



## SAUDI BOARD OF RADIOLOGY TECHNOLOGY & MEDICAL IMAGING (SBRT & MI)

2020



بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ





الهيئة السعودية للتخصصات الصحية  
Saudi Commission for Health Specialties

## CONTRIBUTORS

---

## COPYRIGHTS AND AMENDMENTS

All rights reserved. © 2019 Saudi Commission for Health Specialties. This material may not be reproduced, displayed, modified, distributed, or used in any other manner without prior written permission of the Saudi Commission for Health Specialties, Riyadh, Kingdom of Saudi Arabia. Any amendment to this document shall be endorsed by the Specialty Scientific Council and approved by Central Training Committee. This document shall be considered effective from the date the updated electronic version of this curriculum was published on the commission's Website, unless a different implementation date has been mentioned.

**Correspondence:** Saudi Commission for Health Specialties P.O. Box: 94656

Postal Code: 11614 Contact Center: 920019393

**E-mail:** [Curricula@scfhs.org.sa](mailto:Curricula@scfhs.org.sa)

**Website:** [www.scfhs.org.sa](http://www.scfhs.org.sa)

---

## ACKNOWLEDGMENTS

First and foremost, we would like to thank Allah, the Almighty, for helping us develop this curriculum. Further, we thank the curriculum specialists Associate Prof. Zubair Amin and Dr. Sami Al Shmarri who assisted us in the development of this curriculum.

The core curriculum team of the Saudi Board of Radiology Technology & Medical Imaging (SBRT&MI) appreciates the valuable contributions and feedback from the following members of the supervisory committee and curriculum workshop team during the manual construction: **Dr. Ali Zailae, Dr. Rafat Mohtasib, Mr. Ahnaf Arafah,** and trainee representative **Mr. Ali Aamry.** This work could not have been accomplished without their support.

Moreover, we thank those who initiated this program in 2009: Dr. Mubarak Al Shamari, Dr. Mohammad Al Habdan, and Mr. Hesham Al Ghanmi. We acknowledge the contributions of: Dr. Khalid Alzimami, Dr. Khalid Alyousef, Dr. Hussain Almohiy, Mr. Hassan Aldossari, Mr. Nabeel Mishah, Mr. Abdullah Alshehri, Mr. Ali Almutairi, and Mr. Abdullah Khardali.

We acknowledge that the CanMEDS framework is a copyrighted project of the Royal College of Physicians and Surgeons of Canada. Many of the descriptions and RT&MI competencies have been acquired from their resources.

---

---

## ABBREVIATIONS

SBRT&MI	Saudi Board of Radiology Technology and Medical Imaging
RT&MI	Radiology Technology & Medical Imaging
CT	Computed Tomography
MRI	Magnetic Resonance Imaging
US	Ultrasonography, Ultrasound
NM	Nuclear Medicine
IPEM	Institute of Physics and Engineering in Medicine
ABSNM	American Board of Science in Nuclear Medicine
CanMEDS	Canadian Medical Education Directives for Specialists
SCFHS	Saudi Commission for Health Specialties
KFMC	King Fahad Medical City
KSMC	King Saud Medical City
KAUH	King Abdulaziz University Hospital
RPS	Retropharyngeal Space
PBL	Practice-Based Learning
WBL	Work-Based Learning
PACS	Picture Archiving and Communication System
ALARA	As Low As Reasonably Achievable
QC	Quality Control
RIS	Radiology Information System



---

## TABLE OF CONTENTS

<b>Introduction</b>	<b>7</b>
<b>Training Program Structure</b>	<b>9</b>
<b>Specific Learning Objectives and Competencies</b>	<b>13</b>
<b>Teaching and Learning Activities</b>	<b>24</b>
<b>General X-ray Section</b>	<b>25</b>
<b>Interventional Radiology and Fluoroscopy</b>	<b>28</b>
<b>Magnetic Resonance Imaging (MRI)</b>	<b>30</b>
<b>Nuclear Medicine (NM)/Pet Imaging</b>	<b>35</b>
<b>Computer Tomography (CT)</b>	<b>39</b>
<b>Ultrasound (US)</b>	<b>43</b>
<b>Work-Based Learning (WBL)</b>	<b>50</b>
<b>Other Courses</b>	<b>64</b>
<b>Suggested Reference Books</b>	<b>66</b>
<b>Assessment</b>	<b>68</b>
<b>Exam Blueprints</b>	<b>72</b>
<b>References</b>	<b>75</b>
<b>Appendices</b>	<b>76</b>



---

## INTRODUCTION

The goal of the Saudi Board of Radiology Technology and Medical Imaging (SBRT&MI) is to produce the best possible qualified technologists who practice safely and meet the healthcare needs of society. This program is designed to help new graduates to gradually improve their field-specific skills and achieve promotion to a higher academic grade once they complete their courses.

Several countries in the Western World introduced fellowship programs for health science graduates. Some of these fellowship programs may take up to six years. For example, the Institute of Physics and Engineering in Medicine (IPEM) in the UK offers fellowships, which are designed for clinical scientists and clinical technologists. In the USA, several specialty boards exist, e.g., the American Board of Science in Nuclear Medicine (ABSNM). They provide a similar program.

The SBRT&MI program is unique and follows the Canadian Medical Education Directives for Specialists (CanMEDS) framework. The CanMEDS framework is applied in postgraduate training programs in many countries. It offers a competency model that places emphasis on not only Radiology Technology & Medical Imaging expertise but also on multiple additional non-Radiology Technology & Medical Imaging expert roles that competently address the healthcare needs of society. The Saudi Commission for Health Specialties (SCFHS) is adopting the CanMEDS framework to establish a core curriculum for all training programs. The RT&MI residents will function within seven CanMEDS roles, i.e., Radiology Technology & Medical Imaging expert, communicator, collaborator, manager, health advocate, scholar, and professional.

