are designed to introduce the resident to areas of imaging frequently encountered during on-call duties. During this time, the resident will learn radiology terminology and how to structure a report. A key component of this introductory phase includes the basics of PACS, image manipulation, and communication skills.

Students should concentrate on mastering the basics, including imaging-based anatomy, imaging physics, radiation safety, contrast administration, and all related issues, with focus on ultrasound and MRI physics and techniques during their respective introductory rotations.

The remainder of R1 focuses on the “building blocks” of radiology. The rotations are as follows.

Two months: ultrasound, chest, and fluoroscopy/ER

The entire first rotation should focus on ultrasound, with exclusive hands-on scanning of patients.

One month: musculoskeletal radiology, neuroradiology, general CT, general MRI, body CT, and nuclear medicine.

Second Year (R2)

The second year concentrates on further building of resident knowledge and experience in cross-sectional imaging. The knowledge gained in the R1
rotations is enhanced and integrated into these rotations. This year also introduces the residents to pediatric radiology through a 2-month block rotation that aims to educate the trainees in specific pediatric imaging techniques and help them acquire the necessary skill sets to best serve this unique population. The residents are also introduced to breast imaging.

During this year, the residents are encouraged to enroll in courses on the basics of conducting research as well as evidence-based medicine courses. These will prepare the residents for the QI/research rotation during the following year.

The typical rotation design for this year is as follows.
Two months: pediatric radiology, chest
One month: ultrasound, body MRI, nuclear medicine, breast imaging, musculoskeletal radiology, neuroradiology, body CT, and an elective subject.

**Third Year (R3)**
The third year introduces the residents to vascular and interventional radiology through a 2-month dedicated rotation with hands-on training in various radiological procedures.

The year also introduces a 1-month rotation in cardiac imaging, which is a comprehensive rotation wherein the residents work closely with cardiac radiologists and cardiologists, thus covering cardiac CT, cardiac MRI, and nuclear cardiac imaging.

Residents also spend a month in research and quality improvement, where they are given the opportunity to either conduct a research project under faculty supervision, with the aim of producing publishable material, or undertake a departmental quality improvement project. There is an elective month during the R3 year. If desired, this can be used to attend a 4-week radiology/pathology course at the American Institute of Radiologic Pathology (AIRP), which is conducted in the USA under the auspices of the American College of Radiology.

The typical rotation design for this year is as follows.
One month: body CT, nuclear medicine, ultrasound, breast imaging, neuroradiology, fluoroscopy/ER, cardiac imaging, research/QI, and pediatric radiology.

Two months: interventional radiology

**Fourth Year (R4)**

This year offers rotations that review the core radiology knowledge and is intended to round off the consultancy skills of senior residents and serve as a foundation for the review of content relevant for examination and certification purposes. This year encourages residents to tailor their rotation design to include those areas that best suit their personal learning objectives and future career directions. This flexibility is implemented by offering 2 months of elective rotations.

The rotations serve to consolidate consultancy skills in diagnostic imaging, because they permit graded responsibility and semi-independent reporting under staff supervision, fostering a “ready for practice” model for the successful completion of R4. During these months, the senior resident aims to perform the responsibilities and carry the workload of a junior staff radiologist. Review of core material for exam preparation through “on-the-job” exposure to important aspects of all imaging modalities is advocated.

The fourth year also debuts exposure to PET/CT imaging during the NM rotation. The residents are expected to familiarize themselves with the physics as well as the technical aspects of this imaging modality, including imaging protocols, indications, contraindications, patient preparation, and image interpretation.

The rotation design for this year includes 1-month rotations in body CT, chest, nuclear medicine (including PET/CT), breast imaging, neuroradiology, pediatric radiology, interventional radiology, body MRI, ultrasound, and musculoskeletal radiology. The year is rounded off with 2 months of elective rotations.

The inclusion of time for OB examinations in ultrasound exposure is highly encouraged.

R4 residents should supervise/teach junior residents and start conducting clinical–radiological meetings under staff supervision.
### 2.2.2 Rotation Design

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*include PET
AIRP optional*
2.3 Admission Requirements

In accordance with and without contradiction to the SCFHS training rules and regulations, the following requirements must be fulfilled by any candidate accepted into the training program:

- All candidates must hold a medical degree such as an M.B.B.S. or its equivalent from a university recognized by the commission.
- All candidates must have completed a 12-month rotating internship.
- All candidates must have passed the Saudi Medical Licensing Exam (SMLE).
- All candidates must provide a comprehensive CV with references from two (2) consultants, preferably from the field of radiology, who should provide recommendation letters stating the suitability of the candidate for training in radiology.
- All candidates must provide a letter from a sponsoring organization, approving and pledging support for the candidate’s total period of training, i.e., 4 years, and for sponsored positions.
- All candidates must sign a written pledge to abide by the rules and regulations of the training program and the Saudi commission.
- All candidates must be registered as training radiologists at the Saudi Commission for Health Specialties (SCHS).
- All candidates must have basic life support certification and malpractice insurance.

2.4 Training Requirements

This is a joint training program, and residents are expected to show total commitment toward the program and the SCHS.

Training should be conducted in institutions accredited for training by the Saudi Board of Radiology. All candidates will rotate through most, if not all, of these institutions during their training. Training will be comprehensive, involving all subspecialties and including inpatients, outpatients, and emergency (on call) cases. Residents must be actively involved in patient care, so that they acquire hands-on experience. The degree of involvement and responsibility will be gradually adjusted according to the level of the
Trainee and their general competence. Trainees will be bound by the rules, regulations, and obligations set by the SCHS.

2.5 Vacations, Holidays, Special Circumstances, and On-Call Duties

- In accordance with and without contradiction to the SCHS training rules and regulations, residents are entitled to 30 days of vacation each year, including intervening weekends.
  - Local training committees/centers may elect to implement a certain minimum number of days for vacation approval.
  - The resident cannot take more than 5 working days off during any single rotation, including Eid days. This limit may be exceeded in only two circumstances:
    - If the Eid vacation time designated for staff by the training center exceeds 5 days, in which case the resident has the option to take those additional days off from his/her annual leave balance.
    - If there is an approved course/activity conducted by the residency program that requires resident attendance. These days will not be deducted from the resident’s annual leave balance.

However, in either situation, the total number of days off during any rotation must not exceed 10 working days, with no more than five representing annual vacation days.

- Should a resident choose to drop a rotation, the rotation must be compensated before the completion of training by deduction from the annual vacation days. Similar rules will apply if the resident needs to compensate for a failed rotation.
- If more than three rotations are dropped and/or failed, an additional year of compensation training will be required.
- Sick leaves and maternity leaves will be compensated during or at the end of training.
• After the fourth month of training, on-call duties will commence and should be no less than three calls and no more than 8 calls per month. **Only** first-on-call residents are released from all clinical duties on the day following their discussion with and receipt of on-call cases from the attending consultant(s). Continuation of one’s daily duties is, however, encouraged to afford continuous care to patients and enhance clinical exposure.

• Senior residents who are second-on-call should attend patients with the first-on-call residents as needed (review must not exceed 2 hours per case) or provide immediate presence when requested and for ambiguous cases. They must also accompany the first-on-call residents during the case discussion with the attending consultant(s) the following morning. However, second-on-call residents will **not** be permitted to take the following working day off unless **objective and verified** circumstances can be presented to the program director.
SECTION 3

3.1 General Radiological Objectives (competencies)

3.1.1 Medical Expert

Junior Level Knowledge
- To recognize basic radiological anatomy and variants thereof.
- To understand the basic physical principles behind radiological techniques.
- To learn the indications and absolute and relative contraindications for various contrast media.
- To recognize the appropriate indications and contraindications of various radiological techniques.
- To recognize radiological emergencies and common pathologies and understand their management.
- To list the most important differential diagnoses for various imaging findings.

Junior Level Skills
- To identify and manage reactions to contrast media.
- To appropriately perform and prescribe radiological examinations.
- To recognize and describe imaging techniques and findings.
- To generate an accurate and informative radiology report.
- To perform basic imaging-related non interventional procedures.
- To perform basic post-processing procedures and image analysis.

Senior Level Knowledge
- To recognize detailed and complex radiological anatomy.
- To understand the advanced physical principles behind radiological techniques.
- To understand advanced imaging techniques and technical problem-solving approaches.
To recognize unusual imaging presentations of common pathologies.
To develop in-depth fund of differential diagnoses for various imaging findings.
To recognize and recommend the most appropriate next step in patient management

**Senior Level Skills**
- To perform basic imaging-related interventions and advanced non interventional procedures.
- To generate an appropriate opinion about complex imaging findings.
- To perform advanced post-processing procedures and image analysis.
- To acquire and practice skills related to basic imaging informatics.

### 3.1.2 Communicator

**Junior Level**
- To demonstrate effective communication skills while dealing with patients and their families, staff members, and referring clinical services.
- To communicate critical findings directly to the referring physician in a timely fashion.
- To document pertinent conversations with the clinician in the report.
- To generate well-organized reports, accurately conveying the relevant findings, diagnosis, and recommendations.

**Senior Level**
- To communicate effectively and empathetically with patients and their families.
- To recognize the physical and psychological needs of patients undergoing radiological investigations and/or treatment and their families, including the needs of culture, race, and gender.
- To develop effective oral skills for individual consultations and case presentations, radiology conferences, and scholarly work.
3.1.3 Collaborator

**Junior Level**
- To demonstrate good consulting skills when interacting with other physicians and health team members.
- To interact appropriately with radiology department and hospital staff members, demonstrating a team approach toward patient care.

**Senior Level**
- To work effectively as part of a multidisciplinary team in daily patient management.
- To actively participate in multidisciplinary team meetings.
- To work with clinical colleagues on research or quality improvement projects.

3.1.4 Manager

**Junior Level**
- To manage time effectively in order to ensure productiveness and timeliness of service provision.
- To consider available imaging resources when planning and recommending patient care, using them effectively and efficiently.
- To prioritize radiological studies based on urgency and clinical need.
- To manage night duty responsibilities efficiently and effectively.

**Senior Level**
- To effectively manage technologists, nurses, and junior staff during the delivery of appropriate patient care.
- To supervise the night duty activities of junior residents.

3.1.5 Health Advocate

**Junior Level**
- To provide a safe environment for patients and staff members.
- To minimize risk to patients undergoing radiological studies.
• To apply the ALARA principle.

**Senior Level**
• To recognize quality improvement opportunities within the imaging environment.
• To apply quality improvement methods for the enhancement of patient and staff safety.
• To apply appropriate and advanced radiation minimization strategies during patient care.
• To participate in imaging-related community or healthcare facility awareness efforts.

**3.1.6 Scholar**

**Junior Level**
• To set personal learning goals and objectives during rotations.
• To focus on basic introductory texts relevant to each rotation.
• To understand methods for extracting scientific information from the medical literature.
• To teach medical students, technologists, and peers.
• To contribute to teaching files.

**Senior Level**
• To assume a leadership role while teaching others, with teaching/supervision of junior residents on rotation, elective students, and off-service residents.
• To know how to search for information about rare or unusual cases.
• To understand methods for executing good clinical research projects.
• To demonstrate the ability to critically appraise journal articles.
• To practice evidence-based medicine.

3.1.7 Professional
• To adhere to relevant Islamic principles, medical ethics, and medicolegal requirements.
• To act as a role model and mentor for junior staff.
• To deliver the highest-quality care with integrity, honesty, and compassion.
• To exhibit appropriate personal and interpersonal professional behavior.
• To assess one’s own performance, strengths, limitations, and weaknesses.
• To maintain patient and family confidentiality.
• To demonstrate a sense of accountability.
• To demonstrate a commitment to his/her patients, profession, and society and to his/her own personal development.

3.2 Rotational Objectives

3.2.1 CT Body Rotation

<table>
<thead>
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<th>Number of rotation months</th>
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</table>

In addition to the general competencies addressed under 3.1 General Radiological Objectives (competencies), the following competencies are also required for this rotation.

Medical Expert
Junior Resident Knowledge
• To recognize basic radiological anatomy and variants based on CT, including but not limited to internal viscera, abdominal
organs, omentum, mesentery and peritoneum, abdominal vessels, and abdominal spaces.

- To understand the basic physical principles behind CT and the associated protocols and techniques, effects of modifying scanning parameters on image quality, and patient radiation dose.
- To understand the indications and absolute and relative contraindications for various contrast media.
- To recognize the appropriate indications and contraindications for various abdominal CT protocols.
- To recognize abdominal radiological emergencies and common pathologies and understand their management.
- To list the most important differential diagnoses for various CT imaging findings.

**Junior Resident Skills**

- To identify and manage reactions to contrast media.
- To appropriately perform and prescribe radiological examinations.
- To recognize and describe imaging techniques and findings.
- To generate an accurate and informative radiological report.

**Senior Resident Knowledge**

- To recognize detailed and complex anatomy on CT images.
- To understand the advanced physical principles behind radiological techniques (iterative reconstruction versus filtered back projection).
- To understand advanced imaging techniques and problem-solving methods (dual energy imaging techniques).
- To recognize unusual imaging presentations of common pathologies.
• To develop a strong fund of differential diagnoses for various abdominal CT findings.
• To recognize and recommend the most appropriate next step in patient management.

Senior Resident Skills
• To generate an appropriate opinion about complex imaging findings.
• To perform common post-processing tasks for abdominal imaging studies, including multiplanar reformation (MPR), maximum intensity projection (MIP), minimum intensity projection (MinIP), and vessel analysis.
• To acquire and practice basic skills related to imaging informatics (fetching and transferring images to and from advanced visualization systems).

Examples of useful reading material
3.2.2 Breast Imaging

<table>
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<th>Number of rotation months</th>
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In addition to the general competencies addressed under General Radiological Objectives, the following competencies are also required for this rotation.

By the end of training, the residents must demonstrate basic knowledge, technical skills, and the attitude necessary for the competent performance of all aspects of breast imaging.

Medical Expert
Junior Resident Knowledge

- To demonstrate an understanding of appropriate positioning and basic mammographic techniques.
- To recognize a good-quality mammogram.
- To recognize commonly encountered physiological breast changes.
- To demonstrate an understanding of important technical and physical factors important for obtaining an optimal mammographic study.
- To recognize the need for diagnostic mammography, including additional mammographic views as necessary.
- To demonstrate the ability to identify the mammographic/sonographic features of malignant and benign breast diseases.
- To demonstrate the ability to develop a sound approach toward the assessment of breast calcifications and masses.
- To demonstrate the ability to understand the role of ultrasound in breast imaging.
- To demonstrate an understanding of the indications for stereotactic biopsy, US-guided core biopsy, and cyst aspiration.
- To demonstrate familiarity with evaluation of the male breast.
Junior Resident Skills
- To describe the mammographic/sonographic features of malignant and benign breast diseases.
- To recognize and describe the approach toward the assessment of breast calcifications and masses.
- To generate an effective mammography/sonography report according to recent ACR-Lexicon.

Senior Resident Knowledge
- To demonstrate an understanding of common imaging-related artifacts.
- To recognize the clinical impact of physiological breast changes related to advanced breast imaging modalities.
- To recognize a good-quality mammogram, ultrasound, and MRI.
- To demonstrate the ability to discuss the technical and physical aspects important for obtaining optimal breast MRI/US studies.
- To recognize the need for additional breast imaging studies.
- To demonstrate the ability to identify the features of malignant and benign breast diseases using various imaging modalities.
- To understand the steps of core needle biopsy/localization techniques.
- To demonstrate an understanding of the indications and techniques for stereotactic biopsy, US-guided core biopsy, and cyst aspiration.
- To demonstrate the ability to establish a plan for the management or follow-up of probably benign disease/lesions.
- To demonstrate an understanding of the techniques and indications for galactography.
- To demonstrate familiarity with the evaluation of postsurgical and postradiation breast changes.
- To demonstrate an understanding of the radiological–pathological correlation and understand patient management in case of pathological variations from the mammographic study findings.
- To demonstrate a basic understanding of the indications for and interpretation of breast MRI studies.
Senior Resident Skills

- To develop a sound approach toward the management of breast calcifications and masses.
- To establish a plan for the management/follow-up of probably benign lesions.
- To perform targeted breast ultrasound (when feasible).
- To describe the steps of core needle biopsy/ localization techniques.
- To generate an effective mammography/sonography/MRI report according to recent ACR-Lexicon.

Examples of useful reading material

- Breast Imaging: The Core Curriculum, by Gilda Cardinosa
- Breast Imaging Companion, by Gilda Cardinosa
- Breast Imaging: The requisites, by Debra Ikeda
- Breast Imaging: Case Review Series by Cecilia M Brennecke MD
- Diagnostic Imaging: Breast, by Wendie Berg
3.2.3 General Diagnostic Ultrasound

<table>
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<th>Number of rotation months</th>
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*The first rotation must be spent performing hands-on scanning. See section 4.1.2 Imaging Examination Techniques

In addition to the general competencies addressed under section 3.1 General Radiological Objectives (competencies), the following competencies are also required for this rotation.

**Medical Expert**

Junior Resident Knowledge

- To understand the basic physical principles of diagnostic ultrasound, including the basic physics of sound transmission, transducer design and applications, image formation and interpretation, and potential artifacts
- To gain knowledge of the ultrasonographic anatomy of the abdomen and pelvis.
- To understand the advantages and disadvantages of ultrasound compared with those of other imaging modalities in terms of both clinical and radiological diagnoses.

Junior Resident Skills

- To demonstrate the ability to perform a thorough ultrasound examination of the abdomen and pelvis (during first/technical month of R1) by starting the scanner and selecting the appropriate transducer(s), setting the TGC controls, and exposing and developing the hard-copy images, if necessary.
- To demonstrate the ability to identify common abdominal/pelvic abnormalities encountered in daily practice.
• To observe small organs during scanning (thyroid, breast, scrotum) and interventional procedures, which will vary according to patient referrals.
• To gradually assume responsibility for each abdominal/pelvic patient examination, subsequently reviewing each case with the radiologist in charge prior to reporting.
• To familiarize himself/herself with applications of abdominal and peripheral Doppler examinations, particularly peripheral venous Doppler studies.

Senior Resident Knowledge
• To expand his/her knowledge of the physics of ultrasound to include the following:
  o Physics of duplex and color Doppler
  o Basic Doppler spectral analysis
  o Methods of quality control
• To understand the advantages and limitations of percutaneous fine needle aspiration biopsy.
• (Encouraged) To understand the basics of obstetrical imaging, including obstetrical complications and common fetal anomalies.