The SBRT&MI program consists of four years of full-time supervised residency training in radiology technology and medical imaging (RT&MI) and related fields. The training institution must be accredited by the SCFHS to offer the SBRT&MI program. The RT&MI residents will benefit from comprehensive training and be actively involved in patient care. Their responsibilities will increase with increasing experience and competency. Rules and regulations of the training program are to be followed.

Upon successful completion of the training program, RT&MI residents will be awarded the "Saudi Board in RT&MI" qualification. At this stage, they will have a degree of competency and experience considered adequate for the practice of clinical radiographic technology and will become eligible for a position in radiology departments as technical consultants after fulfilling the requisite years of experience demanded by the SCFHS. The residents will be consulted regarding exam selection and postprocessing, education of residents and staff, research on the development of new methods for protocol optimization, and implementation of quality patient care.

The SBRT&MI program was designed to cover three major areas in RT&MI that exhibit the highest demand:

1. Cross-sectional imaging: computed tomography (CT) and magnetic resonance imaging (MRI);
2. Ultrasonography (US);
3. Nuclear medicine (NM).

The program includes both theoretical and practical parts to introduce the candidates to very advanced techniques in each proposed specialty. The first part (first and second year) of the program covers generic, basic, and overall knowledge and understanding of RT&MI modalities of cross-sectional imaging such as general X-ray, angiography, fluoroscopy, NM, US, and CT and MRI. Further, all techniques and relevant physics are included. The second part (third and fourth year) is dedicated to one of the specialties (NM, US, or CT and MRI).

The purpose of this curriculum is to define the training process and competencies required for the SBRT&MI certification. After training, the RT&MI specialists will be able to work as senior technologists in RT&MI departments and promoted after three years of experience to consultant technologist. This curriculum will be reviewed every four years or at any time, if necessary. All trainees having satisfactorily completed the program are eligible candidates for the SBRT&MI examination Part 2.

---

## TRAINING PROGRAM STRUCTURE

The SBRT&MI program is a four-year, full-time residency in accredited institutions. The program comprises training for acquiring cognitive and technical skills and to understand how they relate to patient care, safety, physics, applied anatomy, pathology, and physiology of health and diseases. The training involves practical procedures and interpretation methods taught in a sequential and integrated manner through lectures, tutorials, seminars, and hands-on experience.

### Objectives

The overall objective is to guide RT&MI residents in a well-structured comprehensive training program certified by the SCFHS in clinical RT&MI. After successful completion of the training and the final certification exam, the graduates will function as independent first specialists in RT&MI fields.

The SBRT&MI program prepares residents to:

- Plan and provide both routine and complex RT&MI care for a wide variety of patients by applying advanced knowledge and clinical skills;
- Acquire competencies and confidence in various RT&MI exams;
- Reinforce the ability to interpret submitted RT&MI exams accurately and efficiently with the best image quality using effective protocols;
- Keep abreast with modern technology regarding RT&MI;
- Communicate, understand, and function effectively with other healthcare professionals and understand their organizational systems;
- Acquire experience in teaching and research to upgrade clinical knowledge. At the end of this program, the RT&MI resident will have acquired the CanMEDS framework competencies and can function effectively in the following roles:
  - Radiology & Medical Imaging expert,
  - communicator,
  - collaborator,
  - leader,
  - health advocate,
  - scholar,
  - professional.

### Admission Requirements for Candidates

The SCFHS requires three years of experience for the eligibility to attend the SBRT&MI admission exam. The objective of this is to gain experience in a wide field of clinical practices in an approved radiology institution.

Candidates for the SBRT&MI residency program are selected based on the admission exam results and an interview conducted by the national and (or) regional committee with the following requirements:

1. Admission to the program is in accordance with the SCFHS training rules and regulations;
2. Candidates must hold at least a Bachelor's degree in medical imaging or its equivalent from a university recognized by the commission;

3. Three confidential reference letters;
4. Results from an admission exam and interview to evaluate each candidate;
5. Registration as a specialist in RT&MI at the SCFHS;
6. Minimum three-year work experience in RT&MI in a recognized hospital;
7. Good command in spoken and written English;
8. Candidates must have a basic-life-support certification.

## General Training Requirements

- RT&MI residents shall obey the training regulations and obligations established by the SCFHS and their training center.
- RT&MI residents shall be enrolled in full-time continuous education for the entire duration of the program.
- Training is to be conducted in institutions accredited by the SCFHS.
- Training shall be comprehensive and include general clinical education in the first part and specialized education in US, NM, or CT and MRI in the second part.
- RT&MI residents shall be actively involved in examination requests, the taking of patient histories, and clinical examinations to achieve diagnoses, and with a gradually increasing responsibility regarding clinical and technical aspects.

## Contents of Training

### First Year (R1)

The first year of training consists of six months of rotations for general X-ray, two months for angiography, and four months for fluoroscopy. The rotations introduce the RT&MI resident to areas of general imaging; this can entail performing routine examinations as well as on-call duties. During this time, the resident will receive training in the necessary radiological exams of the above-mentioned specialties.

A key component of the introductory phase includes the basics of picture archiving and communication systems (PACS), image manipulation, and communication skills.

Students should concentrate on mastering the basics, including PACS, RIS, imaging-based anatomy, imaging physics, radiation safety, contrast administration, and all related issues with a focus on general X-ray, angiography, fluoroscopy, and radiographic techniques during the respective rotations.