Senior Resident Skills
• To demonstrate the ability to scan small organs (breasts, thyroid, scrotum) and perform gynecological ultrasound examination, including transvaginal scanning, in addition to routine imaging.
• To demonstrate the ability to perform some basic duplex Doppler studies, such as Doppler venous studies, upper and lower extremity studies, and carotid and renal artery studies.
• To attend and participate in ultrasound-guided biopsies as delegated by the supervising radiologist, once the expected level of skills in scanning has been achieved (this may be alternatively accomplished during interventional rotations).
• To supervise and/or perform daily scheduled ultrasound examinations (may include neonatal heads) in consultation with the supervising radiologist, as agreed upon with the individual radiologist, on a daily basis.
• Additional expertise in arterial/venous Doppler and ultrasound-guided biopsies will be acquired.
• To demonstrate the ability to manage the patient independently during a procedure, in close association with the specialist or referring physician. The resident should know when the patient’s best interests are served by discontinuing a procedure or referring the patient to another physician.

Specific Objectives under the Medical Expert Role
I. Background/Technical Considerations
   A. PHYSICS
   • Definition of ultrasound and relationship of sound waves used in imaging and those of higher/lower frequency with other properties.
   • Frequency, sound speed, wavelength, and intensity/decibels.
   • Interaction of sound waves with tissues, including reflection, attenuation, scattering, refraction, absorption, and acoustic impedance.
   • Generation/detection of ultrasound waves.
   • Doppler phenomenon.
   • Pulse-echo principles.
   • Beam formation/focusing.

   B. BIOEFFECTS/SAFETY
   • Thermal/nonthermal effects on tissue.
   • Relative effects of gray scale, M-mode imaging, pulsed wave Doppler, color flow imaging, power imaging, and harmonics.
   • Contrast agents.

   C. IMAGING APPLICATIONS/EQUIPMENT OPERATION
   • Transducer choice.
• Frequency: gray scale/Doppler (understand tradeoff of penetration/resolution); the optimal gray scale probe may not be the optimal Doppler probe.
• Shape: linear, sector, curved.
• Approach: external, endocavitary, translabial.
• Display: gray scale, M-mode, pulsed wave Doppler, color/power imaging, three dimensional.
• Image orientation: standard images in different planes.
• Image optimization: power output, gain, time gain compensation.
• Image recording options: electronic, film, paper, and videocassette.
• Endocavitary imaging: vaginal, rectal, endoscopic techniques.
• Interventional techniques.

D. ARTIFACTS
• Underlying principles (straight narrow sound beams, simple reflection, and constant sound speed).
• Beam width artifacts, side lobes, slice thickness.
• Multiple reflection artifacts: mirror image/reverberations.
• Tissue characteristics: shadowing/enhancement.
• Refractive artifacts.
• Doppler artifacts: pulse wave, color imaging (including aliasing).

E. QUALITY ASSURANCE
• Equipment QA Program
• Phantoms: spatial/contrast resolution
• Sonologist-/physician-based QA

II. Clinical Applications of Ultrasound
A. GENERAL CONSIDERATIONS
• The protocols for each routine examination should be understood. Published protocols from the American Institute of Ultrasound in Medicine (AIUM) or the American College of Radiology (ACR), with or without local modifications, are acceptable frames of reference.
• Basic cross-sectional/ultrasound anatomy/range of normal sonographic findings based on age and sex for each of the anatomic areas included below.
• General diagnostic criteria used to evaluate tissue characteristics and to distinguish normal from abnormal, cystic from solid, etc.
• Clinical applications/limitations of ultrasound and the use of other imaging studies to complement ultrasound.
• Techniques for ultrasound-guided invasive procedures, including aspiration (tissue masses, fluid collection), biopsy, catheter placement (pleural, peritoneal, other fluid collection), and amniocentesis.
• Reporting skills/requirements.

B. SPECIFIC APPLICATIONS

NECK
• Thyroid: size, shape, multinodular goiter, benign/malignant neoplasms, associated adenopathy, localization of parathyroid masses, biopsy of thyroid/parathyroid masses or adenopathy.
• Vascular examinations: carotid duplex examinations (with Doppler spectrum analysis), including normal appearance, arterial occlusion, stenosis, plaque, subclavian steal, jugular thrombosis.

CHEST
• Pleural fluid: simple vs. loculated/complex masses, aspiration/catheter drainage of fluid.
• Vascular: subclavian vein thrombosis.
• Breast: cystic vs. solid masses, malignancies, abscesses, ultrasound-guided needle localization/biopsy/cyst aspiration.
• Cardiac: pericardial effusion.

ABDOMEN
• Liver: normal size, shape, echo texture, Doppler and color imaging of the hepatic arteries and veins and portal veins, diffuse disease, focal mass (cyst, hemangioma, hepatocellular carcinoma, metastatic lesions), cirrhosis/portal hypertension, varices, transplant evaluation, intrahepatic portosystemic shunt Doppler evaluation.
- Gallbladder/bile ducts: normal gallbladder, intra- and extrahepatic duct size, gallstones, acute cholecystitis (calculus/acalculous), hyperplastic cholecystosis, sludge, polyps, carcinoma, HIV-related biliary disease, biliary obstruction/dilatation, duct stones.
- Pancreas: normal anatomy/size, duct size, acute/chronic pancreatitis, pseudocyst, calcifications, cysts, masses (benign/malignant).
- Spleen: normal anatomy/size, focal lesions (cystic vs. solid), trauma, splenic varices.
- Kidneys/Ureters: normal anatomy/size, cysts (simple/complex), cystic diseases, renal cell carcinoma, angiomyolipoma, hydronephrosis/hydrourerter, calculi, abscess/pyelonephritis, perinephric fluid, renal arterial Doppler (including the use of the resistive index), renal transplant evaluation (include Doppler).
- Adrenal glands: focal lesion (cyst/solid).
- Peritoneal cavity: localization/quantification/aspiration of fluid (free/loculated), including abscess, blood, omental mass, and free air.
- Gastrointestinal tract: normal appearance, appendicitis, pyloric stenosis, intussusception, mass.
- Retroperitoneum/vessels: adenopathy, aorta (normal/aneurysm, including proximal and distal extents), inferior vena cava (normal/thrombosis).

PELVIS (without pregnancy)
- Urinary bladder: mass, calculi, obstruction, infection, diverticula, ureterocele, color flow imaging of ureteral jets.
- Ovary: normal size, shape, echogenicity, physiological variation (follicles, corpus luteum). Torsion, infection, abscess, cystic/solid
mass. Cystadenoma/carcinoma, hemorrhagic cyst, dermoid cyst, endometrioma.

- Fallopian tubes: hydrosalpinx, pyosalpinx.
- Prostate: normal size, shape, echogenicity, cystic/solid mass, carcinoma, abscess, biopsy.
- Scrotum: normal size, shape, echogenicity of testis and epididymis, cystic/solid testicular or extratesticular mass. Testicular carcinoma, torsion, epididymitis/orchitis, varicocele, hydrocele, spermatocele, trauma.

**EXTREMITIES**

- Vascular: venous thrombosis evaluation (upper and lower extremities) with compression/Doppler/color imaging, venous insufficiency, aneurysm, pseudoaneurysm/compression, arteriovenous fistula.
- Musculoskeletal: cystic/solid mass, torn/inflamed tendon, neonatal hip, foreign body.

**OBSTETRICS (EARLY PREGNANCY)**

- Normal findings: gestational sac appearance, size, growth, yolk sac, embryo, cardiac activity, amnion, chorion, embryology, normal early fetal anatomy/growth, crown rump measurement, multiple gestations, correlation with hCG levels.
- Abnormal findings: spontaneous abortion, embryonic death, blighted ovum, bleeding/hematoma, ectopic pregnancy, gestational trophoblastic disease, gross embryonic structural abnormalities.

**SECOND/THIRD TRIMESTER (encouraged)**

- Normal findings: fetal anatomy/development, placenta, biometry, amniotic fluid, multiple gestations, umbilical cord Doppler, alpha-fetoprotein testing, complete examination according to the AIUM/ACR guidelines. Amniocentesis, chorionic villous sampling guidance.
- Nonfetal abnormalities: oligohydramnios, polyhydramnios, placenta previa, placental abruption, placental masses, two-vessel umbilical cord, cord masses, cervical shortening/dilatation (including translabial imaging).

Understand the significance of borderline findings: choroid plexus cyst, echogenic focus in the heart, echogenic bowel, borderline hydrocephalus.

Examples of useful reading material

Junior Rotation
- Primer of Diagnostic Imaging. 5th Edition (Consult relevant information for clinical understanding of ultrasound).
- ACR US teaching files.

Senior Rotation
3.2.4 Fluoroscopy/Emergency Radiology Rotation

<table>
<thead>
<tr>
<th>Number of rotation months</th>
<th>R1</th>
<th>R2</th>
<th>R3</th>
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In addition to the general competencies addressed under 3.1 General Radiological Objectives (competencies), the following competencies are also required for this rotation.

**Rotation Structure**

The first rotation will include 1 week of observation and assisting technologists in a variety of digital radiological examinations. Please see section 4.1.2 Imaging Examination Techniques for further details.

The remainder of the time spent in these rotations will be used to combine simultaneous clinical practice, performance, and reporting of the following:

- Adult fluoroscopic examinations
- Emergency department X-ray studies
- Adult routine abdominal X-ray studies

**Medical Expert**

**ER Junior Resident Knowledge**

After completing 1 month of ER imaging, the resident should demonstrate the following:

- Know the most frequent indications for standard radiographic imaging
- Recognize the normal anatomy of the chest, abdomen, pelvis spine, and extremities on radiographs.
- Familiarize with the different lines and tubes seen on radiographs and learn how to detect their complications and displacement.
- Recognize pathologies and discuss the characteristics of commonly seen pathologies.
- Know the most frequent indications for emergency CT.
- Know how to detect normal variations.
FL Junior Resident Knowledge

- To learn the indications and absolute and relative contraindications for various fluoroscopic procedures and the relevant contrast media used.
- To know when and how to use different types of contrast media, e.g., barium, high and low osmolar contrast media.
- To familiarize with the different lines and tubes seen on radiographs and learn how to detect their complications and displacement.
- To understand the appropriate indications, views, and patient positions for emergency radiographic studies.
- To list the most important differential diagnoses for relevant imaging findings.

Junior Resident Skills

- To safely perform basic fluoroscopic techniques, with appropriate positioning and guidance of the patient. This includes common upper and lower GI studies (swallow, meal, and enema) and common GU studies (intravenous and retrograde pyelography, VCUG, urethrography, and hysterosalpingography).
- To demonstrate the ability to detect the most common findings encountered in these basic examinations, such as anatomic variants, tumors, stenoses, ulcers, and functional abnormalities.

Senior Resident Knowledge

- To recognize unusual radiographic and fluoroscopic appearances of common pathologies.
- To recognize the most appropriate next step in emergency and fluoroscopic patient management.
- To recognize the common patterns of disease on nonemergency abdominal radiographs and their differential diagnoses, including but not limited to abdominal masses, calcifications, and bowel wall thickening.
Senior Resident Skills

- To appropriately perform advanced fluoroscopic techniques, including small bowel follow through, fistulography and cholangiography/ERCP, and examination of difficult patients.
- To demonstrate the ability to supervise technical staff and ensure accurate performance of fluoroscopic studies.

Manager

To demonstrate awareness of the indications for standard CR imaging as well as urgent CT examinations.

Health advocate

Junior Level
To select the safest and best-suited approach for a fluoroscopic procedure.

Senior Level
To apply techniques to minimize exposure doses during fluoroscopic procedures, both for the patient and for the radiologist and staff.

Examples of useful reading material

- Textbook of Gastrointestinal Radiology, 2-Volume Set, 2014, by Richard M. Gore, MD and Marc S. Levine, MD
- Gastrointestinal Radiology: A Pattern Approach, 1996, by Ronald L. Eisenberg
- Emergency Radiology: Case Studies, 2007, by David Schwartz
- Textbook of Uroradiology, 2012, by Reed Dunnick, MD and Carl Sandler, MD
- Aids to Radiological Differential Diagnosis, 6th ED, by Stephen G. Davies, Stephen Chapman, & Richard Nakielny
### 3.2.5 Body Magnetic Resonance Imaging Rotation

<table>
<thead>
<tr>
<th>Number of rotation months</th>
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In addition to the general competencies addressed in section 3.1 General Radiological Objectives (competencies), the following competencies are also required for this rotation.

**Medical Expert**

**Junior Resident Knowledge**
- To recognize basic abdominal radiological anatomy and variations based on MRI and their various appearances on different sequences (T1WI, T2WI, DWI, dynamic contrast-enhanced sequences), including but not limited to internal viscera, abdominal organs, omentum, mesentery and peritoneum, abdominal vessels, abdominal spaces, prostate, pelvic floor, genitourinary organs, and pelvic organs.
- To understand the basic physical principles behind MRI and the associated protocols and techniques, effects of modified scanning parameters on image quality and acquisition time, and common MRI artifacts.
- To list the most important differential diagnoses for various body MRI findings.
- To understand the basics of MRI safety and hardware (coils, magnet, etc.).

**Junior Resident Skills**
- To practice measures for MRI contrast safety and the prevention of nephrogenic systemic fibrosis (NSF).
- To appropriately perform and prescribe body MRI examinations.
- To recognize and describe body MRI techniques and findings.
- To generate an accurate and informative body MRI report.

**Senior Resident Knowledge**
- To recognize detailed and complex radiological anatomy.
• To understand the advanced physical principles behind MRI sequences (motion-insensitive sequences, parallel imaging, spectroscopy, perfusion, diffusion, elastography).
• To understand organ-specific contrast agents, advanced imaging techniques, and problem-solving procedures.
• To understand advanced imaging techniques (MR enterography, MR elastography, MR defecography, iron quantification).
• To recognize unusual imaging presentations of common pathologies.
• To develop a strong fund of differential diagnoses for body MRI findings.
• To recognize and recommend the most appropriate next step in patient management.

**Senior Resident Skills**

• To generate an appropriate opinion about complex imaging findings.
• To perform common post-processing tasks for abdominal MRI studies, including multiplanar reformation (MPR), maximum intensity projection (MIP), minimum intensity projection (MinIP), and vessel analysis. To process ADC maps from different b-values and produce perfusion maps (multiparametric prostate imaging).
• To acquire and practice basic skills related to imaging informatics (fetching, transferring images to and from advanced visualization systems).

**Examples of useful reading material**

3.2.6 Nuclear Medicine/PET Imaging Rotation

<table>
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In addition to the general competencies addressed in section 3.1 General Radiological Objectives (competencies), the following competencies are also required for this rotation.

Medical Expert
Junior Resident Knowledge

- **Basic Science**
  - Basic statistics
  - Quantitative imaging and basic modeling
  - Radiation dose from radiopharmaceuticals
  - Management of radiation accidents related to radionuclide radiology
  - Principles of quality assurance in the radiopharmacy

- **Regulatory Framework**
  Appreciation of legislative frameworks

- **Clinical Application for Each System**
  - Appropriate anatomy, physiology, pathophysiology, and biochemistry of systems under investigation
    - Indications for specific radiotracers, including sensitivity and specificity
    - Role of comparative imaging tests
    - Radiation protection issues for each choice of tracer
    - Role of PET-CT in the staging of malignancies

- **System-Specific Knowledge: CNS**
  - Radiopharmaceuticals for use in CNS imaging, e.g., cerebral blood flow, blood–brain barrier, and neuroreceptor imaging

- **System-Specific Knowledge: Endocrine**
  - Adrenal, thyroid, and parathyroid imaging and uptake measurements where appropriate
• System-Specific Knowledge: Gastrointestinal
  o Includes salivary gland imaging, gastrointestinal transit studies, gastrointestinal blood loss, Meckel’s diverticulum imaging
  o Hepatic and hepatobiliary studies
• System-Specific Knowledge: Infection and Inflammation
  o Basic science of infection/inflammation, including cellular mechanisms
  o Clinical spectrum of occult sepsis
• System-Specific Knowledge: Lymphoscintigraphy
  o Lymphedema evaluation and sentinel node localization
  o Mechanisms of tumor spread and concept of the sentinel node
• System-Specific Knowledge: Oncology
  o Imaging of tumor sites using radionuclide techniques, including introductory PET-CT and hybrid imaging
• System-Specific Knowledge: Ophthalmic System
  o Nasolacrimal drainage
• System-Specific Knowledge: Pediatrics
  o Imaging of children using radionuclides
  o Understanding of the growth and maturation of children with special reference to the handling of radiotracers by immature organs
  o Specific indications for children, particularly with regard to the renal tract, biliary tract, and skeleton
  o Knowledge of statutory issues related to children (e.g., Children’s Act)
  o Principles of consent with regard to children
• System-Specific Knowledge: Pulmonary System
  o Pulmonary embolism, regional ventilation, mucociliary and small solute clearance
  o Clinical risk factors and presentation of PE
  o Indications for and evidence base supporting ventilation perfusion imaging
• Contribution of D-dimer measurements and leg Doppler studies and role of CTPA
• Clinical features and management of obstructive pulmonary disease, bronchiectasis, and alveolitis and correlation with imaging findings

• **System-Specific Knowledge: Skeletal System**
  o Bone and bone marrow scans

• **System-Specific Knowledge: Urogenital System**
  o Renal and bladder function

**Junior Resident Skills**

• **Basic Science**
  o Practical experience with monitoring devices, probes, dose calibrators, gamma cameras, and positron emission tomography systems
  o Safe handling and administration of radiopharmaceuticals
  o Practical management of radioactive contamination

• **Clinical Application**
  o Patient preparation prior to the test
  o Choice of radiopharmaceutical
  o Radiotracer preparation and its quality assurance
  o Measurement and drawing up of tracer
  o Radiopharmaceutical injection
  o Auditing of study outcomes
  o Review of sequential data for patients and comparison with other assessment methods

• **System-Specific Skills: Endocrine**
  o Utility of intraoperative probe detection of parathyroids

• **System-Specific Skills: Lymphoscintigraphy**
  o Surface localization of the sentinel node
  o Calibration and use of the hand help probe

• **System-Specific Skills: Cardiovascular System**
  o Setting up of instrumentation prior to ECG gating and SPECT acquisition
- Performance of physiological or pharmacological stress tests prior to myocardial perfusion studies
- Techniques of tomography reconstruction and qualitative and quantitative analyses

**Senior Resident Knowledge**

- **Basic Science**
  - Parametric and nonparametric statistics
  - Modeling tracer kinetics and quantitative imaging
  - Calculation of radiation dose from radiopharmaceuticals (effective dose)
  - Management of radiation accidents related to radionuclide radiology
  - Physicochemical and biological properties of less common radiopharmaceuticals and those under development
  - Cell labeling techniques
  - Quality control parameters determining the quality of radiopharmaceuticals, including radionuclide and radiochemical purity

- **Regulatory Frameworks**
  - Understanding of Saudi Arabia regularity frameworks related to the practice of radionuclide radiology
  - Understanding NCCN guidelines for regulation of PET-CT practice indications

- **Clinical Application For Each System**
  - Role of PET-CT in staging of malignancies

- **System-Specific Knowledge: CNS**
  - Role of PET-CT in neurodegenerative diseases, Parkinson’s disease, and epilepsy, with general awareness of non-FDG tracers

- **System-Specific Knowledge: Endocrine**
  - Clinical presentation of thyroid disease
  - Role of complementary investigations, including thyroid biochemistry and immunology
○ Imaging of endocrine tumors, e.g., carcinoid, APUD
○ Familiarity with the use of intraoperative probe detection of parathyroids
○ Indications for PET-CT in cases of thyroid tumors

- **System-Specific Knowledge: Gastrointestinal**
  ○ Splenic function assessment
  ○ Imaging of inflammatory bowel disease

- **System-Specific Knowledge: Lymphoscintigraphy**
  ○ Familiarity with hybrid imaging techniques

- **System-Specific Knowledge: Oncology**
  ○ Imaging of tumor sites using radionuclide techniques, including PET-CT
  ○ Role in diagnosis, staging, localization, therapy, and monitoring responses to treatment
  ○ Role in relation to other imaging techniques

- **System-Specific Knowledge: Cardiovascular System**
  ○ Myocardial perfusion imaging, infarct imaging, and radionuclide ventriculography
  ○ Principles of myocardial perfusion and SPECT imaging
  ○ Imaging protocols used to evaluate myocardial viability
  ○ Role of other diagnostic tests and imaging studies relevant to cardiology

- **PET-CT: Basic Science**
  ○ Theory of production and decay of positron radionuclides used in clinical PET and PET-CT
  ○ Compartment analysis methods
  ○ Appropriate mathematics and physics applied to the PET tracer theory, modeling of tracer kinetics, and quantitative imaging
  ○ Radiopharmacy of the tracers used in PET
  ○ Physiological principles of the techniques
  ○ Dosimetry of the various tracers used
  ○ Legal aspects associated with tracers
  ○ Methods of measurement of tracer activity and imaging equipment required
  ○ SUV quantification, variables, and errors associated with quantitative measurements
- Understanding of equipment and dedicated PET and PET-CT
- Cyclotron physics
- Physiology and patient preparation, fasting diabetes levels, use of sedation

**PET-CT: Role in Oncology**
- Basic science of tumor metabolism
- Normal and physiological variations in tracer distribution and overlap with benign conditions leading to FDG uptake
- PET tracers used for tumor detection
- Effects of chemotherapy and radiotherapy
- Role in tumor diagnosis, staging, and recurrence
- Role with respect to comparative imaging

**PET-CT: Role in Neuropsychiatry**
- Normal variation of PET tracers within the brain
- Role in diagnosis of common brain disorders such as epilepsy and dementia
- Role in the evaluation of brain tumors
- Role with respect to comparative imaging

**PET-CT: Role in Cardiology**
- FDG PET for the assessment of myocardial viability
- Assessment of myocardial ischemia using other PET tracers, e.g., Rb-, N-13 ammonia, O-15 water
- Principles of pharmacological stress tests
- Control and monitoring of glucose metabolism for FDG injections
- Role with respect to comparative imaging

**Functional and Molecular Imaging**
- Relationship of radionuclide imaging with other functional imaging techniques, e.g., functional MRI, spectroscopy, perfusion imaging, and diffusion-weighted imaging
Senior Resident Skills

- **Basic Science**
  - Practical experience with monitoring devices, probes, dose calibrators, gamma cameras, and positron emission tomography systems
  - Safe handling and administration of radiopharmaceuticals
  - Handling of incidents of radioactive spillage or contamination

- **Clinical Application**
  - Choice of protocols
  - Familiarity with setting up of instrumentation, choice of collimator, and scanning procedures
  - Familiarity with data processing, image reconstruction, quantification, and image display
  - Image variants, artifacts, sources of error, and assessment of utility
  - Auditing of study outcomes
  - Review of sequential data for patients and comparison with other assessment methods

- **System-Specific Skills: Endocrine**
  - Clinical examination of the thyroid
  - Correlation of imaging and clinical findings

- **System-Specific Skills: Cardiovascular System**
  - Familiarity with techniques of tomographic reconstruction, filter selection, and qualitative and quantitative analyses

- **Basic Science**
  - Practical experience with monitoring devices, probes, dose calibrators, gamma cameras, and positron emission tomography systems

- **Role of PET-CT**
  - Patient preparation prior to the test
  - Choice of radiopharmaceutical
  - Measurement and drawing up of tracer
  - Radiopharmaceutical injection
  - Setting up of instrumentation, choice of collimator, and scanning procedure
• Data processing, image reconstruction, quantification, and image display
• Image interpretation and reporting (including PET-CT), including normal variations, artifacts, sources of error, and assessment of utility
• Auditing of study outcomes
• Review of sequential data for patients and comparison with other assessment methods

• SPECT and PET Machines
  • Knowledge of the type of crystals used and appropriate settings for each examination
  • Knowledge of the crystal energy ranges and the clinical impact on image quality and interpretation
  • Performance of daily QCs with the medical physicist and understanding of the effects of the results on final diagnosis interpretations
  • Methods to prevent artifacts by changing machine settings and software

• Radiation Protection
  • Radiopharmacy guidelines and practices
  • Radiation protection techniques during diagnostic and therapeutic dose deliveries
  • Radiation protection during injection and dose delivery in the facility and department
  • Radiation protection for the patient, environment, and hospital staff

Communicator
Junior Level
  • To counsel and obtain consent from high-risk patients for the use of high-energy, high-dose, and beta-emitting tracers used for diagnosis and therapy.

Senior Level
  • To deliver clear clinical instructions to patients undergoing PET-CT, with FDG preparation minimum 24 hours before scanning.
To clearly instruct the patient about prohibited examinations and food intake prior to specific NM or PET examinations such as thyroid scanning, iodinated IV contrast administration, and iodine salt intake.

To counsel and obtain consent from high-risk patients for the use of high-energy, high-dose, and beta-emitting tracers used for diagnosis and therapy.

To deliver solid and clear instructions regarding radiation protection for the treated patients and methods of dealing with breast feeding and maintaining appropriate distance from children & family, in addition to environmental safety instructions such as those pertaining to toilet utilization.

**Collaborator**

*Junior Level*
- To interact with other departments with regard to delivery of the appropriate tracer and dose, including the radiopharmacy, cyclotron, and medical physics departments.
- To request the daily QC report for the radioactive material and SPECT and PET machines from other relevant departments.

*Senior Level*
- To interact with other departments with regard to delivery of the appropriate tracer and dose, including the radiopharmacy, cyclotron, and medical physics departments.
- To request the daily QC report for the radioactive material and SPECT and PET machines from other relevant departments.

**Manager**

*Junior Level*
- Time management for delivery of the radioactive material, taking into consideration the half-life of the tracer and its effects on scanning quality and SUV value calculation for determining the impact on the clinical judgment.

*Senior Level*
- Time management for delivery of the radioactive material, taking into consideration the half-life of the tracer and its effects on
scanning quality and SUV value calculation for determining the impact on the clinical judgment.

- Management of the patient uptake time and the time required for necessary settings in the uptake rooms, such as light, sound, privacy, and room temperature, all of which need to be carefully standardized and supervised, considering their impact on the final image quality and clinical judgment.

**Health Advocate**

**Junior Level**
- To participate in spreading awareness about the inappropriate use of NM.
- To promote adherence to hospital and international appropriateness criteria for diagnostic NM.

**Senior Level**
- To participate in spreading awareness about the inappropriate use of PET and NM.
- To promote adherence to hospital and international appropriateness criteria for diagnostic and therapeutic PET and NM.

**Examples of useful reading material**
- The Requisites of Nuclear Medicine (for junior residents), by Harvey A. Ziessman, Janis P. O’Malley, James H. Thrall
3.2.7 Neuroradiology Rotation

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In addition to the general competencies addressed in section 3.1 General Radiological Objectives (competencies), the following competencies are also required for this rotation.

Medical Expert
Junior Resident Knowledge
- To understand the basic imaging anatomy of the brain, skull, paranasal sinuses, facial bones, orbits, and neck, along with the normal variations.
- To demonstrate an understanding of the basics of CT and MRI physics and techniques related to neuroimaging.
- To recognize the indications and contraindications for different neuroimaging examinations.
- To recognize the indications and contraindications for CT and MR contrast material administration.
  - To understand the imaging findings and management of the following neuroemergencies: Intracranial and spinal bleeding
  - Stroke
  - Cerebral edema
  - Cerebral venous thrombosis
  - Acute white matter diseases
  - Brain herniation
  - Hydrocephalus
  - Cerebral and meningeal infections
  - Traumatic injury of the brain, skull, face, and neck
  - Traumatic spine injuries
  - Spinal cord compression
- To understand the imaging findings and management of the following common neurological and head and neck problems:
  - Common congenital malformations
• Common inflammatory diseases
• Common neoplasms
• To list common differential diagnoses for various imaging findings.

Junior Resident Skills
• To exhibit competency in prioritization, protocol development, and interpretation of normal and abnormal neuro-CT and MRI studies.
• To identify and appropriately manage contrast media complications.
• To exhibit competency in the interpretation of normal and common abnormalities of the brain and spine and neuroemergencies.
• To perform basic post-processing of vascular and volumetric neuro-CT and MRI studies.

Senior Resident Knowledge
• To understand detailed and complex imaging anatomy of the brain, skull, paranasal sinuses, facial bones, orbits, and neck.
• To demonstrate an understanding of the advanced CT and MRI physics and techniques related to neuroimaging, e.g., perfusion, tractography, spectroscopy, etc.
• To demonstrate a basic understanding of the indications for and the techniques and risks of cerebral and spinal angiography.
• To understand usual and unusual imaging findings and manage the following common neurological and head and neck problems:
  o Congenital malformations
  o Inflammatory and infective conditions
  o Neoplasms
  o Degenerative diseases
• To correlate imaging findings with clinical data and other imaging data and generate appropriate lists of differential diagnoses.
• To recognize and recommend the most appropriate next step during management.
Senior Resident Skills
- To perform and interpret fluoroscopy-guided lumbar myelography.
- To generate an appropriate opinion about complex brain, head and neck, and spinal studies.
- To perform advanced post-processing of vascular, volumetric, and functional neuro-CT and MRI studies.
- To acquire and practice basic skills related to imaging informatics with regard to neuroimaging.
- To appropriately present and discuss cases in multidisciplinary meetings.

**Communicator**

**Junior Level**
- To counsel and obtain consent from high-risk patients for the use of iodinated and MRI contrast media for neuroimaging.

**Senior Level**
- To counsel and obtain consent from patients for diagnostic angiography of the brain, spine, and neck.

**Collaborator**

**Junior Level**
- To fast-track and supervise neuroemergency cases during regular working hours to assure proper and timely imaging.

**Manager**

**Senior Level**
- To effectively and efficiently help in assigning cases to various scanners according to the clinical condition and scanner capabilities.

**Health Advocate**
- To participate in spreading awareness about the inappropriate use of neuroimaging.
- To promote adherence to hospital and international appropriateness criteria for neuroimaging.
Examples of useful reading material

Essential
- Radiologic anatomy books, atlases, and online resources

Recommended
- Neuroimaging articles in the following periodicals: Radiographics, Neurographics, Imaging Insights, Radiological clinics of North America, etc.
- Brain Imaging: Case Review Series, by Laurie Loevner, et al.
- Head and Neck Imaging: Case Review Series, by David Yousem.
- Spine Imaging: Case Review Series, by Efrat Saraf-lavi
- Osborn's Brain: Imaging, Pathology, and Anatomy, by Anne Osborn

3.2.8 Interventional Radiology Rotation

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In addition to the general competencies addressed in 3.1 General Radiological Objectives (competencies), the following competencies are also required for this rotation.

Medical Expert
Senior Resident Knowledge
- To describe the normal anatomy of the arterial and venous systems and its relevance to interventional radiology.
- To describe typical endovascular approaches for common disorders using interventional radiology.
- To describe typical approaches for imaging-guided nonvascular procedures.
• To understand the risks involved in common interventional techniques and their management.
• To understand pharmacology, administration, and patient supervision in relation to intraprocedural medications, including sedatives.
• To recognize emergency conditions and their appropriate management.

Senior Resident Skills
• To perform basic catheterization techniques under supervision.
• To perform peripheral arteriography under supervision.
• To perform imaging-guided fluid and abscess drainage.
• To perform imaging-guided biopsy (at least of superficial structures).

Communicator
Senior Level
• To appropriately communicate with the patient in order to obtain informed consent prior to interventional procedures.
• To satisfactorily communicate the outcomes of interventional procedures to patients and their relatives.

Collaborator
Senior Level
To interact appropriately with referring physicians, thus using a team-oriented approach toward patient care.

Manager
• To supervise and teach technical staff to ensure that appropriate support is provided during interventional procedures.

Health Advocate
• To choose the safest and best-suited approach for an interventional procedure.
• To apply techniques to minimize exposure doses during interventional procedures, for both the patient and the radiologist and staff members.
Professional

- To appreciate one’s own limitations and identify the appropriate timing to obtain assistance during interventional procedures.
- To obtain informed consent prior to all procedures.
- To maintain patient dignity and privacy at all times.

Examples of useful reading material

- Vascular and Interventional Radiology: The Requisites, 2e; 2013, by John A. Kaufman, MD, MS, FSIR, FCIRSE, Michael J. Lee, MSc, FRCPI, FRCR, FFR(RCSI), FSIR, EBIR
3.2.9 Musculoskeletal (MSK) Rotation

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In addition to the general competencies addressed in section 3.1 General Radiological Objectives (competencies), the following competencies are also required for this rotation.

**Junior Resident Knowledge**

- To acquire and demonstrate knowledge about radiological anatomy and normal variations in the peripheral and axial skeleton, including the relevant soft tissues and joints.
- To demonstrate the ability to develop an approach toward assessment and diagnosis of tumors and tumor-like conditions, particularly the radiographic features discriminating nonaggressive from aggressive bone lesions.
- To describe the typical radiographic features of common osseous neoplasms.
- To demonstrate the ability to develop an understanding of infection and the methods by which it affects the musculoskeletal system (osteomyelitis, septic arthritis, discitis).
- To demonstrate an understanding of the basic approach toward interpretation of common joint diseases.
- To demonstrate an understanding of fractures and dislocations and their types and general classifications.

**Junior Resident Skills**

- To familiarize with conventional radiographic techniques, including correct positioning for radiographs with special views.
- To appropriately prescribe the protocols for CT and MRI.
- To choose the most suitable method for evaluating musculoskeletal diseases.
- To identify urgent or unexpected findings and communicate them to the referring team in a timely fashion.
**Senior Resident Knowledge**

- To demonstrate the ability to recognize and describe complications of orthopedic devices, including fracture fixation, spine, and arthroplasty hardware.
- To demonstrate the ability to develop an approach toward joint diseases, including knowledge of clinical and imaging features differentiating various forms of arthritis.
- To demonstrate a basic understanding of the relevant clinical management of common musculoskeletal disorders.
- To demonstrate greater efficiency in dealing with plain film examinations and diagnoses, CT and MR interpretations, and case management.
- To demonstrate an understanding of metabolic as well as endocrine and toxic disorders.
- To describe imaging manifestations of miscellaneous MSK disorders, e.g., sarcoidosis, Paget’s hypertrophic osteoarthropathy, osteonecrosis, transient osteoporosis, soft tissue calcification/ossification, etc.
- To demonstrate an understanding of clinical syndromes with MSK manifestations, e.g., neurofibromatosis, etc.
- To demonstrate an understanding of the imaging findings for soft tissue, ligament, and tendon injuries and their associated manifestations.

**Senior Resident Skills**

- To participate in procedural activities and demonstrate an understanding of technical skills and familiarity with indications, patient preparation, and the management of potential complications. In particular, the resident should demonstrate familiarity with the techniques of joint aspirations/injections, e.g., from the shoulder and hip.
- To demonstrate the ability to perform basic CT protocols under limited supervision.
- To perform dynamic functional studies of the joints and muscles.
- To demonstrate familiarity with the appearance of common pathologies on MRI.
- To perform imaging-guided biopsies under supervision.
• To confidently perform post-processing of musculoskeletal images and image fusion.
• To confidently select the optimal imaging parameters for CT and MRI examinations.
• To demonstrate the ability to perform arthrograms and take advantage of any opportunity to learn MSK ultrasound.

**Examples of useful reading material**
- Musculoskeletal MRI, Clyde A. Helms, MD, Nancy M. Major, MD, Mark W. Anderson, MD, Phoebe Kaplan, MD
- Bone and Joint Imaging, 3e, Donald Resnick, Mark Kransdorf
- Fundamentals of Skeletal Radiology, 4e, Clyde A. Helms, MD
- Arthritis in Black and White, 3e, Anne C. Brower, Donald J. Flemming

**3.2.10 Pediatric Rotation**

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*In addition to the general competencies addressed in section 3.1 General Radiological Objectives (competencies), the following competencies are also required for this rotation.*

**Medical Expert**

**Junior Resident Knowledge**

**Conventional radiography**
- To demonstrate basic knowledge in all aspects of pediatric conventional radiography.
- To be competent enough to interpret pediatric inpatient, outpatient, and emergency patient radiographs, including skull X-rays and neck, soft tissue, chest, abdominal, and skeletal radiographs.

**Fluoroscopy**
- To demonstrate basic knowledge of appropriate fluoroscopic techniques to minimize radiation.
• To demonstrate in-depth knowledge of the appropriate indications for a variety of fluoroscopic procedures, including emergencies.
• To demonstrate knowledge about normal anatomy in upper GI studies, contrast enemas, and VCUG studies.

CT
• To demonstrate knowledge about the appropriate indications for a variety of CT procedures, including emergencies.
• To demonstrate basic knowledge about pediatric pathologies and their associated CT findings, including emergencies.

Ultrasound
• To obtain technical knowledge about ultrasound scanning for a wide range of pediatric sonographic studies.
• To be competent enough to determine the appropriate indications for a variety of pediatric sonographic examinations, including emergencies.

MRI
• To demonstrate basic knowledge about general pediatric pathologies and their associated MRI findings, including emergencies.

Junior Resident Skills
• To be competent enough to perform and interpret various GI/GU fluoroscopic studies.
• To be competent enough to deal with various reactions to contrast media, asthmatic children, and children with renal failure.
• To be competent enough to perform and interpret various neonatal and pediatric sonographic emergencies.