### Second Year (R2)

The second year of this program concentrates on intensifying the knowledge and technical experience of RT&MI residents regarding the physics of cross-sectional imaging (CT and MRI), US, and NM. RT&MI residents are also introduced to specific pediatric imaging techniques, which helps them acquire the necessary skills to serve the population. Moreover, RT&MI residents are introduced to breast imaging.

During the second year, RT&MI residents are encouraged to enroll in courses to conduct research as well as evidence-based medical-imaging courses. These will prepare the residents for the research project in the following year.

The typical rotation program of the second year, including hands-on scanning of patients, is as follows:

- three months: physics and general US procedures;
- three months: physics and general MRI procedures;
- three months: physics and general CT procedures;
- three months: physics and general NM procedures.

### **Third Year (R3)**

The third year includes rotations with hands-on training in one of the fields chosen by the RT&MI resident (US, NM, or CT and MRI).

The third year also introduces the resident to more detailed physics as well as imaging. The learning period consists of a comprehensive rotation program, wherein the residents work closely with senior technologists and radiologists, thus covering basic and some advanced imaging procedures.

Moreover, RT&MI residents dedicate two weeks to research and quality improvement. Here, they are given the opportunity to either conduct a research project under faculty supervision with the aim of producing publishable material, or to undertake a departmental quality improvement project. There are two weeks during R3 in which residents can choose the education program. If desired, they can attend local or international medical-imaging courses.

The typical rotation program is as follows:

- two weeks: research, quality courses, and rotation;
- two weeks: medical-imaging courses and conferences;
- eleven months: rotation in one of the fields chosen by the RT&MI resident (CT and MRI, US, or NM).

### **Fourth Year (R4)**

In fourth year advanced rotations are offered in one of the fields chosen by the RT&MI resident in R3. The fourth year is intended to deepen the skills of senior RT&MI residents and serves as a foundation for the review of the content relevant for examination and certification purposes. This year encourages RT&MI residents to tailor their rotation program to areas that suit their personal learning objectives and future career directions best. This flexibility is implemented by offering two months of elective rotations in advanced imaging or a chosen subspecialty.

The rotations serve to consolidate technical and clinical skills in one modality of medical imaging. They permit graded responsibility and independent scanning under staff supervision. During these months, the senior RT&MI resident aims to perform the responsibilities and carry the workload of a junior staff technologist. The review of core material for exam preparation through on-the-job exposure to important aspects of imaging modalities is advocated.

Further, the fourth-year debuts exposure to advanced imaging during the rotation. The RT&MI residents are expected to familiarize themselves with advanced physics as well as technical aspects of the chosen imaging modality, including imaging protocols, indications, contraindications, patient preparation, and image interpretation.

The rotation design for the fourth year includes ten-month rotations in one of the modalities chosen by the RT&MI resident in R3. The year offers two months of elective subspecialty rotations that can be taken anytime during the year with the approval of the program director.

The R4 RT&MI residents should supervise and teach junior residents and start conducting clinical–radiological meetings under staff supervision.

### Minimum Training Requirements for SBRT&MI Residents

The SCFHS requires four years of training and a completion of the allocated requirements for eligibility to participate in the SBRT&MI examination:

- clinical rotations,
- research activities,
- participation in teaching activities.

Further, RT&MI residents should rotate between more than one training center during their residency.

### Minimum Research Requirements for SBRT&MI Residents

During the second part of the program (third and fourth year), RT&MI residents will be trained as clinical researchers with in-depth knowledge of statistical and analytical skills regarding population-based clinical studies, or outcomes of research. The guiding principle of the clinical research education is to teach RT&MI residents perform a clinical research project under a mentorship.

The RT&MI resident needs to have a research mentor. The selection of the research mentor will be done by the RT&MI resident but must be approved by the director of the SBRT&MI program. Further, RT&MI residents will have to submit a written research proposal, which will be reviewed by the committee of the SBRT&MI program.

The RT&MI residents are expected to complete **one** of the following research activities during their education program:

- Submit a case report for presentation at one of the local or international specialty conferences;
- Write a review paper as first author;
- Conduct an original research project: It is expected that the results will be presented as an abstract at a scientific meeting and subsequently published in a peer-reviewed journal.

The RT&MI residents will have covered most of the knowledge-based research objectives by the end of the fourth year.

### VACATION AND CONFERENCE LEAVES

RT&MI residents are granted 4 weeks of vacation per year in accordance with the SCFHS rules and regulations. Vacation time must be requested at least four weeks in advance and approved by the program director. In addition, RT&MI residents are granted five working days per year for conference leave. The conference must be approved by the program director.



---

## SPECIFIC LEARNING OBJECTIVES AND COMPETENCIES

### 1. Radiology Technology & Medical Imaging expert:

#### Definition:

As Radiology Technology & Medical Imaging experts, RT&MI residents comprise all CanMEDS roles, applying RT&MI knowledge, clinical skills, and professional attitudes to provide patient-centered care. Being an RT&MI expert is the central role of technologists educated in the CanMEDS framework.

#### Elements:

- Integration and application of all CanMEDS roles for patient care;
- Recognize basic and advanced radiological anatomy;
- Understand the basic and advanced physical principles behind radiological techniques;
- Understand basic and advanced imaging techniques and technical problem-solving approaches;
- Learn the indications and absolute and relative contraindications for various contrast media;
- Recognize the appropriate indications and contraindications of various radiological techniques;
- Recognize and manage radiological emergency procedures and common pathologies;
- List the most important differential diagnoses for various imaging findings;
- Recognize unusual imaging presentations of common pathologies;
- Understand postprocessing, image manipulation, and protocol optimization;
- Understand rules of health informatics in radiology and optimal PACS utilization;
- Application of ethical principles for patient care;
- Respect principles of patient safety and avoid adverse events.