Senior Resident Knowledge
Conventional radiography
• To be competent enough to report neonatal radiographs and identify abnormalities such as diseases of prematurity and their complications.
• To identify and report congenital malformations, congenital heart diseases, and skeletal abnormalities such as dysplasias.
• To be competent enough to detect common findings of child abuse and communicate such cases.

Fluoroscopy
• To be competent enough to diagnose advanced pediatric fluoroscopic abnormalities, including emergencies.

CT
• To demonstrate advanced knowledge about pediatric pathologies and their associated CT findings, including congenital thoracic, abdominal, and pelvic malformations and age-specific tumors.

Ultrasound
• To demonstrate competent knowledge of the normal sonographic anatomy of the pediatric brain, spine, head/neck, chest, abdomen, pelvis, small organs, vascular system, and MSK system and their common pathologies.

MRI
• To demonstrate in-depth knowledge about the appropriate indications for a variety of general pediatric MRI procedures, including emergencies.
• To demonstrate advanced knowledge about general pediatric pathologies and their associated MRI findings, such as congenital anomalies and pediatric malignancies.

Senior Resident Skills
• To demonstrate competency in pediatric conventional radiographic quality assurance.
• To be competent enough to diagnose and treat intussusceptions by either pneumatic or contrast reduction techniques.
• To provide specific CT protocols tailored for pediatric patients to minimize radiation exposure.
• To be competent enough to perform and interpret advanced neonatal and pediatric sonographic studies.
• To be competent enough to identify children who require sedation and those who require general anesthesia for CT/MRI studies.
• To be competent enough to prescribe appropriate protocols for specific pediatric MRI examinations.
Examples of useful reading material

- Pediatric Radiology: The Requisites, 3e (Requisites in Radiology) Hardcover – May 27, 2009, by Johan G. Blickman, MD, PhD, FACR (Author), Bruce R. Parker, MD (Author), Patrick D. Barnes, MD (Author)
- Imaging of the Newborn, Infant, and Young Child, ISBN/ISSN: 0-7817-3458-4, Author: Leonard E Swischuk
- Pediatric Sonography, ISBN/ISSN: 0-7817-2753-7, Author: Marilyn J Siegel
- Diagnostic Imaging Pediatrics, ISBN: 141602333X, Author: L. Donnelly
- Diagnostic Imaging Pediatric Neurology, ISBN: 1416049185
- Emergency Imaging of the Acutely Ill or Injured Child, ISBN/ISSN: 0-683-30710-X, Author: Leonard E Swischuk
- The core curriculum: Pediatric imaging, ISBN 0781759803, Author: M.J Siegel
- Practical Pediatric Imaging Diagnostic Radiology of Infants and Children, ISBN/ISSN: 0-316-49473-9, Author: Donald R Kirk
- Cleveland Clinic Children’s Hospital Pediatric Radiology on line learning curriculum https://www.cchs.net/peditaricradiology

3.2.11 Chest Imaging Rotation

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In addition to the general competencies addressed in 3.1 General Radiological Objectives (competencies), the following competencies are also required for this rotation.

Medical Expert
Junior Resident Knowledge

- To demonstrate an understanding of the anatomy of and normal variations in the thorax, including the chest wall, pleura, vessels, mediastinum, and lungs, on conventional radiographs and CT.
• To demonstrate an understanding of pulmonary physiology relevant to imaging interpretation.
• To demonstrate knowledge about the procedure for obtaining chest radiographs and CT scans and the physics governing the acquisition of a satisfactory image.
• To understand techniques to minimize exposure doses during chest radiography and chest CT.
• To describe monitoring and support devices (tubes and lines) and confidently identify them on imaging studies.
• To demonstrate the ability to recognize radiological patterns of diseases and pathological signs in the chest with their differential diagnoses, including consolidation, atelectasis, nodules and masses, interstitial diseases, and diseases of the airways, mediastinum, and pleura.
• To demonstrate the ability to recognize common thoracic emergencies on chest radiographs and CT scans, including pneumothorax, tension pneumothorax, acute aortic emergencies, and acute pulmonary embolism.

Junior Resident Skills
• To demonstrate an organized approach toward interpretation of chest radiographs and CT scans.
• To plan and supervise the appropriate performance of chest radiography, thoracic CT, high-resolution chest CT, and CT pulmonary angiography (CTP).
• To plan and prepare a protocol for CT examination of the chest and adapt the same according to individual cases.
• To perform appropriate common post-processing tasks for thoracic imaging studies, including multiplanar reformation (MPR), maximum intensity projection (MIP), minimum intensity projection (MinIP), and vessel analysis.
Senior Resident Knowledge

- To recognize the secondary pulmonary lobule and its components.
- To recognize and understand the following:
  - Alveolar lung diseases and atelectasis
  - Solitary and multiple pulmonary nodules
  - Benign and malignant lung neoplasms
  - Thoracic disease in immunocompetent, immunocompromised, and post-transplant patients
  - Congenital lung diseases
  - Pulmonary vascular diseases
  - Airway and obstructive lung diseases
  - Interstitial lung diseases
  - Diseases of the pleura and diaphragm
  - Mediastinal and hilar diseases
  - Diseases of the thoracic aorta and great vessels
  - Chest trauma
  - The postoperative chest
- To understand how to plan and prepare a protocol for an MRI examination of the chest and adapt it according to individual cases.
- To demonstrate an understanding of common indications for imaging-guided diagnostic and therapeutic procedures.

Senior Residents Skills:

- To prepare a patient for chest CT, including verification of the indications, venous access, and beta-blocker therapy.
- To choose optimal acquisition parameters and post-processing tools for chest CT.
- To optimize nonroutine CT protocols, e.g., ECG-gated thoracic aorta imaging, low-dose CT, and inspiratory and expiratory protocols.
- To confidently perform radiological staging of bronchogenic cancer
• To independently perform post-processing tasks for chest imaging studies, including multiplanar reformation (MPR), maximum intensity projection (MIP), minimum intensity projection (MinIP), volume rendering (VRT), and vessel analysis.

• To demonstrate an understanding of common indications for imaging-guided diagnostic and therapeutic procedures.

• To perform ultrasonographic examinations and aspirations of pleural fluid under imaging guidance.

Examples of useful reading material


### 3.2.12 Cardiac Imaging Rotation

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*In addition to the general competencies addressed in section 3.1 General Radiological Objectives (competencies), the following competencies are also required for this rotation.*
**Medical Expert**

**Senior Resident Knowledge**

- To demonstrate in-depth knowledge about cardiovascular anatomy and normal variations in CT and MRI findings.
- To demonstrate a basic radiological and pathophysiological understanding of acquired cardiovascular diseases of the coronary arteries, myocardium, pericardium, endocardium, and heart valves, including but not limited to the following:
  - Acute coronary syndromes
  - Myocardial ischemia
  - Myocardial infarction
  - Postmyocardial infarction syndromes
  - Ventricular aneurysms
  - Arteritis
  - Cardiac tumors
  - Cardiomyopathy, including acute myocarditis
  - Dilated cardiomyopathy
  - Restrictive and obstructive cardiomyopathy
  - Cardiomyopathy related to systemic disease
  - Infiltrative cardiomyopathy
  - Sudden-death syndromes in young patients and athlete’s heart

- To describe the imaging features and basic clinical features of adult congenital heart disease.
- To describe the principles and techniques of coronary calcification scoring (calcium scoring) and understand the limitations of coronary calcification scoring and its epidemiological implications.
- To describe the imaging features and basic clinical features of diseases of the major vessels, including thoracic aneurysms, acute and chronic aortic dissection, Marfan’s syndrome, and Takayasu’s disease.
Senior Resident Skills

- To prepare a patient for cardiac CT, including the verification of indications, venous access, and beta-blocker therapy.
- To select optimal acquisition parameters for cardiac CT.
- To select optimal post-processing tools for cardiac CT.
- To prepare a patient for cardiac MRI, including the verification of indications, venous access, and medication (e.g., stress tests).
- To select optimal acquisition parameters for cardiac MRI.
- To select optimal post-processing tools for cardiac MRI.
- To apply ECG gating for cardiac CT and MRI.
- To determine the optimal timing for contrast bolus administration during cardiac CT and MRI.
- To perform coronary calcification scoring.
- To independently perform post-processing tasks for cardiac and vascular imaging studies, including multiplanar reformation (MPR), maximum intensity projection (MIP), minimum intensity projection (MinIP), volume rendering tools (VRT), and vessel analysis tools.
- To understand the mean exposure doses for CT examinations.

Examples of useful reading material

- **Cardiac CT, An Issue of Radiologic Clinics of North America**
  - Jill E. Jacobs, MD
  - Copyright 2010, Saunders
  - ISBN: 978-1-4377-2594-0

- **Thoracic Imaging: Pulmonary and Cardiovascular Radiology, 2010**
  - By W. Richard Webb MD and Charles B. Higgins

- **Clinical Cardiac MRI**
  - By Jan Bogaert and Steven Dymarkowski
3.2.13 General MRI Rotation

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*In addition to the general competencies addressed in section 3.1 General Radiological Objectives (competencies), the following competencies are also required for this rotation.*

**Rotation structure**

This rotation will be performed during the first year of training. It will comprise the following:

- Two weeks of technical MRI (See Imaging Examination Techniques for further details).
- One week of clinical neuro-MRI.
- One week of clinical non-neuro-MRI (MSK system, abdomen, etc.).

**Medical Expert**

**Junior resident knowledge**

- To recognize the basic anatomy of the brain, spine, abdomen, and large joints (knee, hip, shoulder) on MRI and their various appearances on different sequences such as T1WI, T2WI, DWI, contrast-enhanced MRI, etc.
- To understand the basic physical principles behind MRI and its basic protocols and techniques, including the effects of modified scanning parameters on image quality, acquisition time, and the correction of MRI artifacts.
- To recognize the appropriate basic indications and contraindications for various MRI examinations.
- To understand the basics of MRI safety and hardware (coils, magnet, etc.).

**Junior resident skills**

- To practice measures for MRI contrast safety and prevention of complications such as nephrogenic systemic fibrosis (NSF).
- To appropriately prescribe basic MRI examinations.
- To recognize and describe basic MRI techniques and findings.
- To generate an accurate and informative MRI report.

**Examples of useful reading material**
- **MRI in Practice, 2012**
  By Catherine Westbrook
- **Duke Review of MRI Principles: Case Review Series, 2012**

### 3.2.14 General CT Rotation

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In addition to the general competencies addressed in section 3.1 General Radiological Objectives (competencies), the following competencies are also required for this rotation.

**Rotation structure**

This rotation should be performed within the first 6 months of training, before any other rotations involving CT.

It will include a week of learning each of the following disciplines:

- Technical CT imaging (See Imaging Examination Techniques for further details)
- Neuro-CT
- Chest CT
- Abdominal CT

**Medical Expert**

Junior resident knowledge

- To recognize basic anatomy of the brain, chest, abdomen, and pelvis, including major vascular structures, on CT.
• To understand the basic physical principles behind CT and the protocols and techniques, including the effects of modified scanning parameters on image quality and patient radiation dose.
• To learn the indications and absolute and relative contraindications for the various contrast media used during CT.
• To recognize the appropriate basic indications and contraindications for various CT examinations.
• To recognize basic emergencies on CT and their appearances.

Junior resident skills
• To identify and understand reactions to contrast media.
• To appropriately prescribe emergent/urgent CT examinations.
• To recognize and describe basic CT imaging techniques and findings in emergency situations.
• To generate an accurate and informative CT report.

Examples of useful reading material
SECTION 4

4.1 Non-rotational Skills

4.1.1 Contrast Media Management

Goals
- To acquire solid knowledge about different types of radiographic and MRI contrast media.
- To understand the indications, doses, concentrations, complications, and contraindications of various contrast media.
- To become familiar with the risk factors for contrast-induced nephropathy (CIN) and methods for handling such cases.
- To familiarize with the risk factors for nephrogenic systemic fibrosis (NSF) and methods to avoid such conditions.
- To demonstrate the ability to conduct prophylaxis and initial management of moderate or severe contrast media reactions.
- To familiarize with the current standards and guidelines for the use of iodinated and MRI contrast media.

Training Methods
- To take responsibility for prescription and supervision of contrast media administration during the pertinent rotations.
- Attending related courses and/or workshops required by the program.
- Feedback from the training supervisors regarding knowledge and skills of the trainee in the area of contrast media management.

Evaluation
- Attendance at required courses/workshops will be monitored and incorporated into the resident’s annual evaluation score.
- Performance in handling contrast-related issues during clinical duties will be assessed by rotation supervisors and reflected in the relevant categories of the rotation evaluation form.
- Appropriate cases/questions may be included in the promotion or part I/II examinations.
Examples of useful reading material

- ACR Manual on Contrast Media.  
- Standards for intravascular contrast agent administration to adult patients.  
  http://www.rcr.ac.uk/docs/radiology/pdf/BFCR(10)4_Stand_contast.pdf
- Protocol for the safe administration of iodinated contrast media in diagnostic radiology. Radiology Departments at Heart of England NHS Foundation Trust.  

4.1.2 Imaging Examination Techniques

Goals

- To familiarize with the various major imaging equipment and their components.
- To understand the optimal techniques for performing high-quality examinations using ultrasound, CT, MRI, and conventional radiography, including appropriate techniques for the following:
  - Patient screening
  - Patient preparation
  - Patient positioning
  - Contrast administration
  - Protocol application
  - Radiation exposure reduction and protection
- To perform basic ultrasound examinations.
- To understand the effects of changes in imaging parameters on image quality and the factors that can help in avoiding imaging artifacts.
- To recognize methods for adapting examinations according to difficult or risky patient situations.
• To understand the process of imaging quality assurance and image transfer to PACS.

Methods
• Dedicated time to be spent with technologists will be allocated to first-year residents, so that they can observe and assist in examinations:
  o One week for conventional radiography during the first rotation in fluoroscopy/ER.
  o One week for CT during the first general CT rotation.
  o Two weeks for MRI during the first rotation in general MRI.
  o The entire duration of the first rotation for ultrasound.
• Residents will be required to perform some basic ultrasound examinations under supervision.

Evaluation
• An evaluation form (See Page 149) for the period spent with each modality will be filled by the supervising technologist(s) and verified by the program director.
• Participation in a minimum number of specific examinations will be required, as specified on the evaluation form.
• Evaluations will be collated, averaged, and incorporated into the “general knowledge and noninterpretive skills” component of the annual evaluation.

Examples of useful reading material
General books
• Getting Started in Clinical Radiology: From Image to Diagnosis, by George W. Eastman.
• Radiologic Science for Technologists: Physics, Biology, and Protection.
CT books
- Computed Tomography for Technologists: A Comprehensive Text, by Lois Romans
- Computed Tomography: Physical Principles, Clinical Applications, and Quality Control, 3e (CONTEMPORARY IMAGING TECHNIQUES), by Euclid Seeram
- Computed Tomography Paperback, by Stewart Bushong
- Computed Tomography for Technologists: Exam Review, by Lois Romans
- CT & MRI Pathology: A Pocket Atlas, by Michael Grey, Jagan Ailinani

X-ray books
- Textbook of Radiographic Positioning and Related Anatomy, 8th Edition; Kenneth L. Bontrager and John Lampignano; Elsevier publications
- Clarks’ positioning in radiography, by Wilson
- Radiographic Pathology for Technologists, by Nina Kowalczyk

MRI books
- Handbook of MRI Technique, by Catherine Westbrook
- MRI in Practice Paperback, by Catherine Westbrook, Carolyn Kaut Roth
- Handbook of MRI Scanning, by Geraldine Burghart, Carol Ann Finn
- MRI Parameters and Positioning, by Torsten Bert Moeller
- CT & MRI Pathology: A Pocket Atlas, by Michael Grey, Jagan Ailinani (repeated)

Ultrasound books
- Ultrasound Scanning: Principles and Protocols, by Betty Bates Tempkin
- Workbook for Textbook of Diagnostic Sonography, by Sandra L. Hagen-Ansert
- Sonography: Introduction to Normal Structure and Function, by Reva Arnez Curry
• Diagnostic Ultrasound, 4th Edition; Carol Rumack, Stephanie Wilson, J William Charboneau, and Deborah Levine; Mosby publications

Nuclear Medicine books
Nuclear Medicine and PET/CT: Technology and Techniques, by Paul E. Christian

4.1.3 On-call Duties
Residents will be assigned to appropriate on-call duties according to a prearranged department schedule (See section under Vacations, Holidays, Special Circumstances, and On Call Duties).

Goals
• To gain adequate exposure to imaging of emergency conditions.
• To develop confidence and decision-making skills in critical situations.
• To recognize and practice the reactive, active, and proactive roles of radiology professionals in the interdisciplinary management of medical and surgical emergencies.
• To demonstrate the ability to triage patients and prioritize radiology examinations during on-call duties.
• To acquire effective communication skills that allow clear and accurate delivery of radiology information to referring physicians and treating teams.
• To demonstrate awareness of self-limitations and the optimal timing to seek help from seniors.

Training Methods
Junior residents
• First-on-call in the hospital during nights, weekends, and holidays.
• Consultation with second-on-call residents regarding difficult cases.
• Reporting on-call radiology examination findings under senior staff supervision as per hospital policy.
• Adherence to hospital policies and procedures pertinent to on-call radiology services.
• Feedback from seniors on performance during on-call duties and opportunities for improvement.
• Presentation of educational cases managed during on-call duties in the department meetings, under supervision of the second- and third-on-call residents.

Senior residents
• Second-on-call in the hospital during nights, weekends, and holidays.
• Consultation with third-on-call residents regarding difficult cases.
• Supervision of on-call radiology examination reporting by the junior residents or reporting these examination findings as per hospital policy.
• Adherence to hospital policies and procedures pertinent to on-call radiology services.
• Feedback from seniors on performance during on-call duties and opportunities for improvement.
• Supervision of junior residents during their presentation of educational cases managed during on-call duties in the department meetings.

Evaluation
• Prompt response and availability of assigned residents throughout on-call duty is mandatory. Nonadherence is subject to severe disciplinary action.
• An evaluation form (See page 148) will be filled by the program director a minimum of three times per year, after gathering feedback from at least three other appropriate staff members. The average score will be incorporated into the resident’s annual evaluation score.
Examples of useful reading material

- Top 5 Challenges On-call Radiology Residents Face. [http://rsna.org/Top_5_Challenges_On-call_Radiology_Residents_Face.aspx](http://rsna.org/Top_5_Challenges_On-call_Radiology_Residents_Face.aspx)

4.1.4 Quality Improvement

Overview

- Quality improvement (QI) is now widely recognized as an essential process for improving clinical and technical operations in radiology departments.
- QI involves both prospective and retrospective reviews. It is aimed at improvement—measuring where you are figuring out ways to make things better. It specifically attempts to create systems that prevent errors. It is a continuous process (continuous QI or CQI) that must occur consistently in an ongoing fashion.
- CQI helps in improving patient care and clinical workflow, while increasing the confidence of residents with regard to their problem-solving abilities.