#### Key and Enabling Competencies:

RT&MI residents are able to:

1. Function effectively as RT&MI residents and comprise all CanMEDS roles to provide optimal, ethical, and patient-centered medical care:
  - Effectively perform radiological procedures and case discussions including assessments, diagnoses, and recommendations in written and/or verbal form;
  - Demonstrate effective use of all CanMEDS competencies relevant in RT&MI;
  - Identify and respond appropriately to relevant ethical issues arising in patient care;
  - Prioritize professional duties appropriately and effectively when facing multiple patients and problems;
  - Demonstrate compassionate patient-centered care.
2. Establish and maintain clinical and technical radiological knowledge, skills, and attitudes appropriate for RT&MI:
  - Apply knowledge of clinical, socio-behavioral, and fundamental biomedical sciences relevant in RT&MI specialties, including:
    - The characteristics of all RT&MI types, including but not limited to physical and technical aspects, patient positioning, and use of contrast media;
    - Theoretical, practical, and legal aspects of radiation safety, including but not limited to alternative imaging techniques and their possible harmful side-effects;

- Human anatomy at all ages, both conventional and multiplanar, with emphasis on imaging applications;
- All aspects of RT&MI, including but not limited to anatomic normal variants and disease processes, factors affecting the interpretation of imaging and differential diagnoses, correlation of imaging with pathology, complications, including but not limited to contrast media reactions. This includes the appropriate application of general X-ray, fluoroscopy, US, CT, MRI, NM, and other imaging modalities, as well as interventional procedures relevant to imaging the:
  - Abdominal/pelvic area
    - Gastrointestinal (GI) system
    - Hepato–pancreatico–biliary system
    - Renal and urinary tract
    - Male reproductive system
    - Spleen, lymphatic system, and bone marrow
    - Retroperitoneum
  - Chest (cardiac imaging)
    - Air spaces
    - Airways
    - Interstitium
    - Mediastinum, including but not limited to great vessels and esophagus
    - Pleura
    - Heart and pericardium
    - Chest wall
  - Head and neck
    - Nose, sinuses, and facial bones
    - Orbits
    - Temporal bone, cerebellopontine angle, and skull base
    - Larynx, hypopharynx, and trachea
    - Oral cavity and pharyngeal mucosal space
    - Submandibular space
    - Carotid space
    - Masticator space
    - Retropharyngeal space (RPS) and prevertebral space
    - Parotid gland, thyroid gland, and esophagus
  - Dental and maxillofacial region
  - Brain
    - Pituitary and parasellar region
    - Skull
  - Spinal cord and related structures, including but not limited to peripheral nerves
  - Cranial nerves
  - Intracranial and extracranial cerebral vessels
  - Musculoskeletal imaging
    - Shoulder, clavicle, and upper arm
    - Elbow and forearm
    - Hand and wrist
    - Pelvis, hip, and thigh
    - Knee and leg
    - Ankle and foot
    - Spine

- Bone
  - Development
  - Marrow
  - Peripheral nerves
  - Breast
  - Malignant diseases
  - Benign diseases
  - Gynecological imaging
  - Ovaries
  - Non-ovarian adnexa
  - Non-pregnant uterus and cervix
  - Endometrium
  - Vagina and labia
  - Obstetrical imaging
  - Uterus, placenta, cord, and adnexa
  - Fetus
  - Pediatric area
  - Head, neck, and spine
  - Chest/cardiac system
  - Musculoskeletal system
  - Abdomen and pelvis
  - Vascular and interventional radiology
  - Lymphatic system
  - Cardiac system
  - Arterial and venous vascular systems
  - Abdominal area
  - Chest and neck
  - Peripheral area
  - Interventional procedures
  - Upper and lower urinary system
  - GI system
  - Hepatobiliary system
  - Respiratory system
  - Musculoskeletal system.
- Describe the CanMEDS framework for competencies relevant in the RT&MI specialties;
  - Obtain lifelong relevant learning skills, implement a personal program to remain abreast of current issues, and enhance areas of professional competency;
  - Contribute to the enhancement of quality care and patient safety in practice by integrating the best practices available in RT&MI.
3. Perform complete and appropriate assessment of patients necessary before, during, and after radiological procedures:
- Effectively identify and explore issues requiring attention by including the patient preferences and context of his or her complaint;
  - Perform a focused physical examination for the purposes of safety, prevention, diagnosis, and/or management;

- Select medically appropriate radiological procedures in a resource-effective and ethical manner to ensure medical exams with minimized exposure to contrast agents and radiation. This is particularly important for pregnant and pediatric patients, patients of childbearing age, and medically compromised patients;
  - Demonstrate effective clinical and technical problem-solving skills and judgment.
4. Use radiological diagnostic procedures effectively:
    - Implement effective radiological diagnostic procedures in collaboration with patients and their families;
    - Demonstrate effective, appropriate, and timely applications of radiological diagnostic procedures relevant in RT&MI practice;
    - Demonstrate knowledge of acceptable and expected results of investigations and/or interventions as well as unacceptable and unexpected results. This includes the knowledge of and ability to manage radiological-imaging-related complications;
    - Ensure that appropriate informed consent is obtained for radiological imaging procedures;
    - Ensure that patients receive appropriate end-of-life care.
  5. Demonstrate proficient and appropriate use of radiological-imaging-procedure skills:
    - Demonstrate effective, appropriate, and timely performance of relevant radiological imaging procedures;
    - Ensure that appropriate informed consent is obtained for procedures;
    - Demonstrate appropriate documentation and dissemination of information related to the performed procedures and their outcomes.
  6. Seek appropriate consultation from other health professionals and recognize the limits of his or her own expertise:
    - Demonstrate insight into the limitations of his or her own expertise via self-assessment;
    - Seek and include the knowledge of another health professional, if required, for an effective, appropriate, and timely consultation to realize optimal patient care.

## 2. Communicator:

### Definition:

As communicators, RT&MI residents can form appropriate relationships with patients and their families to facilitate the gathering and sharing of essential information for carrying out effective radiological imaging procedures.

### Elements:

- Patient-centered approach to communication;
- Rapport, trust, and ethics;
- Build satisfying relationships with patients, their families, and caregivers;
- Shared decision-making;
- Mutual understanding;
- Elicit and synthesize information for patient care;
- Convey effective oral and written information for patient care;
- Use of verbal and nonverbal professional communication.

## Key and Enabling Competencies:

RT&MI residents are able to:

1. Develop professional relationships with patients and their families:
  - Recognize that being a good communicator is a core clinical skill for RT&MI residents, and effective communication can foster patient satisfaction, adherence to treatment plans, and improved clinical outcomes;
  - Establish positive relationships, characterized by understanding, trust, respect, honesty, and empathy with patients and their families;
  - Respect patient confidentiality, privacy, and autonomy;
  - Be aware of and responsive to nonverbal cues.
2. Accurately obtain and synthesize relevant information and the perspectives of patients, their families, colleagues, and other professionals:
  - Seek out and synthesize relevant information from other sources such as the families of patients, caregivers, and other professionals.
3. Accurately convey relevant information and explanations to patients, their families, colleagues, and other professionals:
  - Deliver information to patients, their families, colleagues, and other professionals in a humane and understandable manner that encourages discussion and participation in the decision-making process.
4. Develop a common understanding of issues, problems, and plans with patients, their families, colleagues, and other professionals to develop shared-care plans:
  - Effectively identify and explore problems that require attention, including the context of the complaint of a patient and his or her responses, concerns, and preferences during medical-imaging procedures;
  - Encourage questions, discussions, and interaction during medical-imaging procedures;
  - Include patients, their families, and relevant healthcare professionals in the decision-making process;
  - Effectively address challenging communication issues, such as obtaining informed consent, addressing anger, confusion, and misunderstandings.
5. Effectively convey oral and written information regarding medical-imaging procedures:
  - Maintain clear, accurate, and appropriate records (e.g., written or electronic) of medical-imaging procedures;
  - Effectively present the findings of medical-imaging procedures in verbal or written reports;
  - Develop oral skills for individual consultations, case presentations, radiology conferences, and scholarly work.

### 3. Collaborator:

#### Definition:

As collaborators, RT&MI residents work within a healthcare team to achieve optimal patient care.

**Elements:**

- Collaborative care, culture, and environment;
- Shared decision-making;
- Shared knowledge and information;
- Delegation;
- Effective teams;
- Respect for other RT&MI residents and members of healthcare teams;
- Leadership based on patient needs;
- Constructive negotiation;
- Organizational structures that facilitate collaborations;
- Understand roles and responsibilities;
- Recognize his or her own roles and limits;
- Effective collaborations between primary care providers and specialists.

**Key and Enabling Competencies:**

RT&MI residents are able to:

1. Interact effectively and appropriately with other healthcare teams:
  - Clearly describe their roles and responsibilities to other professionals;
  - Describe the roles and responsibilities of other professionals within the imaging team;
  - Recognize and respect the diversity of roles, responsibilities, and competencies of other professionals in relation to their own;
  - Work with others to assess, plan, provide, and integrate care for individual patients (or groups of patients);
  - Work with others to assess, plan, provide, and review other tasks such as research problems, educational work, program reviews, or administrative responsibilities;
  - Effectively participate in meetings/settings of other teams;
  - Provide quality care;
  - Describe the principles of team dynamics;
  - Respect team ethics including confidentiality, resource allocation, and professionalism;
  - When appropriate, demonstrate leadership in imaging teams.
2. Work effectively with other health professionals to prevent, negotiate, and resolve conflicts:
  - Demonstrate a respectful attitude toward other colleagues and members;
  - Work with other professionals to prevent conflicts;
  - Conduct collaborative negotiations to resolve conflicts;
  - Respect differences, misunderstandings, and limitations regarding other professionals;
  - Recognize his or her own differences, misunderstandings, and limitations;
  - Reflect on interprofessional team functions.

**3. Manager:**

**Definition:**

As managers, RT&MI residents engage with others to contribute to the vision of a high-quality RT&MI healthcare system and take responsibility for the delivery of excellent patient care through their activities as clinicians, administrators, scholars, and/or teachers.

### Elements:

- RT&MI residents as active participants in the RT&MI healthcare system;
- Collaborative decision-making;
- Quality assurance and improvement;
- Organize, structure, and finance the RT&MI healthcare system;
- Manage changes;
- Leadership;
- Supervise others;
- Administration;
- Consideration of justice, efficiency, and effectiveness in the allocation of finite RT&MI healthcare resources for optimal patient care;
- Budgeting and finances;
- Priority setting;
- Practice management;
- Human resources for RT&MI health;
- Time management;
- Negotiations;
- Career development;
- Information technology for RT&MI healthcare;
- Effective meetings and committees.