General Objective

As an essential core component of the curriculum, residents are expected to receive training in the basic principles of QI, which is implemented during a dedicated course and/or a comprehensive rotation. The rotation is continuously structured to cover four core themes over the course of the rotation. Residents are assigned an appropriate mentor to guide them through each theme.
To achieve this goal, residents must be introduced to the general concepts of CQI in a hospital where an active quality and performance improvement program exists.

- Residents must participate in QI projects as part of their training in systems-based practice and exercise the fundamentals of quality and performance improvement.
- Residents must execute at least one project during their rotation.
- Residents can assist in departmental preparations for a Joint Commission International (JCI) or other accreditation body survey.

**Goals**

- To familiarize with QI terminology as well as available tools and methodology for improving the quality of technical and clinical performance in a radiology department. For instance, Key performance indicators (KPIs) and the Plan-Do-Study-Act (PDSA) cycle.
- To familiarize with the workflow of the radiology department and other departments (surgery, medicine, and emergency medicine) and quality assurance (QA) systems and ensure that they participate in the hospital’s QI activities.
- To understand and apply audit procedures, including problem identification, action planning, and reassessment.
- To familiarize with the tools used to manage the quality of radiology services.
- To understand how performance improvement relates to patient safety in radiology.
- To complete a mentored research project and present their results at department QI rounds.
- To participate in departmental and hospital QI activities by
attending committee meetings.
• To participate in hospital QA committee and departmental morbidity and mortality (M and M) meetings,
• To increase awareness about current research topics in quality in radiology and that they initiate and complete a project and participate in ongoing departmental QA audits.
• To acquire the necessary skills for scientific presentation and public discussions.
• To recognize opportunities for improvement in the radiology department's functions
• The elective includes online learning sessions with a list of independent study materials provided to each resident. Some examples are given below:

  www.IHI.org
  www.patientsafety.gov
  www.RMF.org
  www.jointcommission.org
  www.rmfinteractive.com
  www.apiweb.org
  www.RMF.org
  www.rmfcmecom

**Specific Objectives (to cover the following topics):**
**Patient safety**
• Improve the accuracy of patient identification.
• Improve the effectiveness of communication among caregivers and ensure that they report critical results of tests and diagnostic procedures on a timely basis.
• Improve the safety of using medications and ensure that all medications, medication containers, and other solutions on and off the sterile field in perioperative and other procedural settings are labeled.
• Minimize the risk of healthcare-associated infection.
• Safe procedure check list (Time out chart).
Other examples of patient safety QI project topics that are particularly relevant to radiology include the following:

- Safe use of iodinated contrast material
- Radiation safety
- MRI safety

**Practice Guidelines**

The most important aspect of the communications parameter is the communication of urgent, critical, or unexpected findings.

- Accuracy of Interpretation (Double Reading)
- Reporting Timeliness (Reporting Turnaround Time)
- Critical Value Reporting

**Training Methods**

- A dedicated 1-month full-time rotation in either research or quality management is conducted during the third year of training. If the resident chooses to perform a QI project, then during this month he/she will select a supervisor, work on the selection of a topic, and start the project.
- It is expected that the project will span more than a month. Therefore, completion of the work should be parallel to the other subsequent rotations.
- It is highly desirable for the resident to work on presenting the quality project results in national and international meetings and work hard to publish the work in indexed journals.
- Residents are expected to read and adhere to hospital manuals of radiology performance improvement programs and departmental guidelines.
- Residents are expected to attend multidisciplinary QI departmental meetings.
- Attendance at dedicated courses or workshops that enhance quality management skills may be required by the program.
**Evaluation**

- Attendance at required lectures/courses designed for quality management will be monitored and incorporated into the final annual evaluation score.
- On completion of the rotation, residents will present the findings of their project in a departmental QA round.
- Panel scoring of the QI abstract presentation will be conducted at the end of the third year, during the Residents Radiology Research Day. This will count as the rotation score for that month. (This project can replace the standard research project).

**Suggested Projects**

- Reduction of the incidence and risk of contrast nephropathy
- Communication of critical radiology results
- Evaluation of incident reporting in radiology
- Root cause analysis of interpreting errors in abdominal CT scans
- Analysis of misses in oncological follow-up CT scans
- Appropriateness of studies ordered in the emergency department.
- Significance of a nonvisualized appendix on a CT scan for suspected appendicitis
- Management of intravenous contrast reactions
- The ACR’s Appropriateness Criteria serves as an excellent tool for engaging residents in the ongoing assessment of quality assurance in imaging. The ACR’s Practice Guidelines, Technical Standards, and Appropriateness Criteria are educational tools designed to promote quality and improve patient care. Therefore, incorporation of the ACR appropriateness criteria into resident education will help them in learning how to function as consultants. (Available in the website [https://acsearch.acr.org/list](https://acsearch.acr.org/list)).

**Examples of useful reading material**

- Quality improvement program, Royal College of Radiologists, UK. [https://www.rcr.ac.uk/content.aspx?PageID=2439](https://www.rcr.ac.uk/content.aspx?PageID=2439)

• https://acsearch.acr.org/list

4.1.5 Radiology Research Skills

Goals
• To familiarize with research study types and their advantages and disadvantages from the perspective of radiology.
• To demonstrate the ability to ask research questions and design proper research methods to answer those questions.
• To understand and practice appropriate methods for research study conduct, data collection, and result analysis and discussion.
• To demonstrate awareness of the current research topics in radiology.
• To familiarize with the ethical requirements of research and adhere to the same.
• To acquire the essential skills required for writing scientific manuscripts.
• To demonstrate awareness of resources for radiology research.
• To acquire the skills for scientific presentations and public discussions.

Training Methods
• A dedicated 1-month, full-time rotation in either research or quality management is conducted during the third year of training. If the resident chooses to perform a research project, then during this month he/she will select the supervisor, work on the selection of a research topic, and start the project.
• It is expected that the project will span more than 1 month. Therefore, completion of the work should be parallel with the other subsequent rotations.
• The supervisor will help the residents in accessing the essential resources that will allow appropriate understanding of research
skills and periodically discuss the progress of the residents with them.

- Attendance of dedicated courses or workshops that enhance research skills may be required by the program.
- Oral abstract presentation of the study results at the end of the year, on the Residents Radiology Research Day, is required.
- It is highly desirable for residents to work on presenting the research results at national and/or international meetings and work hard to publish their work in indexed journals.
- Programs are also strongly encouraged to conduct “journal club” sessions, during which various preselected published research material can be critically appraised in a group discussion format.

**Evaluation**

- Attendance at designated courses/lectures will be monitored and incorporated into the annual evaluation score.
- Panel scoring of the research abstract presentation will be conducted at the end of the third year, on the Residents Radiology Research Day. This will count as the rotation score for that month.

**Examples of useful reading material**

- Academic radiology and research/Guidance and advice, Royal College of Radiologists, UK. [https://www.rcr.ac.uk/content.aspx?PageID=1964](https://www.rcr.ac.uk/content.aspx?PageID=1964)
4.1.6 Reporting skills

**Goals**

- To understand the importance of radiology reports along with the treating team.
- To familiarize with the essential qualities of a good radiology report.
- To recognize the common flaws in radiology reports.
- To demonstrate the ability to produce good-quality reports for all radiology modalities.
- To demonstrate awareness of the new IT solutions in radiology reporting.

**Training Methods**

- A half-day hands-on course on reporting skills will be conducted during the second year of training. The aim of this course is to teach general guidelines for writing good-quality radiology reports and give live demonstrations of report correction and editing to improve the quality. The resident will write several
reports in this course, and he/she will receive immediate feedback on these reports.

- Feedback is received from seniors with whom the resident is working during all rotations. It is expected that the supervisor will give feedback about the resident’s reports, and the resident should show progressive improvement over time.

**Evaluation**

- Attendance of the reporting skills course is compulsory.
- The quality of resident’s reporting will be part of the final evaluation of all rotations in the skills and communication fields.

**Examples of useful reading material**

4.1.7 Sedation and Analgesia

Overview
This is a full-day course that is provided to the senior radiology residents at the beginning of the third year. It will be delivered by a radiologist with adequate background in sedation/analgesia and/or by an anesthetist, if possible.

Prerequisites
The resident must have a valid BLS certificate. An ACLS certificate is also encouraged.

General Objective
To introduce the residents to the general concepts of sedation/analgesia that are related to common diagnostic and interventional radiological procedures. Basic related knowledge, skills, and attitudes would be emphasized upon.

Specific Objectives (To cover the following topics)
- Definitions: minimal sedation or anxiolysis, moderate sedation/analgesia, conscious sedation, deep sedation/analgesia, general anesthesia.
- Privileges, safety, policies, and procedures related to sedation/analgesia are to be explained in view of each hospital guidelines.
- Patient preparation (including informed consent) and preprocedural assessments.
- Pharmacology (indications, contraindications, mechanism of action, dosage, side effects, interactions, reversal) of the commonly used medications [at least the following: midazolam, fentanyl, naloxone, flumazenil, chloral hydrate, morphine, meperidine (pethidine), adrenaline, atropine].
- Equipment and intraprocedural care, monitoring, and resuscitation.
- Patient-controlled analgesia (PCA).
- Post-procedural care and discharge.
Training Methods

- Lectures.
- Interactive case-based scenarios.

Evaluation:

- MCQs (minimum of 20 in 30 minutes, 1.5 min per MCQ)
- DOPS (minimum of 1 per resident, 5–10 minutes each)

Examples of useful reading material

4.1.8 Imaging Informatics and Advanced Visualization

Overview
Imaging informatics aims to improve the efficiency, accuracy, usability, and reliability of medical imaging services within the healthcare enterprise. It is devoted to the study of how information about and contained within medical images is retrieved, analyzed, enhanced, and exchanged throughout the medical enterprise.

Goals
- To acquire the essential skills of advanced visualization system functions (3D volume rendering, maximum intensity projection, minimum intensity projection, multiparametric quantification).
- To familiarize with the current standards for image and report sharing.
- To understand how to use the internet as a decision-support tool to search for knowledge from existing online educational resources.
- To be aware of Digital Imaging and Communications in Medicine (DICOM) basics.
- To demonstrate awareness of Integrated Health Enterprise (IHE) profiles.

Training Methods
- A dedicated two-level course will be conducted during residency training to cover the fundamentals of imaging informatics. The first level shall be implemented during R1-R2. The second level shall be implemented during R3-R4.
- Certain relevant skills should be demonstrated during clinical residency rotations as follows:
  - Basic use of PACS workstations as well as RIS and HIS user interfaces
  - Use of speech recognition and template reporting
  - Use of personal and system teaching files, if applicable, from the vendor.
- Advanced visualization system function skills should be conveyed, mainly but not completely limited to neuro, body, and cardiac rotations, including the following:
- 3D visualization using volume rendering, maximum intensity projection, and minimum intensity projection, along with their advantages and disadvantages
- Tubular/luminal structure analysis (vessel analysis, MRCP, colonography)
- Multiparametric quantifications (ADC values, perfusion parameters, cardiac functional values, iron quantification, elastography, etc.).

- Self-directed learning utilizing the suggested reading references below or as suggested during the courses.

**Evaluation**
- Attendance of the two-level course designed for imaging informatics will be monitored and incorporated into the final annual evaluation score.
- Appropriate and capable use of advanced visualization systems will be included in the general radiological skills component of the rotation evaluation, particularly in the pertinent applicable rotations (neuro, body, and cardiac).
- Part II written examinations may include some relevant MCQs.

**Examples of useful reading material**
- Practical Imaging Informatics  
- PACS: A Guide to the Digital Revolution
- [http://pubs.rsna.org/topic/in?SeriesKey=radiographics&sortBy=Ppub](http://pubs.rsna.org/topic/in?SeriesKey=radiographics&sortBy=Ppub)
- [http://pubs.rsna.org/topic/in?SeriesKey=radiology&sortBy=Ppub](http://pubs.rsna.org/topic/in?SeriesKey=radiology&sortBy=Ppub)
4.2 Academic Activities and Courses

4.2.1 Didactic Academic Activities
Various academic activities are provided to residents enrolled in the radiology residency training program. These will include any or all of the following.

Case-Based Tutorials (mandatory)
One-hour dedicated teaching sessions are conducted by a tutor in a classroom with all residents. These sessions should be held at least three times per week.

Goals
- To discuss and review imaging appearances and the approaches toward the diagnosis of various radiological conditions.
- To learn how to logically present and discuss radiological cases, in preparation for clinical consultations, multidisciplinary clinical–radiological meetings, or examination settings.
- To develop a sense of confidence in handling clinical discussions with peers and referring clinicians.

Training Methods
- Cases are preselected by the tutor or his/her designee for discussion.
- Cases are presented as unknowns, and a resident is selected to discuss an individual case in front of his/her colleagues.
- Residents actively participate in the discussion of cases.

Evaluation
- Feedback is provided by the tutor to residents about their performances during discussions.
- Attendance during these sessions will be recorded and must be >80% for the year.
Case of the Day/Morning Report
This is mentored by a consultant each week. The case(s) is prepared and assessed by a resident according to the schedule.

Journal Club
This is conducted once or twice a month. Journal articles are preselected, and the activity is prepared and discussed by residents under the supervision of a consultant.

Quiz
Quizzes may be conducted intermittently at the discretion of the program director.

Self-Directed Learning (SDL)
Residents are encouraged to manage their time to conduct self-directed learning by utilizing hospital facilities such as the library, PCs, etc.

Radiological Grand Rounds
A 30–40-min formal lecture is presented by residents as an overview of a specific topic, attended by all residents and radiology staff in the center. The goal is to train the residents in preparing and presenting lectures and searching the literature for a specific topic.

Annual Research/QI Day
A yearly meeting to present research or QI projects is conducted for radiologists and residents in each region. This is an excellent way to stimulate residents and consultants to get involved in research and quality improvement. It is held annually at the end of the academic year, and third-year residents present abstracts and are judged and critiqued by an experienced staff panel.

For more information, see sections 4.1.4 Quality Improvement and 4.1.5 Radiology Research Skills.
Half Academic Day Clinical Radiology Lectures
This is held once every week and is attended by all residents in each region. Attendance will be incorporated into an annual overall evaluation score.

Suggested Topics
**Musculoskeletal System**
- **Imaging and Prosthesis: Knee and Hip Prostheses**
  At the end of this lecture, the resident must demonstrate the following abilities:
  - Describe the general types of joint prostheses
  - Assess the prosthesis
  - Detect any complications associated with the prosthesis

- **Imaging of Benign Bone Tumors**
  At the end of this lecture, the resident must demonstrate the following abilities:
  - Describe the approach toward bone tumors
  - Describe the osseous lesion
  - Determine tumor aggressiveness

- **Imaging of Malignant Bone Tumors**
  At the end of this lecture, the resident must demonstrate the following abilities:
  - Describe the approach toward bone tumors
  - Describe the osseous lesion
  - Determine tumor aggressiveness

- **Arthritis I**

- **Arthritis II**
  At the end of these two lectures, the resident must demonstrate the following abilities:
  - Describe the approach toward arthritides
  - Describe the joint lesion
  - Determine a justifiable differential diagnosis

- **Infections of Bone and Soft Tissue**
At the end of this lecture, the resident must demonstrate the following abilities:
  o Describe the approach toward bone and soft tissue infections
  o Describe the infectious process
  o Determine a justifiable differential diagnosis

• **Metabolic Diseases**
  *Hyperparathyroidism, Rickets, Osteomalacia, Paget’s disease, Scurvy*

• **Metabolic Diseases**
  *Hematological (Sickle cell disease and Thalassemia), hypervitaminosis D and A, Acromegaly, Gaucher’s disease*

At the end of these two lectures, the resident must demonstrate the following abilities:
  o Describe the approach toward metabolic bone diseases
  o Describe the systemic disease
  o Determine a justifiable differential diagnosis

• **Musculoskeletal Soft Tissue Tumors**
  At the end of this lecture, the resident must demonstrate the following abilities:
  o Describe the approach toward soft tissue tumor
  o Describe the soft tissue tumor
  o Determine a justifiable differential diagnosis

• **Sports Medicine I**
  *MRI of the Knee/MRI of the Wrist*

• **Sports Medicine II**
  *MRI of the Shoulder/MRI of the Ankle*
  At the end of this lecture, the resident must demonstrate the following abilities:
  o Describe the approach toward sports medicine
  o Describe the mechanism underlying injury
  o Determine a justifiable differential diagnosis
• **Fractures from Head to Toe**
  At the end of this lecture, the resident must demonstrate the following abilities:
  - Describe the approach toward osseous fractures
  - Describe fractures and their complications.
  - Determine a justifiable differential diagnosis

**Neuroradiology**

• **Anatomy of the Brain, Spinal Cord, and Cerebral Vasculature**
  **Congenital Anomalies of the Spine and Spinal Cord**
  At the end of this lecture, the resident must demonstrate the following abilities:
  - Describe the radiological anatomy of the CNS
  - Describe congenital anomalies of the CNS

• **Congenital Malformations of the Brain**
  **Neural Tube Closure, Posterior Fossa Malformation, and Cysts**
  **Diverticulation and Cleavage Sulcation and Cellular Migration**
  At the end of this lecture, the resident must demonstrate the following abilities:
  - Describe congenital anomalies of the CNS

• **Vascular Malformation of the Spine and Brain**
  **Intracranial Aneurysms**
  At the end of this lecture, the resident must demonstrate the following abilities:
  - Describe vascular malformations of the spine and brain
  - Describe the types of intracranial aneurysms
• **CNS Trauma**
  *Spinal Trauma, Facial Bone Trauma, and CT and MRI for Craniocerebral Trauma*
  At the end of this lecture, the resident must demonstrate the following abilities:
  - Describe the types of CNS trauma
  - Describe the different appearances on each imaging modality

• **Stroke**
  *Intracranial Hemorrhage*
  At the end of this lecture, the resident must demonstrate the following abilities:
  - Describe the approach toward stroke and intracranial hemorrhage imaging
  - Describe the different appearances on each imaging modality

• **MR Spectroscopy**
  *Diffusion-Weighted MRI*
  At the end of this lecture, the resident must demonstrate the following abilities:
  - Describe the approach toward spectroscopy and diffusion-weighted MRI
  - Describe the physics and imaging characteristics of this modality

• **MRI of Brain Tumors: Supratentorial and Infratentorial Tumors**
  *Sellar and Parasellar Tumors*
  At the end of this lecture, the resident must demonstrate the following abilities:
  - Describe the approach toward brain tumors
  - Describe the different appearances on each imaging modality
  - Describe methods of categorizing each tumor
• **Tumors of the Spine and Spinal Cord**  
At the end of this lecture, the resident must demonstrate the following abilities:  
  o Describe the approach toward spine and spinal cord tumors  
  o Describe the different appearances on each imaging modality  
  o Describe methods of categorizing each tumor  

• **Metabolic Diseases of the Brain: Inherited and Acquired**  
At the end of this lecture, the resident must demonstrate the following abilities:  
  o Describe the approach toward metabolic diseases of the brain  
  o Describe the differences between inherited and acquired diseases  

• **Infectious Diseases of the Spine**  
**Infectious Diseases of the Brain**  
At the end of this lecture, the resident must demonstrate the following abilities:  
  o Describe the approach toward infectious diseases of the brain and spine  
  o Describe the different appearances on each imaging modality  

• **Imaging of the Nasopharynx**  
At the end of this lecture, the resident must demonstrate the following abilities:  
  o Describe the approach toward diseases of the nasopharynx  
  o Describe the anatomy of the nasopharynx on CT/MRI  
  o Describe the approach toward diseases of the nasopharynx
• **Imaging of Epilepsy: Temporal and Nontemporal**  
  At the end of this lecture, the resident must demonstrate the following abilities:  
  o Describe the approach toward imaging patients with epilepsy  
  o Describe the pathophysiology of epilepsy and its effects on imaging findings

• **Imaging of Degenerative Discs**  
  At the end of this lecture, the resident must demonstrate the following abilities:  
  o Describe the approach toward degenerative diseases of the discs  
  o Describe the complications of such diseases

• **Imaging of the Orbit**  
  **Imaging of the Paranasal sinuses: Infection and Tumors**  
  At the end of this lecture, the resident must demonstrate the following abilities:  
  o Describe the approach toward infection of the paranasal sinuses  
  o Describe the approach toward tumors of the paranasal sinuses

• **Temporal Bone Imaging**  
  At the end of this lecture, the resident must demonstrate the following abilities:  
  o Describe the approach toward imaging of the orbit  
  o Describe the approach toward imaging of the temporal bone

*Breast Imaging*  
• **Mammography**  
  At the end of this lecture, the resident must demonstrate the following abilities:  
  o Describe the techniques and implications of mammography
• Breast Ultrasound and Intervention
  At the end of this lecture, the resident must demonstrate the following abilities:
  o Describe the techniques and implications of ultrasonography
  o Describe the different appearances of breast diseases on ultrasonography

• Breast MRI
  At the end of this lecture, the resident must demonstrate the following abilities:
  o Describe the techniques and implications of breast MRI
  o Describe the different appearances of breast diseases on MRI

Chest Radiology
• Imaging of the Mediastinum
  Anatomy/mediastinal masses/infection
  At the end of this lecture, the resident must demonstrate the following abilities:
  o Describe the imaging approach toward mediastinal anatomy
  o Describe the imaging approach toward mediastinal masses
  o Describe the imaging approach toward mediastinal infections

• ICU/Emergency Chest Radiology
  At the end of this lecture, the resident must demonstrate the following abilities:
  o Describe the approach toward ICU radiology
  o Describe the approach toward chest radiology
• **High-Resolution Chest CT**  
  At the end of this lecture, the resident must demonstrate the following abilities:  
  o Describe the approach toward high-resolution chest CT  
  o Describe the technical physics of high-resolution CT

• **Lung Neoplasms**  
  At the end of this lecture, the resident must demonstrate the following abilities:  
  o Describe the imaging approach toward lung neoplasms  
  o Describe the different histological features of each neoplasm

• **Immunological Disease/Vasculitis**  
  At the end of this lecture, the resident must demonstrate the following abilities:  
  o Describe the imaging approach toward immunological diseases  
  o Describe the imaging approach toward vasculitis

• **Imaging of the Pleura/Diaphragm/Chest Wall**  
  At the end of this lecture, the resident must demonstrate the following abilities:  
  o Describe the imaging approach toward diseases of the pleura  
  o Describe the imaging approach toward diseases of the diaphragm  
  o Describe the imaging approach toward diseases of the chest wall

• **Cardiac Imaging**  
  At the end of this lecture, the resident must demonstrate the following abilities:  
  o Describe the imaging approach toward diseases of the heart  
  o Describe how to manipulate the cardiac workstation

**GU System**

• **Contrast Media and Contrast Reactions**
At the end of this lecture, the resident must demonstrate the following abilities:

- Describe the different types of contrast media used for imaging
- Assess and detect complications related to contrast media injection

- **Adrenal Imaging + Scrotal Imaging**
  At the end of this lecture, the resident must demonstrate the following abilities:
  - Describe the imaging approach toward adrenal pathologies
  - Describe the imaging approach toward scrotal pathologies

- **Approach Toward Renal Masses + Cystic Renal Disease**
  At the end of this lecture, the resident must demonstrate the following abilities:
  - Describe the imaging approach toward renal masses
  - Describe the imaging approach toward cystic renal diseases

- **Lesions of the Renal Papillae and Calyces + Renal Infections and Renal Vascular pathology**
  At the end of this lecture, the resident must demonstrate the following abilities:
  - Describe the imaging approach toward renal papillae calyces
  - Describe the imaging approach toward renal infections
  - Describe the imaging approach toward renal vascular pathologies
• **Imaging of the Ureters, Bladder, and Urethra**
  At the end of this lecture, the resident must demonstrate the following abilities:
  o Describe the imaging approach toward ureter pathologies
  o Describe the imaging approach toward bladder pathologies
  o Describe the imaging approach toward urethral pathologies

• **Imaging of the Ovaries and Uterus**
  At the end of this lecture, the resident must demonstrate the following abilities:
  o Describe the imaging approach toward ovarian pathologies
  o Describe the imaging approach toward endometrial pathologies

• **Congenital Disorders of the Genitourinary Tract**
  At the end of this lecture, the resident must demonstrate the following abilities:
  o Describe the imaging approach toward congenital disorders of the genitourinary tract
  o Understand the use of different modalities for diagnosis

• **Obstetrical Imaging**
  At the end of this lecture, the resident must demonstrate the following abilities:
  o Describe the imaging approach toward obstetrics
  o Emphasize on ultrasound features during diagnosis
GI System

- **MDCT of the Abdomen and Pelvis + Body MRI Techniques**
  - **Liver Tumors: Benign and Malignant**
    - At the end of this lecture, the resident must demonstrate the following abilities:
      - Describe the approach toward liver tumors
      - Assess the imaging features of benign and malignant liver diseases
      - Detect complications associated with liver tumors

- **Liver infections + Diffuse liver diseases**
  - At the end of this lecture, the resident must demonstrate the following abilities:
    - Describe the approach toward liver infections
    - Describe the approach toward diffuse liver diseases

- **Gallbladder and Bile Ducts**
  - At the end of this lecture, the resident must demonstrate the following abilities:
    - Describe the approach toward gallbladder and bile duct diseases
    - Select the appropriate imaging modality for each disease

- **Pancreatitis + Pancreatic Tumors**
  - At the end of this lecture, the resident must demonstrate the following abilities:
    - Describe the approach toward pancreatitis
    - Describe the approach toward pancreatic tumors

- **Disorders of the Gut: Esophagus + Disorders of the Gut: Stomach**
  - At the end of this lecture, the resident must demonstrate the following abilities:
    - Describe the imaging approach toward esophageal diseases
    - Describe the imaging approach toward stomach diseases
• **Disorders of the Gut: Small Bowel**
  At the end of this lecture, the resident must demonstrate the following abilities:
  o Describe the imaging approach toward small bowel diseases

• **Disorders of the Gut: Large Bowel**
  At the end of this lecture, the resident must demonstrate the following abilities:
  o Describe the imaging approach toward large bowel diseases

• **The Mesentery and Peritoneum and Splenic Disorders**
  At the end of this lecture, the resident must demonstrate the following abilities:
  o Describe the imaging approach toward diseases of the peritoneum
  o Describe the imaging approach toward splenic disorders

**Interventional Radiology**

• **Diagnostic Vascular Radiology**
  At the end of this lecture, the resident must demonstrate the following abilities:
  o Describe the approach toward vascular radiology, including the technical aspects

• **Interventional Nonvascular Radiology**
  At the end of this lecture, the resident must demonstrate the following abilities:
  o Describe the approach toward nonvascular interventional radiology, including the technical aspects

• **Contrast Media and Reactions to Contrast Media**
  At the end of this lecture, the resident must demonstrate the following abilities:
- Describe the types of contrast media and their side effects
- Manage any associated complications

- **Interventional Ultrasound and CT-Guided Biopsies**
  At the end of this lecture, the resident must demonstrate the following abilities:
  - Describe how and when to perform CT-/US-guided biopsies

- **GI and Hepatobiliary Interventional Radiology**
  At the end of this lecture, the resident must demonstrate the following abilities:
  - Describe how and when to perform GI and hepatobiliary interventions

- **Intervention for Thromboembolic Vascular Diseases**
  At the end of this lecture, the resident must demonstrate the following abilities:
  - Describe how and when to perform interventions for thromboembolic diseases

**Nuclear Medicine**

- **Endocrine Radioisotope Imaging**
  At the end of this lecture, the resident must demonstrate the following abilities:
  - Describe the approach toward endocrine radioisotope imaging
  - Describe the pharmacology of the radioisotope

- **Skeletal Radionuclide Imaging**
  At the end of this lecture, the resident must demonstrate the following abilities:
  - Describe the approach toward skeletal radionuclide imaging
  - Describe the pharmacology of the radioisotope

- **Radionuclide Gastrointestinal Imaging**
At the end of this lecture, the resident must demonstrate the following abilities:
  o Describe the approach toward gastrointestinal radioisotope imaging
  o Describe the pharmacology of the radioisotope

• Genitourinary Radioisotope Imaging
  At the end of this lecture, the resident must demonstrate the following abilities:
  o Describe the approach toward genitourinary radioisotope imaging
  o Describe the pharmacology of the radioisotope

• Pulmonary Radioisotope Imaging
  At the end of this lecture, the resident must demonstrate the following abilities:
  o Describe the approach toward pulmonary radioisotope imaging
  o Describe the pharmacology of the radioisotope

• Cardiovascular Radionuclide Imaging
  At the end of this lecture, the resident must demonstrate the following abilities:
  o Describe the approach toward cardiovascular radioisotope imaging
  o Describe the pharmacology of the radioisotope

• Quality Control
  At the end of this lecture, the resident must demonstrate the following abilities:
  o Describe the importance of quality control in nuclear medicine
  o Describe the QC steps to be taken in any nuclear medicine department

**Pediatric Radiology**
• Radiology of Congenital Cardiovascular Diseases
  At the end of this lecture, the resident must demonstrate the following abilities:
At the end of this lecture, the resident must demonstrate the following abilities:

- **Neonatal Brain US**

  - Describe the approach to neonatal brain US, including the technical aspects

- **Neonatal Intestinal Obstruction**

  - Describe the imaging approach toward neonatal intestinal obstruction

- **Pediatric Gastrointestinal Radiology**

  - Describe the imaging approach toward pediatric gastrointestinal radiology

- **Neonatal Chest Radiology**

  - Describe the imaging approach toward neonatal chest radiology

- **Pediatric Chest Radiology**

  - Describe the approach toward pediatric chest radiology

- **Non-Neoplastic Pediatric Musculoskeletal Radiology**

  - Describe the imaging approach toward non-neoplastic pediatric musculoskeletal radiology
• **Radiology of Pediatric Genitourinary diseases**
  At the end of this lecture, the resident must demonstrate the following abilities:
  - Describe the imaging approach toward genitourinary radiology

### 4.2.2 Courses

Several courses will be organized for radiology residents to augment their training in various important aspects. These courses will include, but are not limited to the following:

- **First year:** Emergency radiology, contrast media management, radiological physics
- **Second year:** Research skills, fundamentals of quality management, reporting skills

#### Emergency Radiology Course

**Goals**
The goal of this course is to prepare first-year residents to assume on-call duties.

**Training Methods**
The following didactic lectures are conducted early during the first year of training.
<table>
<thead>
<tr>
<th>Lecture title</th>
<th>Objectives</th>
</tr>
</thead>
</table>
| Chest          | • Emergencies related to great vessels injuries  
                    • Appearance of PE on CT pulmonary angiograms, techniques of examination, and the indications and contraindications  
                    • Signs of pneumomediastinum and pneumothorax |
| MSK            | • Appearance of unstable fractures, particularly spine fractures  
                    • Appearance of septic arthritis and osteomyelitis  
                    • Appearances of necrotizing fasciitis |
| Neuroradiology | • Signs of CNS infarcts on CT and MRI  
                    • Appearance of intracranial hemorrhage  
                    • Appearance of brain edema  
                    • Appearance of brain herniation  
                    • Appearance of cord compression and spine infection |
<table>
<thead>
<tr>
<th>Lecture title</th>
<th>Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Genitourinary</td>
<td>• Appearance of renal infection and inflammation, hydronephrosis, and renal</td>
</tr>
<tr>
<td></td>
<td>injuries</td>
</tr>
<tr>
<td></td>
<td>• Testicular torsion and infection</td>
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<td>• Ovarian torsion and pelvic infection</td>
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<td></td>
<td>• Ectopic pregnancy and abortion</td>
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<tr>
<td>• Gastrointestinal</td>
<td>• Bowel perforation</td>
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<td></td>
<td>• Bowel ischemia</td>
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<td></td>
<td>• Solid organ injury</td>
</tr>
<tr>
<td></td>
<td>• Appendicitis and infective processes</td>
</tr>
<tr>
<td>• Reactions to Contrast Media</td>
<td>• Various types of reactions to contrast media</td>
</tr>
<tr>
<td></td>
<td>• Treatment of each type and premedication</td>
</tr>
<tr>
<td></td>
<td>• Risk of nephrogenic systemic fibrosis related to gadolinium-based contrast</td>
</tr>
<tr>
<td></td>
<td>agents</td>
</tr>
</tbody>
</table>
### Lecture title

<table>
<thead>
<tr>
<th>Pediatrics</th>
</tr>
</thead>
</table>

### Objectives

- Appearance of intussusception and its treatment
- Fractures related to children, including child abuse
- Respiratory infection, including epiglottitis, retropharyngeal abscess, and foreign body aspiration

### Evaluation

Attendance will be incorporated into the final annual evaluation score. Emergency cases will be part of the promotion examination and the part 1 written examination and on-call duty evaluation.

### Examples of useful reading material

Please refer to the references under the section On-Call Duties.

### Contrast Media Management Course

See the section Contrast Media Management for details.

### Radiological Physics Course

**Goals**

- To gain professional competence in radiation physics and applied physics and their clinical applications in radiology.
- To understand the various fundamentals of imaging modalities and their concept variations.
• To learn basic imaging-related mathematics and calculations, as well as dosimetry applications.
• To clearly understand radiation principles in order to properly deal with radiation hazards and implement radiation protection measures according to international guidelines and recommendations.
• To differentiate between modality-specific imaging chains and associated technology.
• To recognize the technical parameters that can affect image quality and radiation dose.
• To understand the principles and practice of digital image-processing techniques.
• To recognize modality-specific image artifacts.
• To learn about the impact of emerging technologies on current practice.
• To grasp the salient aspects of radiobiology and the safe practice of radiation protection principles.
• To test problem-solving skills using RAPHEX-type examinations.

Training Methods
• A 2-week course in imaging-related physics will be conducted annually, which must be attended by all first-year residents. The required curriculum is listed below in the course content.
• Discussion of applied physical principles that influence image quality and patient/staff safety with radiology staff during case readout and tutorial sessions.
• Training centers may optionally provide additional lectures or activities to their residents.

Evaluation
• The attendance rate at the 2-week physics course will be incorporated into the overall annual performance evaluation score.
• Incorporation into the radiological knowledge/skills and safety aspects of the rotation evaluations.
• Annual promotion exams.
• Part I examination.
**Course Content**

**Radiation Physics**

- Radiation
- Definition
- Forms
  - Electromagnetic
    - Wave Model
    - Photon Model
      - Frequency
      - Wavelength
      - Energy
      - Spectrum
  - Particulate Radiation
    - Mass Energy Equivalence
- Atom
  - Structure
    - Orbits Cloud
      - Composition
  - Nonionized Atom
    - Ionized Atom
    - Excited Atom
  - Electron Binding Energy and Energy Levels
    - Electron Transitions
      - Characteristic X-ray
      - Auger Electron
- Nucleus
  - Composition
  - Nuclear Force and Energy Levels
  - Classification of Nuclides
  - Nuclear Stability
  - Radioactivity
    - Decay (Transformation)
      - Alpha Decay
      - Beta-minus Decay
      - Beta-Plus Decay
      - Electron Capture Decay
- Isomeric Transition
  - Decay Scheme
  - Decay Law
  - Half-Life

- Gamma Rays
- Internal Conversion Electrons
- Nuclear Binding Energy and Mass Defect
- Nuclear Fission and Fusion

- Interaction of Radiation with Matter
  - Energy Transfer
  - Scattering

- Interaction of Particulate Radiation
  - Electron Interaction
  - Positron Annihilation
  - Neutron Interaction
  - Alpha
  - Proton

- Interaction of X-Rays and Gamma Rays (Photon)
  - Coherent or Rayleigh Scattering
  - Compton Scattering
  - Photoelectric Effect
  - Pair Production

**Diagnostic Radiology**
- Conventional and Digital X-Ray Imaging
- Basics of X-Ray Production
- Particulate Radiation
- Interactions of Particulate Radiation with Matter
- Characteristic X-Rays
- Bremsstrahlung Radiation
- **X-Ray Generators**
  - Transformers and Production of High Voltage
  - Control of Tube Voltage, Tube Current, and Exposure Time
  - Conventional Single and Three-Phase X-Ray Generators
  - High-Frequency X-Ray Generators

- **X-Ray Tubes and Source Assemblies**
  - Modern Diagnostic X-Ray Tube
  - Line Focus Principle
  - Heel Effect
  - Heat Units and Rating Charts

- **X-Ray Beam: Radiation Quantities and Units**
  - Beam Intensity and Exposure
  - Radiation Absorbed Dose and Kerma
  - Exposure, Energy Fluence, Photon Fluence, and Absorbed Dose
  - Measurement Techniques and Ionization Chamber

- **X-Ray Beam: Geometrical Properties**
  - Principles of Shadow Formation
  - Inverse Square Law
  - Magnification and Distortion
  - Collimator Design and Off-Focus Radiation