### Key and Enabling Competencies:

RT&MI residents are able to:

1. Participate in activities that contribute to the effectiveness of RT&MI healthcare organizations and systems:
  - Work collaboratively with other people from different organizations;
  - Participate in systematic quality process evaluations and improvements such as those involving patient safety initiatives;
  - Describe the structure and functions of the healthcare system regarding the specialties, including the roles of RT&MI residents and technologists;
  - Describe the principles of healthcare finances including remuneration of technologists, budgeting, and organizational funding.
2. Manage resident practice and careers effectively:
  - Establish priorities and manage time to balance patient care, practice requirements, outside activities, and a personal life;
  - Manage finances and human resources;
  - Implement processes to ensure personal practice improvement;
  - Employ information technology appropriately for patient care.
3. Allocate finite RT&MI healthcare resources appropriately:
  - Recognize the importance of a just allocation of healthcare resources, balanced effectiveness, efficiency, and access to optimal patient care;
  - Apply evidence and management processes to provide cost-appropriate care.

4. Appropriately serve in administration and leadership roles:
  - Effectively chair or participate in committees and meetings;
  - Lead or implement changes in the RT&MI healthcare system;
  - Plan the relevant elements of RT&MI healthcare delivery (e.g., work schedules).

## 5. Health Advocate:

### Definition:

As health advocates, RT&MI residents contribute their expertise to improving RT&MI health with their work within communities or patient populations. They work with those they serve to determine and understand needs, speak on behalf of others when required, and support the mobilization of resources for an effective change.

### Elements:

- Support for individual patients, populations, and communities;
- Role of RT&MI professionals in society;
- Responsible use of authority and influence;
- Mobilize resources according to demand;
- Adapt practice, management, and education to the needs of individual patients;
- Provide a safe environment for patients and staff members;
- Minimize risks for patients undergoing radiological studies;
- Apply as-low-as-reasonably-achievable (ALARA) principles and implications of RT&MI health policy;
- Interactions with other CanMEDS professionals and competencies in advocacy.

### Key and Enabling Competencies:

RT&MI residents are able to:

1. Respond to individual RT&MI healthcare needs and issues of a patient:
  - Identify the RT&MI healthcare needs of individual patients;
  - Identify opportunities for advocacy, RT&MI health promotion, and disease prevention for individuals to whom care is provided;
  - Incorporate disease prevention, health promotion, and surveillance of RT&MI health in interactions with individual patients.
2. Respond to RT&MI healthcare needs of the communities they serve:
  - Describe the practice to communities;
  - Identify opportunities for advocacy, RT&MI health promotion, and disease prevention in communities and respond appropriately;
  - Appreciate the possibility of competing interests between different communities and populations.
3. Promote the RT&MI health of individual patients, communities, and populations:
  - Describe approaches for the implementation of changes in determinants of RT&MI health in populations;
  - Describe how public policy affects the RT&MI health of the specified populations;
  - Identify points of influence in the RT&MI healthcare system and its structure;



- Describe the ethical and professional issues inherent in RT&MI health advocacy;
- Appreciate possible conflicts between RT&MI health advocates and managers or gatekeepers when serving a patient or a community.
- Realize the role of an RT&MI professional by collectively advocating RT&MI health and patient safety.

## 6. Scholar:

### Definition:

As scholars, RT&MI residents are expected to demonstrate a lifelong commitment to an excellent practice through continuous learning, evidence evaluation, and by teaching others and contributing to scholarships.

### Elements:

- Engage in continuous enhancement of professional activities through lifelong learning;
- Reflection on all aspects of RT&MI practice;
- Self-assessment;
- Identify gaps in RT&MI knowledge;
- Access information for RT&MI practice;
- Translate knowledge into professional competencies;
- Enhance professional competencies;
- Use a variety of learning methods;
- Assess learners;
- Provide feedback;
- Mentoring;
- Maintain teacher–student ethics, carefully resolve power issues, maintain confidentiality, and appropriate boundaries;
- Conduct research and scientific inquiries;
- Cope with research ethics, disclosure, conflicts of interest, human subjects, and industry relations.

### Key and Enabling Competencies:

RT&MI residents are able to:

1. Maintain and enhance professional activities via lifelong learning:
  - Know principles of competency maintenance;
  - Know principles and strategies for implementing a personal RT&MI knowledge management system;
  - Recognize and reflect on learning issues in RT&MI practice;
  - Conduct personal RT&MI practice audits;
  - Pose appropriate learning questions;
  - Integrate new RT&MI learning techniques into practice;
  - Evaluate impact of changes on RT&MI practice;
  - Document the learning process.
2. Critically evaluate RT&MI information and its sources and apply it to practice decisions appropriately:
  - Describe the principles of critical appraisal;

- Critically appraise retrieved evidence in order to address clinical questions;
  - Integrate critical-appraisal conclusions into clinical care.
3. Appropriately facilitate learning for patients, their families, students, residents, other health professionals, the public, and others:
    - Know the learning principles relevant in the RT&MI education program;
    - Collaboratively identify the learning needs and desired learning outcomes of others;
    - Select effective teaching strategies and content to collectively facilitate the learning process;
    - Give effective lectures and presentations;
    - Assess and reflect on teaching encounters;
    - Provide effective feedback;
    - Describe the principles of ethics with respect to teaching.
  4. Contribute to the development, dissemination, and translation of new RT&MI knowledge and practices:
    - Describe the principles of research and scholarly inquiries;
    - Describe the principles of research ethics;
    - Pose scholarly questions;
    - Conduct systematic research for evidence;
    - Select and apply appropriate methods for addressing questions.

## Professional

### Definition:

As professionals, RT&MI residents are committed to the RT&MI health and well-being of individuals and society via ethical practice, profession-led regulations, and high personal standards regarding their behavior.