- **X-Ray Beam: X-Ray Spectrum**
  - X-Ray Spectrum
  - Duane–Hunt Law
  - Effects of kV, mA, and Filtration
    - Intensity of Characteristic versus Bremmstrahlung Radiation

- **Interaction of X-Rays with Matter: Concepts**
  - Photon Attenuation
  - Scattering

- **Absorption**
- Interaction of X-Rays with Matter: The Patient
  - Incident and Transmitted X-Ray Spectra
  - Effects of kVp on Compton Scatter and Absorption
- Effects of kVp, mA, and Filtration on Transmitted Spectra
  - Absorption Edges and Contrast Media
- X-Ray Image: Basics
  - Subject Contrast
  - Effects of Scatter on Subject Contrast
- Scatter Control
- X-Ray Image: Digital Radiographic Systems
  - Basics
  - Digitizers (Digitizing an Analog Film Image)
- Computed Radiography
  - Digital Flat Panel Systems
- X-Ray Image: Conventional Fluoroscopy
  - Conventional Fluoroscopy Systems
  - X-Ray Image Intensifier
- Lens System
  - Video Camera
  - Video Monitor
- Automatic Brightness Control (ABC)
- Automatic Gain Control (AGC)
  - Digital Fluoroscopy
- Digital Fluorography
- Digital Subtraction Angiography (DSA)
- Angio Fluoroscopic Digital Image Processing
X-Ray Image Quality: Digital Image Quality
- Digital Image Fundamentals and Pixel Size
- Pixel Size in Digital Fluoroscopy

Digital Image Quality
- Digital Subtraction Angiography and Noise
- Noise Sources in Digital X-Ray Imaging

X-Ray Image: Mammography
- Image Quality Consideration
- Target, Filter, Tube Potential Considerations

Equipment Design Considerations
- X-Ray Tube and Geometry
- Grid
- AEC
- Screen/Film Processing Considerations
- ACR Accreditation

Computed Tomography (CT)
- CT vs. Radiography
- CT Image Formation
- CT Scan Configuration
- Source Detector Configuration
- Multirow Detector vs. Single-Row Detector
- Axial Scanning vs. Helical Scanning
- Detectors
- X-ray Tube

Tissue Characterization
- CT Number (in Hounsfield Units)
- Definition of Tissue Contrast on CT Images
CT Image Quality
- Noise
- Low Contrast Detectability
- High Contrast Resolution
- FOV

CT Dosimetry
- CT Dose Index (CTDI)
  - CTDI100
  - CTDIw
  - CTDIvol
  - Dose–Length Product (DLP)

CT Dose
- Overdose and Causes
- Dose Management
  - Methods
  - Technology

CT Scan Artifacts

Ultrasound Physics
- Characteristics of Sound Waves
- Sound Propagation
- Wavelength
- Frequency
- Amplitude
- Pressure
- Intensity
- dB scale
- Interactions of Ultrasound with Material
- Impedance
- Reflection
- Refraction
- Scattering
- Attenuation
- Introduction to Image Acquisition
- U/S Components
- Pulse-Echo Imaging
- Transducers
- Image properties and Qualities
- Near vs. Far Field; Fresnel Zone
- Spatial Resolution (axial, lateral, and elevational)
- Distance Measurements
- Contrast
- More on Image Acquisition
- Image Formation (transmit power, gain, TGC, frame rate, etc.).
- Clinical Ultrasound Lecture
- Doppler
- Harmonic Imaging,
- 3D, etc.
- Discussion on Artifacts (includes all types of ultrasound artifacts) and Diagnosis

**Magnetic Resonance Imaging (MRI)**
- Introduction to NMR Theory
- Historical Background
- Atomic Structure
- What are MR Active Nuclei?
- The Hydrogen Nucleus
- Alignment
- Precession
- Resonance
- MR Signal
- Free Induction Decay (FID)
- Relaxation Processes.
- Spin–Spin Relaxation (T2)
- Spin–Lattice Relaxation (T1)

- MR Image Formation
- Magnetic Field Gradient
- Frequency Encoding
- Phase Encoding
- Slice Selection

- MR Image Parameters
- TR and TE
Image Parameters Trade-off and Management
MRI Contrast
T1
T2
Proton Density (PD)
Image Resolution
Signal-to-Noise Ratio
Contrast media: Types and Applications
MRI Instrumentation
MRI System
Magnet and Magnetic Field
Magnet Types
Gradient System
Radiofrequency (RF) System
RF Coil Types
Safety and Hazards in MRI
Hazards from the Static Magnetic Field
Hazards from Switched Gradient Fields
Hazards from Radiofrequency Magnetic Fields
Cryogenic Hazards
Medical Hazards
MRI Pulse Sequences
Spin Echo (SE) Sequences
Conventional SE Sequences
Multi-Echo SE Sequences
Fast SE Sequences
Image Contrast in SE Sequences
Inversion Recovery (IR) Imaging
Gradient Echo (GRE) Sequences
Gradient Echo-Based Sequences
Spoiled Gradient Echo Sequences
Steady-State FLASH Sequences
Steady-State Free Precession Sequences
Image Contrast in GRE Sequences
- Echo Planar Imaging (EPI)
- Imaging Techniques and Applications
- Magnetic Resonance Angiography (MRA)
- Time-of-Flight MRA
- Phase Contrast MRA
- Contrast-Enhanced Angiography
- MRA and MRV
- Diffusion Imaging
- ADC Maps
- Diffusion Tensor Imaging
- Functional MRI

- MR Image Artifacts
- Artifacts Classification
- Chemical Shift Artifacts
- Magnetic Susceptibility Artifacts
- Aliasing and Wrap-Around Artifacts
- Cross-Excitation and Cross-Talk Artifacts
- Truncation Artifacts
- Phase Mismapping Artifacts
- External Artifacts

**Nuclear Medicine Physics**
- Radionuclide Production
- Nuclear Reactor-Produced Radionuclides
  - Neutron Activation
  - Fission
- Cyclotron-Produced Radionuclides
- Considerations in the Production of Radionuclides
- Radionuclide Generators
- Principles of a Generator
- Mo-99/Tc-99m Generator
- Quality Control of a Generator
- Radiopharmaceuticals
- Characteristic of a Radionuclide
- Selection of a Chemical
- Quality Control of a Radiopharmaceutical
- Radiation Detectors
- Gas-Filled Detectors
- Ionization Chamber
- Proportional Chamber
- Geiger–Muller Counter
- Dose Calibrator
- Principles
- Quality Control
- Scintillation Detectors
- The Scintillator
- Sodium Iodide (NaI)
- Advantages of NaI
- Disadvantages of NaI
- Photomultiplier (PM) Tube
- Preamplifier
- Amplifier
- Pulse Height Analyzers
- Pulse Height Spectrometry
- Factors Affecting Pulse Height Spectra

- Scintillation Detector Examples
- Well Counters
- Thyroid Uptake Probe
- Liquid Scintillators
- Thermoluminescent Dosimeters
- Counting Statistics
  - Errors in Measurements:
    - Systematic Errors
    - Random errors
    - Blunders

- Definitions
- Accuracy
- Precision
- Bias

- Examples
- Statistical Tests:
• The Chi-Square Test
• The t-Test

• The Scintillation Camera
• Components of a Gamma Camera
• Collimator
• Types and Characterization
• Performance
• NaI Crystal (Tl)
• Description
• Specifications
• Light guide
• Photomultiplier Tubes (PMTs)
• Description
• Performance
• Position Electronics
• Computer

• Scintillation Camera Characteristics
• Uniformity
• Spatial Resolution
• Linearity
• Energy Resolution
• Sensitivity

• Quality Control
• Important Tests and Their Frequencies

• Image Characteristics and Image Quality
  ▪ Spatial Resolution
  ▪ Contrast
  ▪ Image Quality (Noise)

• Digital Imaging in Nuclear Medicine
• Single Photon Emission Computed Tomography (SPECT)
• Review
• Filtered Back Projection (FBP)
• Iterative Reconstruction
• Advantages and Disadvantages of SPECT
- Image Quality in SPECT
  - Resolution
  - 3D
  - Number of Views
  - Noise
  - Orbit
  - Motion
  - Number of Camera Heads
  - Counts

- Quality Control in SPECT
  - Uniformity
  - Center Of Rotation (COR)
  - Total Performance

- Special Collimators
- Attenuation Correction
- Artifacts in SPECT Imaging

- Positron Emission Tomography (PET)
- Operating Principles
- 2D Acquisition
- 3D Acquisition
- Crystal and Detector
- Calibration Procedures
- Image Quality Issues
- Attenuation Correction
- Artifacts in PET Imaging
- PET/MRI
- Quality Control in PET
- Daily Procedures
- Quarterly Procedures

**Radiation Biology**
- Teaching Content
- Human Response to Ionizing Radiation: Sequence of Events
- Linear Energy Transfer (LET) and Relative Biologic effectiveness (RBE)
- Direct and Indirect Effects of Radiation
- Formation of Free Radicals
- Effects on Cells: DNA and Chromosomes
Cell Sensitivities
- Sensitivities in Different Cycles
- Factors Affecting Cell Sensitivity: Dose Rate, Fractionation, Chemical Modifiers (oxygen effect and radioprotectors)

Cell Survival, Repair, and Death
- Sources of Information on Biological Effects
- Types of Radiation Effects
- Deterministic Effects
- Skin Effects
- Effects on Lens of the Eye
- Doses for Different Deterministic Effects
- Acute Radiation Syndromes

Stochastic Effects
- Cancer Induction
- Hereditary Effects

Early and Late Effects of Radiation
- Lethal Dose LD50/30
- Risk Estimation
- Sources of Radiation Exposure
- Natural Sources
- Artificial Sources
- Medical Sources

Types of Radiation Exposure
- External Exposure
- Internal Exposure
- Categories of Radiation Exposure
- Occupational
- Public
- Medical

Radiation Protection Bodies, Historical Events in Radiation Protection
- Radiation Protection Quantities and Units
- Equivalent Dose
- Effective Dose
- Committed Dose
- Collective Dose

- System of Radiological Protection
- Justification
- Optimization
- Dose/Risk Optimization

- Annual Limit of Intake
- Protection of Pregnant Workers/Patients
- Protection of Apprentices
- Categories of Work Areas
- Cardinal Principles of Radiation Protection
- Radiation Protection in Diagnostic X-ray Imaging
- Sources of Exposure in Diagnostic X-ray Procedures: Staff, Patients, and Public
- Conventional Radiography
- Fluoroscopy and Interventional Radiology
- CT
- Mammography

- Radiation Protection in Nuclear Medicine
- Sources of Exposure in Nuclear Medicine: Staff, Patients, and Public
- Receipt of Radioactive Materials
- Safe Handling and Administration of Radiopharmaceuticals
- Storage and Transfer of Radioactive Materials
- Radioactive Waste Management
- Surveys and Decontamination
- Handling Radiation Incidents
- Handling of Radioactive Patients
- Local and International Rules
- Protection of Lactating Mothers
- Protection of Pregnant Patients

- Radiation Protection in Radiotherapy
- Sources of Exposure for Staff and Public
- Protection of Patients, Staff, and Public
- Interlock Checks
- Radiation Emergencies

- Shielding
  - Factors to Consider in Shielding
  - Primary and Secondary Shielding
  - Testing of Shielding Thickness
  - Shielding Requirements in Diagnostic X-ray, Nuclear Medicine, and Radiation Therapy

- Rationale for the New ICRP Recommendations
- Objectives
- Phases

- Types of Exposure in the New Recommendations
  - Planned Exposures
  - Existing Exposures
  - Emergency Exposures

- New Dose Limits
  - Pregnancy
  - Eye Dose

- Dose Constraints and Reference Levels
- Radiation Weighting Factors
- Protection of the Environment
- New IAEA Basic Standards
- Rationale
- Phases of Development
- Dose Limits and Standards
- Specific Requirements

- Objectives for Patient Dosimetry
- Patient Dose Calculations in X-ray Procedures
  - Output Measurement: Method and Use in Patient Dose Calculation
  - TLD Dosimetry: Method, Calibration, Advantages
  - Film Dosimetry: Method, Calibration, and Advantages
  - EDR Films
- Radiochromic Films
- Patient Skin Dosimeter: Use and Testing
- Patient Dosimetry in CT
- Effective Dose Calculation

- Patient Dose Calculation in Nuclear Medicine
- Diagnostic Procedures
- Therapeutic Procedures
- Fetal Dose
- Review Questions (MCQ) for Part 1, Part 2, and Patient Dosimetry
- Problem-Solving Exercises for Part 1, Part 2, and Patient Dosimetry
- Review Questions on Basic Safety Standards, Dose Limits, and Specific Situational Analysis
- Problem-Solving Exercises

**Examples of useful reading material**
- The Essential Physics of Medical Imaging, by Bushberg, et al.
- Review of Radiologic Physics, by Walter Huda
- ICRP 103, Good Reference for International Radiation Protection Standard
- NCRP 147, Good Reference for Shielding Requirement and Calculation

**Research Skills Course**
See section 4.1.5 Radiology Research Skills for details.

**Fundamentals of the Quality Management Course**
See section 4.1.4 Quality Improvement for details.

**Reporting Skills Course**
See section 4.1.6 Reporting skills for details.

**Other Courses**
Residents are required to present “Certificates of Completion” for the following courses from one of the accredited residency training centers:
- Basic Life Support: during the first and third years of training
• Infection Control course: during the second and fourth years of training
Appropriate completion of these courses will be considered in the overall annual evaluation scores.

4.2.3 Workshops
At least two of the following workshops will be conducted during the program.

**Imaging Informatics and Advanced Visualization Workshop**
See section 4.1.8 Imaging Informatics and Advanced Visualization for details.

**Procedural Sedation and Analgesia Workshop**
See section 4.1.7 Sedation and Analgesia for details.

**Ultrasound for Vascular Access Workshop**

**Program Description**
This 2-day program is specifically designed for staff responsible for vascular access who have little or no experience in diagnostic ultrasound and would like to become proficient in all the basic concepts of ultrasound techniques for peripheral vascular access.

**Specific Topics**
- Basic Physical Principles of Ultrasound
- Basic Physical Principles of Color Doppler Ultrasound
- Ultrasound Artifacts
- Probe Manipulation Techniques
- Needle Guidance Techniques
- Scanning Protocols for Peripheral Vascular Access
- Practical Scanning Tuition on Patient Volunteers
- Practical Needle Guidance Tuition on Phantoms
Course Objectives

- To provide an overview of the basic principles of ultrasound, artifacts, and system controls associated with vascular access.
- To provide the scanning skills required in basic vascular access applications, including needle guidance.
- To provide an understanding of the difficulties encountered during vascular access examinations and needle guidance.

Pediatric Emergency and Critical Care Ultrasound Workshop

This 2-day, hands-on course on pediatric emergency and critical care ultrasound is designed to increase the participant’s knowledge and competency for performing and interpreting pediatric ultrasound examinations.

The topics for this workshop include the following:
Ultrasound imaging fundamentals, FAST, evaluation of the urinary tract in infants and children, applications for pediatric GI conditions such as pyloric stenosis and intussusception, evaluation of appendix and bowel obstruction, evaluation of soft tissue, MSK applications, evaluation of DVT, and scrotal ultrasound.

This course is taught by leading experts in pediatric emergency and critical care ultrasound and includes lectures, interactive case presentations, and extensive hands-on scanning.

Objectives

Upon completion of this program, the following objectives are achieved:
- Increased participant knowledge to better perform and/or interpret pediatric emergency and critical care ultrasound examinations.
- Ability of participants to state the basic fundamentals of ultrasound physics and demonstrate appropriate optimization of system controls.
- Ability of participants to identify normal imaging characteristics of the pediatric kidneys and recognize commonly seen
pathologies associated with renal diseases and the GI tract in infants and children.

- Ability of participants to list the benefits of soft tissue and MSK ultrasound in the pediatric patient.
- Ability of participants to perform a focused two-point venous evaluation for DVT.
- Ability of participants to perform testicular ultrasound and recognize common abnormalities.
- Increased participant confidence to incorporate protocols, techniques, and interpretation criteria to improve diagnostic/treatment accuracy.

Topics
- Imaging fundamentals
- FAST + e-fast
- Pediatric GI: pyloric stenosis, intussusception, appendix, and bowel obstruction
- Ultrasound-guided procedures, including vascular access and lumbar puncture
- Urinary tract infection and renal disease in infants and children
- Soft tissue applications
- Evaluation of DVT
- Rapid fracture diagnosis/post-reduction bony alignment, etc.
- Interactive case studies
- Testicular ultrasound
- Extensive hands-on scanning
4.3 Universal Topics

4.3.1 Intent
These are high-value, interdisciplinary topics of outmost importance to the trainee. The reason for delivering the topics centrally is to ensure that every trainee receives high-quality training and develops essential core knowledge. These topics are common to all specialties.

Topics included here meet one or more of the following criteria:
- Impactful: topics that are common or life-threatening
- Interdisciplinary: topics that are difficult to teach via a single discipline
- Orphan: topics that are poorly represented in the undergraduate curriculum
- Practical: topics that trainees will encounter in hospital practice

4.3.2 Development and Delivery
Core topics for the PG curriculum will be developed and delivered centrally by the Commission through an e-learning platform. A set of preliminary learning outcomes for each topic will be developed. Content experts, in collaboration with the central team, may modify the learning outcomes.

These topics will be didactic in nature, with focus on the practical aspects of care. These topics will be more content-heavy compared with workshops and other planned face-to-face interactive sessions.

The suggested duration of each topic is 90 min.

4.3.3 Assessment
The topics will be delivered in a modular fashion. At the end of each module, there will be online formative assessment. After completion of all topics, there will be a combined summative assessment in the form of context-rich MCQs. All trainees must attain minimum competency in the summative assessment. Alternatively, these topics can be assessed in a summative manner along with specialty examinations.
4.3.4 University Topics Module

Module: Introduction
  o Sepsis, SIRS, DIVC

Module: Cancer
  o Side effects of chemotherapy and radiation therapy

Module: Diabetes and Metabolic Disorders
  o Recognition and management of diabetic emergencies

Module: Medical and Surgical Emergencies
  o Management of acute chest pain
  o Management of acute breathlessness
  o Management of upper GI bleeding
  o Management of lower GI bleeding

Module: Acute Care
  o Preoperative assessment
  o Postoperative care
  o Acute pain management

Module: Ethics and Healthcare
  o Patient advocacy
  o Ethical issues: treatment refusal, patient autonomy
SECTION 5

Assessment
Evaluations and assessments throughout the program are conducted in accordance with the Commission’s training and examination rules and regulations. The process includes the following steps.

5.1. Annual Assessment

1. Continuous Appraisal
This assessment is conducted toward the end of each training rotation throughout the academic year and at the end of each academic year as a continuous assessment in the form of a formative and summative evaluation (See APPENDICES).

1.1 Formative Continuous Evaluation
To fulfill the CanMEDS competencies based on the end-of-rotation evaluation, the resident’s performance will be jointly evaluated by relevant staff for the following competencies:

1. Performance of the trainee during daily work.
2. Performance and participation in academic activities.
3. Performance in a 10- to 20-min direct observational assessment of trainee–patient interactions. Trainers are encouraged to perform at least one assessment per clinical rotation, preferably near the end of the rotation. Trainers should provide timely and specific feedback to the trainee after each assessment of a trainee–patient encounter.
4. Performance of diagnostic and therapeutic procedural skills by the trainee. Timely and specific feedback for the trainee after each procedure is mandatory.
5. The CanMEDS-based competencies end-of-rotation evaluation form must be completed
within 2 weeks after the end of each rotation (preferably in electronic format) and signed by at least two consultants. The program director will discuss the evaluation with the resident, as necessary. The evaluation form will be submitted to the Regional Training Supervisory Committee of the SCFHS within 4 weeks after the end of the rotation.

6. The assessment tools used, can be in the form of an educational portfolio (i.e., monthly evaluation, rotational Mini-CEX*, and CBDs, **DOPS, ***MSF****) (See APPENDICES).

7. Academic and clinical assignments should be documented on an annual basis using the electronic logbook (when applicable). Evaluations will be based on accomplishment of the minimum requirements for the procedures and clinical skills, as determined by the program (See APPENDICES).

Clinical evaluation exercises
  Case-based discussions
  Direct observation of practical skills
  Multisource feedback

1.2 Summative Continuous Evaluation

This is a summative continuous evaluation report prepared for each resident at the end of each academic year. The report may also involve the result of clinical examination, oral examination, objective structured practical examination (OSPE), objective structured clinical examination (OSCE), and American College of Radiology (ACR).

2. End-of-Year Examination

The end-of-year examination will be limited to R1, R2, and R3. The number of exam items, eligibility, and passing score will be in
accordance with the Commission’s training and examination rules and regulations. Examination details and blueprints are posted on the commission website: www.scfhs.org.sa

5.2. Principles of Radiology Examination (Saudi Board Examination: Part I)
This written examination, which is conducted in multiple choice question format, is held at least once a year. The number of exam items, eligibility, and passing score will be in accordance with the Commission’s training and examination rules and regulations. Examination details and blueprints are published on the commission website: www.scfhs.org.sa

5.3. Final In-training Evaluation Report (FITER)/Comprehensive Competency Report (CCR)
In addition to approval of the completion of clinical requirements (resident’s logbook) by the local supervising committee, FITER is also prepared by program directors for each resident at the end of his or her final year in residency (R4). This report may also involve clinical examinations, oral examinations, or other academic assignments.

5.4. Final Radiology Board Examination (Saudi Board Examination: Part II)
The final Saudi Board Examination comprises two parts.

1. Written Examination
This examination assesses the trainee’s theoretical knowledge base (including recent advances) and problem-solving capabilities with regard to the specialty of radiology. It is delivered in multiple choice question format and held at least once a year. The number of exam items, exam format, eligibility, and passing score will be in accordance with the Commission’s training and examination rules and regulations. Examination details and blueprints are published on the commission website: www.scfhs.org.sa

2. Clinical Examination
This examination assesses a broad range of high-level clinical skills, including data collection, patient management, communication, and counseling skills. The examination is held at least once a year, preferably in an OSCE format in the form of patient management problems (PMPs). The exam eligibility, format, and passing score will be in accordance with the Commission’s training and examination rules and regulations.
Examination details and blueprints are published on the commission website: www.scfhs.org.sa

5.5. Certification
Certificates of training completion will only be issued upon the resident’s successful completion of all program requirements. Candidates passing all components of the final specialty examination are awarded the “Saudi Board in Radiology” certificate.

Evaluation
- Monthly end-of-rotation evaluation
The final annual evaluation total is calculated (See page 142) as follows:
### Table 1: Example of Monthly Rotation Evaluation

<table>
<thead>
<tr>
<th>Rotation</th>
<th>Junior</th>
<th>Senior</th>
</tr>
</thead>
<tbody>
<tr>
<td>Neuro</td>
<td>80%</td>
<td>20%</td>
</tr>
<tr>
<td>Chest/cardiac</td>
<td>80%</td>
<td>20%</td>
</tr>
<tr>
<td>CT/MR body</td>
<td>80%</td>
<td>20%</td>
</tr>
<tr>
<td>Ultrasound</td>
<td>80%</td>
<td>20%</td>
</tr>
<tr>
<td>MSK</td>
<td>80%</td>
<td>20%</td>
</tr>
<tr>
<td>Fluor/ER</td>
<td>80%</td>
<td>20%</td>
</tr>
<tr>
<td>Nuc Med</td>
<td>80%</td>
<td>20%</td>
</tr>
<tr>
<td>Intervention</td>
<td>80%</td>
<td>20%</td>
</tr>
<tr>
<td>Breast</td>
<td>80%</td>
<td>20%</td>
</tr>
</tbody>
</table>

**Monthly Rotation Evaluation Components**

All mini-IPX & DOPS performed during 2nd & 4th weeks of rotation on a minimum of two cases each time, preferably by at least two evaluators.
APPENDICES
## Appendix 1 - Example of the “Annual Evaluation Form”

<table>
<thead>
<tr>
<th>Activity/Competency</th>
<th>Method</th>
<th>Scores</th>
<th>Points Key</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>R1</td>
<td>R2</td>
</tr>
<tr>
<td>HAD lectures</td>
<td></td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Tutorials</td>
<td></td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>ER course</td>
<td></td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Physics &amp; radiation safety course</td>
<td>Attendance</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Contrast Management course</td>
<td></td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Reporting skills course</td>
<td></td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Advanced visualization/informatics</td>
<td></td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Research course</td>
<td></td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Quality Improvement course</td>
<td></td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Sedation &amp; analgesia workshop</td>
<td></td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Infection Control course</td>
<td>Certification</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Basic Life Support course</td>
<td></td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Imaging techniques</td>
<td>Evaluation</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>On call performance</td>
<td></td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td><strong>SUBTOTAL</strong></td>
<td></td>
<td><strong>79</strong></td>
<td><strong>96</strong></td>
</tr>
<tr>
<td>Overall monthly rotation average</td>
<td></td>
<td>70</td>
<td>70</td>
</tr>
<tr>
<td>ACR exam score</td>
<td></td>
<td>50</td>
<td>55</td>
</tr>
<tr>
<td><strong>FINAL ANNUAL EVALUATION TOTAL</strong></td>
<td></td>
<td><strong>73</strong></td>
<td><strong>73</strong></td>
</tr>
<tr>
<td><strong>Resident</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Yusuf AlKadhi</strong></td>
<td>Level</td>
<td><strong>R2</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Program Director</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Year</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>2014-15</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Regional Director</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Weights:
- Infection Control course: 1 point per year
- Basic Life Support course: 1 point per year
- Imaging techniques: 5 points per year
- On call performance: 3, 3, 3, 4 points

Points Key:
- Poor: <40%
- Below Average: 40-50%
- Average: 51-60%
- Above Average: 61-75%
- Outstanding: >75%

**Notes:**
- Weighting x 2 where applicable
- N=0, Y=1
- Scores range from 0 to 5
- Overall score calculation includes weighting factors.
Appendix 2 – Example of the “Rotation Evaluation Form”

### Radiology resident rotation evaluation form

<table>
<thead>
<tr>
<th>Name</th>
<th>Yusuf Alkadhi</th>
<th>Level</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotation</td>
<td>FI/ER</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Month</td>
<td>May</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hospital Year</td>
<td>2015</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Workload stats provided by (signature):**
  - 250 XR
  - 0 US
  - 0 OT
  - 0 PN
  - 61 FL
  - 0 MN
  - 0 PR
  - 0 NM

- **No. workdays on leave (max. 3 d):** 5

- **Workload balance (insufficient if negative value):** 5.17

**Weighting Competency Score**

<table>
<thead>
<tr>
<th>Weighting</th>
<th>Competency</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>General (10%)</td>
<td>Radiological knowledge</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Radiological skills</td>
<td>3</td>
</tr>
<tr>
<td>Rotation specific (26%)</td>
<td>Radiological knowledge</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Radiological skills</td>
<td>3</td>
</tr>
<tr>
<td>10%</td>
<td>Communication</td>
<td>3</td>
</tr>
<tr>
<td>5%</td>
<td>Collaboration</td>
<td>3</td>
</tr>
<tr>
<td>10%</td>
<td>Health advocacy &amp; safety</td>
<td>3</td>
</tr>
<tr>
<td>Manager (10%)</td>
<td>Productivity &amp; work ethic</td>
<td>2.8</td>
</tr>
<tr>
<td></td>
<td>Service management</td>
<td>4</td>
</tr>
<tr>
<td>10%</td>
<td>Professionalism &amp; ethics</td>
<td>3</td>
</tr>
<tr>
<td>5%</td>
<td>Scholarly activity</td>
<td>3</td>
</tr>
<tr>
<td>20%</td>
<td>Workplace-based assessments</td>
<td>4</td>
</tr>
</tbody>
</table>

**Scoring scale**

- Poor: 1
- Below average: 2
- Average: 3
- Above average: 4
- Exceptional: 5

**Total Score:** 65

**Comments**

**Signature**

<table>
<thead>
<tr>
<th>Rotation Supervisor</th>
<th>Name</th>
<th>Signature</th>
</tr>
</thead>
</table>

| Resident | | |

<table>
<thead>
<tr>
<th>Program Director</th>
<th>Chairman</th>
</tr>
</thead>
</table>

143
Definitions of Evaluation Items

- **General radiological knowledge and skills**: Appropriate understanding and application of the principles of radiological anatomy, practical physics, imaging artifacts, radiation and contrast issues, and the use of imaging workstations, technology, and resources.

- **Rotation-specific knowledge and skills**: Knowledge of applied radiology is consistent with the level of training and applied to the specific rotation with relevant disease presentations, pathophysiology, causes, and management.

- **Communication**: Obtains appropriate information from referring physicians and appropriately conveys recommendations and critical results. Effectively communicates with radiology staff, peers, patients, and families. Prepares informative reports and shows good oral presentation skills.

- **Collaboration**: Effectively collaborates with other physicians and healthcare professionals to provide good patient care and effectively contributes to other interdisciplinary team activities, e.g., clinical–radiological meetings, research, QI, M&M, etc.

- **Health advocacy and safety**: Communicates the benefits/risks of radiological investigations and treatment, including population screening, and identifies when these would be detrimental to patient health. Promotes patient, family, staff, and community awareness and safety. Applies appropriate procedural precautions and preparations. Handles radiation, medication, and contrast hazards well.

- **Manager - service management**: Effectively utilizes resources to balance patient care, workflow, learning needs, and other activities. Prioritizes examination urgency. Effectively manages support staff and junior trainees. Generates timely reports.

- **Professionalism**: Delivers highest quality care with integrity, honesty, and compassion. Exhibits appropriate personal/interpersonal professional behavior (punctuality, commitment, confidentiality, etc.). Positively accepts critique and recognizes limitations. Adheres to Islamic/medical ethical standards.
• **Scholarly activity:** Develops and maintains a personal continuing education strategy. Searches and critically appraises sources of medical information. Utilizes information technology to optimize patient care. Teaches juniors.

• **Work-based assessment:** Scores of relevant rotational mini-IPX and/or DOPS assessments.

**Others**

- **No. of workdays on leave:** Absence for any reason for more than 5 working days during a single rotation including Eid and statutory holidays results in automatic failure of that rotation.

- **Reported workload:** Failure to achieve minimum reported workload requirement statistics may result in failure of the rotation. Any of the below, when performed alone (or a combination thereof), constitutes the minimum acceptable daily workload (excluding vacations):
  - **General X-ray (XR):** \((R \text{ level } \times 5) + 10\)
  - **Ultrasound (US):** \((R \text{ level } \times 3) + 4\)
  - **CT:** \(R \text{ level } + 3\) (For cardiac CT: \(R \text{ level } \times 0.5\))
  - **MRI:** \(R \text{ level } + 1\) [For body/cardiac MRI: \((R \text{ level } + 2) \times 0.5\)]
  - **Fluoroscopy (FL):** \(R \text{ level } + 3\) (at least half of this is required in FL/ER rotation)
  - **Mammography (Mm):** \(R \text{ level } + 2\)
  - **Procedures (PR):** \(R \text{ level}\) (angiography, biopsies, etc.)
  - **Nuclear Medicine (NM):** \(R \text{ level } + 3\) (R4: PET rotation minimum = 4 cases/day)

- **Workload balance:** A negative value (calculated) indicates that the workload was insufficient for the time spent in the rotation, mandating repetition of the rotation. This value is used to automatically calculate the productivity and work ethic score.
### Appendix 3 – Example of the “Rotation Mini-IPX Form”

<table>
<thead>
<tr>
<th>Resident</th>
<th>Yusuf AlKadhi</th>
<th>R Level</th>
<th>1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rotation</td>
<td>Neuro</td>
<td>Year</td>
<td>2014-15</td>
</tr>
<tr>
<td>Item</td>
<td>1st</td>
<td>2nd</td>
<td>3rd</td>
</tr>
<tr>
<td>Evaluates exam appropriateness/safety</td>
<td>4</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Looks for relevant lab/prior imaging</td>
<td>4</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Understands exam technique</td>
<td>4</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Critiques image quality</td>
<td>4</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Detects findings</td>
<td>4</td>
<td>4</td>
<td>3</td>
</tr>
<tr>
<td>Describes findings appropriately</td>
<td>4</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Mentions pertinent negatives</td>
<td>4</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Diagnosis/Differential Diagnosis</td>
<td>4</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Recommendations</td>
<td>4</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Appropriate handling of result urgency</td>
<td>4</td>
<td>5</td>
<td>2</td>
</tr>
<tr>
<td>Date of assessment</td>
<td>02-Mar-14</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SUBTOTALS</strong></td>
<td>80</td>
<td>88</td>
<td>52</td>
</tr>
<tr>
<td><strong>FINAL TOTAL</strong></td>
<td>85</td>
<td>73.333</td>
<td>4</td>
</tr>
</tbody>
</table>

Evaluators (Min. two)

Prog Dir

*Pls ensure all yellow cells are completed*
### Direct Observation of Procedural Skills (DOPS) evaluation form

<table>
<thead>
<tr>
<th></th>
<th>Weight</th>
<th>Score</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Evaluates indications/risks</td>
<td>15%</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Procedure preparation</td>
<td>20%</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Explains procedure to patient/Informed Consent</td>
<td>10%</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Technical procedure skills</td>
<td>25%</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Prevents/manages complications</td>
<td>15%</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Post-procedure management/instructions</td>
<td>15%</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td><strong>3.6</strong></td>
<td></td>
</tr>
</tbody>
</table>

Evaluator 1
Evaluator 2
Resident feedback acknowledgement
Program Director **Yusuf AlKadhi**
### Appendix 5 – Example of the “On-Call Evaluation Form”

#### On-call Evaluation Form

<table>
<thead>
<tr>
<th>Resident</th>
<th>Yusuf AlKadhi</th>
<th>R Level</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Year</td>
<td></td>
<td></td>
<td>2014-15</td>
</tr>
</tbody>
</table>

#### Assessment

<table>
<thead>
<tr>
<th>Item</th>
<th>Oct-Jan</th>
<th>Feb-Apr</th>
<th>May-Aug</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attendance &amp; availability</td>
<td>4</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Interaction with referring staff</td>
<td>4</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Interaction with technologists</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>Accuracy of findings &amp; reports</td>
<td>2</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Timeliness</td>
<td>4</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>Appropriate utilization of seniors</td>
<td>4</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td><strong>Seniors only:</strong></td>
<td>69.93</td>
<td>56.61</td>
<td>96.57</td>
</tr>
<tr>
<td>Active supervision of juniors</td>
<td>1</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Verification of preliminary reports</td>
<td>1</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td><strong>Seniors only:</strong></td>
<td>57.5</td>
<td>57.5</td>
<td>97.5</td>
</tr>
</tbody>
</table>

| Date of assessment                       | 02-Jan-14 07-Apr-14 11-Jul-14 |
| SUBTOTALS                                | 70 57 97 |
| FINAL TOTAL                              | 74 |

**Evaluators**

<table>
<thead>
<tr>
<th>Evaluator</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Prog Dir**

<table>
<thead>
<tr>
<th>Prog Dir</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Pls ensure all yellow cells are completed*
# Appendix 6 – Pg 1 – Example of the “Tech Week Evaluation Form”

## First Year Resident Technical Rotation Evaluation Form

<table>
<thead>
<tr>
<th></th>
<th>Exceptional</th>
<th>Above expectations</th>
<th>Meets expectations</th>
<th>Below expectations</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attendance/ punctuality</td>
<td>5</td>
<td>4</td>
<td>3</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Communication/ interaction</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technical understanding</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technical performance</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ability to learn</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Total score = ______ x 4 = ______%

Comments

____________________________________________________

____________________________________________________

____________________________________________________

____________________________________________________

Technical staff evaluator ___________________________ signature ______________________

Resident ___________________________ signature ______________________

Program director ___________________________ signature ______________________
### Appendix 6 – Pg 2 – Example of the “Tech Week Evaluation Form”

#### Log book

<table>
<thead>
<tr>
<th>Exam</th>
<th>Required</th>
<th>Observed/Performed</th>
<th>Tech initials</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>X-ray (1 week) – during first FU/ER rotation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chest</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C-spine</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Extremities</td>
<td>10</td>
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</tr>
<tr>
<td>Portable</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shoulder</td>
<td>10</td>
<td></td>
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</tr>
<tr>
<td>Peds</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Abdomen</td>
<td>5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Knee</td>
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<td></td>
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</tr>
<tr>
<td>Pelvis</td>
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<tr>
<td>LS-spine</td>
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<tr>
<td><strong>Ultrasound (4 weeks) - half of cases to be performed by resident</strong></td>
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<tr>
<td>General</td>
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<tr>
<td>Doppler (carotid, DVT)</td>
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<tr>
<td>Small parts (thyroid, scrotum)</td>
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</tr>
<tr>
<td><strong>CT (1 week)</strong></td>
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</tr>
<tr>
<td>Brain</td>
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<td></td>
</tr>
<tr>
<td>Chest</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Abdomen</td>
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</tr>
<tr>
<td>CTA/PE</td>
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<tr>
<td>Peds</td>
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<tr>
<td>Cardiac</td>
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<tr>
<td><strong>MRI (2 weeks)</strong></td>
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