### Elements:

- Humanity;
- Integrity and honesty;
- Compassion and caring;
- Ethics and codes of behavior;
- Responsibilities to society;
- Responsibilities to the profession;
- Responsibilities to oneself;
- Commitment to excellent RT&MI practice and proficiency in the discipline;
- Commitment to the promotion of public goods in RT&MI healthcare;
- Accountability to professional regulatory bodies;
- Commitment to professional standards;
- Bioethical principles and theories;
- Self-awareness;
- Sustainable practice and RT&MI healthcare;
- Self-assessment;
- Disclosure of errors and adverse events.

### **Key and Enabling Competencies:**

RT&MI residents are able to:

1. Demonstrate commitment to patients by applying best practice and adhering to high ethical standards;
  - Exhibit appropriate professional behavior by including honesty, integrity, commitment, compassion, respect, and humanity into the RT&MI practice;
  - Demonstrate commitment to deliver the highest quality of care and maintain competence;
  - Recognize and respond appropriately to ethical issues encountered in RT&MI practice;
  - Manage conflicts of interest appropriately;
  - Recognize the principles and limits of patient confidentiality;
  - Maintain appropriate relationships with patients.
2. Demonstrate a commitment to society by recognizing and responding to societal expectations regarding RT&MI healthcare:
  - Demonstrate a commitment to patients, society, and the profession by responding to societal expectations regarding RT&MI;
  - Demonstrate a commitment to patient safety and quality improvement.
3. Demonstrate a commitment to RT&MI health and sustainable practice:
  - Balance personal and professional priorities to ensure personal health and a sustainable practice;
  - Strive to heighten personal and professional awareness and insight;
  - Recognize professionals in need and respond appropriately.

---

## TEACHING AND LEARNING ACTIVITIES

The RT&MI residents will gain the competencies described in the curriculum through a variety of learning methods. The program comprises training to acquire cognitive and technical skills and to understand how they relate to physics, applied anatomy, pathology, and physiology of health and diseases. Moreover, the training involves practical procedures and interpretation methods taught in a sequential and integrated manner through lectures, tutorials, seminars, and apprenticeships that provide hands-on experience.

1. Formal Teaching and Learning Activities:
  - *Core specialty topics (70%),*
  - *Universal topics (10%),*
  - *Topics selected by RT&MI resident (20%).*
2. Practice-Based Learning (PBL):
  - *Journal club,*
  - *Discussion (logbook),*
  - *Guest speakers on core specialty topics,*
  - *Weekly academic half-day,*
  - *Tutorials.*
3. Work-Based Learning (WBL):
  - *On-call-based learning,*
  - *Clinic-based learning,*
  - *Courses and workshops.*
4. Self-Directed Learning

### 1) Formal Teaching and Learning Activities:

***Core specialty topics (70%)***

#### **General skills needed for all specialties:**

- Patient positioning;
- Awareness of sterile concept;
- Radiation protection;
- Understanding of quality control (QC), radiology information systems (RIS), and PACS;
- Human anatomy and physiology;
- Patient safety and care;
- Radiological pathology;
- Basic Life support;
- Basic knowledge of medical physics (X-ray, CT, MRI, NU, US).

---

## GENERAL X-RAY SECTION

### Training Rotation

The training rotation content will be very comprehensive, as RT&MI residents will be exposed to all areas of general X-ray imaging in the first part of the program (R1).

#### Objective:

Provide RT&MI residents with the capability to perform X-ray scans.

#### Acquired Skills:

- Perform imaging-related noninterventional procedures;
- Perform postprocessing procedures and image analysis;
- Practice skills related to basic imaging informatics;
- Produce high-quality diagnostic X-ray radiographs without supervision at the end of the rotation;
- Improve image quality and respond appropriately to critique.

#### Rotation Duration:

- Six months minimum;
- Can be extended if the RT&MI resident does not meet minimum requirements after the initial period.

#### Training Rotation Plan:

**Six months of rotation (see competency list for clinical rotations regarding general X-ray in APPENDIX 5):**

- Enter patient data;
- Explain procedure before examination;
- Correlate patient to requisition;
- Stock and leave rooms clean and tidy;
- Practice proper infection control techniques;
- Basic understanding of universal precautions and isolation techniques;
- Knowledge of the location of all portable units in wards and surgical areas;
- Practice proper radiation protection techniques for the patient and hospital staff;
- Able to prepare patients for examinations;
- Capable of obtaining allergic history from patients;
- Understand how to enter patient exam information into computers;
- Read requisitions and perform required tests;
- Understand the effects of adjusting exposure factors on film;
- Complete most examinations under direct supervision;
- General knowledge of contrast materials used in the department;
- Load and unload C-arm cassettes;
- Perform portable chest X-rays on wards and ICUs under direct supervision;
- Demonstrate proficiency while correlating patient requisitions;

- Know locations and have a basic understanding of emergency drugs;
- Knowledge of medical terminology;
- Complete most examinations under indirect supervision, including fluoroscopic procedures and portables, while using proper radiation protection;
- Aware of safe use of and care for equipment;
- Correctly identify projection/views and anatomical parts on general radiographs;
- Examine images with the ability to correctly adjust exposure factors;
- Complete the following exams with indirect supervision (in accordance with the clinical rotation competency checklist provided for all exams, adults, and pediatric patients):

### **CHEST & THORAX**

Chest routine  
Chest AP (wheelchair/stretchers)  
Chest–lateral decubitus  
Ribs  
Sternum  
Upper airway (soft-tissue neck)

### **UPPER EXTREMITY**

Thumb or finger  
Hand  
Wrist  
Scaphoid  
Forearm  
Elbow  
Humerus  
Shoulder  
Trauma: shoulder (scapular Y or axillary view)  
Clavicle  
Scapula  
AC joints  
Trauma: upper extremity (non-shoulder)

### **LOWER EXTREMITY**

Femur  
Knee  
Trauma: knee  
Patella  
Tibia–fibula  
Ankle  
Foot  
Forefoot  
Toe  
Calcaneus

## **ABDOMEN**

- Abdomen supine (KUB)
- Abdomen upright
- Abdomen decubitus

## **PELVIS**

- Pelvis
- Hip
- Hip (cross-table lateral)
- Sacroiliac joint

## **SPINE**

- Cervical spine
- Trauma: cervical spine (cross-table lateral)
- Oblique cervical spine
- Cervical spine flexion/extension
- Thoracic spine
- Scoliosis spine
- Lumbar spine
- Sacrum and/or coccyx

## **HEAD**

- Skull
- Paranasal sinuses
- Facial bones
- Orbits
- Nasal bones
- Mandible

## **PEDIATRICS (age 6 or younger)**

- Chest routine
- Upper extremity
- Lower extremity
- Abdomen
- Pelvis
- Mobile study

## **SURGICAL C-ARM PROCEDURES**

- Orthopedic c-arm procedures
- Non-orthopedic c-arm procedures

## **GENERAL PATIENT CARE**

- Transfer of patients
- Care for medical equipment of patients (oxygen tank, IV tubing)

---

## INTERVENTIONAL RADIOLOGY AND FLUOROSCOPY

### Training Rotation

The training rotation content will be very comprehensive as the RT&MI resident will be exposed to interventional radiology in a hands-on environment. In the first year (R1), the rotation segments cover the entire spectrum of interventional radiology exams.

#### Objective:

Provide RT&MI residents with the capability to perform all procedures requested in angiography and fluoroscopy.

#### Acquired Skills:

- Perform imaging-related angiography and fluoroscopy procedures;
- Basic understanding of indications, techniques, and risks of fluoroscopy.

#### Program Duration:

- Six months minimum (four months of fluoroscopy; two months of angiography);
- Can be extended if the RT&MI resident does not meet the minimum requirements after the initial period.

#### Training Rotation Plan:

##### Six months of rotations (see competency list for clinical rotations regarding angiography and fluoroscopy in APPENDIX 6):

- Knowledge of department policies (e.g., working hours, uniform policy, sign-in and -out regulations);
- Operate the angiography unit;
- Aware of different types of catheters and guide wires and different applications of both;
- Correlate patient to requisition;
- Prepare major parts of a procedure tray;
- Knowledge of pre- and post-procedure care;
- Recognize the differences between guidewires and their applications;
- Proper handling of sterilized supplies;
- Prepare and select catheters or special sets for different procedures;
- Coordinate with nurses and physicians in different areas of the hospital for procedures;
- Provide proper post-examination care and instructions to patients and nursing staff when necessary;
- Work in special procedure areas and perform the whole range of examinations/procedures without supervision;
- Demonstrate the ability to complete the following exams under indirect supervision (in accordance with the clinical rotation competency checklist provided for all exams, adults, and pediatric patients):

#### FLUOROSCOPY PROCEDURES

Upper-gastric imaging  
Small bowel series/follow through



Air contrast examination of colon  
Arthrography

**QUALITY CONTROL OF**

Basic radiographic equipment  
Shielding devices

**ADDITIONAL TASKS**

Prepare contrast media  
Format/optimize images  
Ensure radiation safety  
Maintain sterile/isolation precautions  
Insert enema tip

**GENERAL PATIENT CARE**

Transfer of patients  
Care for medical equipment of patients (oxygen tank, IV tubing)

---

## MAGNETIC RESONANCE IMAGING (MRI)

### Training Program

#### Objective:

- Provide RT&MI residents with the capability to master all MRI scans.

#### Acquired Skills:

- Understand and master the physics and principles of magnetic resonance (MR);
- Perform imaging-related MRI procedures;
- Understand indications, techniques, and risks of MRI.

#### Program Duration:

- Three months in the first part of the program (second year, R2);
- Two years for subspecialty in the second part of the program (third and fourth year, R3 and R4).

### Training Rotation Plan

#### Three months for the first rotation (R2) (see competency list for clinical rotations regarding MRI in APPENDIX 7):

- Orientation of the department;
- Orientation of the physics of MRI;
- Orientation of magnets including coils;
- Orientation of basic departmental policies and procedures;
- Training in MR safety;
- The training in patient care skills includes:
  - Communication with patients and explanation of examinations;
  - MR screening sheets and questionnaires;
  - Practice of proper patient transfer techniques to ensure proper body mechanics.
- Interpretation of requests and correlation to patients;
- Observe and assist scanning technologists;
- Cross-sectional anatomy of the brain, neck, and spinal cord;
- Basic MR physics;
- Correct positioning of coils for routine examinations;
- Begin routine scanning under direct supervision (routine scans of brain, cervical spine, thoracic spine, lumbar spine, and knee);
- Complete the following exams under indirect supervision (in accordance with the clinical rotation competency checklist provided for all exams, adults, and pediatric patients):

### BODY PROCEDURES (ABDOMEN & PELVIS)

Routine liver scan  
Routine MRCP scan

## **NEURO & ENT PROCEDURES**

Routine brain scan (infants, children, and adults)  
Orbits/PNS  
Routine (cervical, thoracic, and lumbar) spine scan

## **PEDIATRIC MSK PROCEDURES**

Knee meniscus/trauma  
Routine shoulder scan  
Routine ankle scan  
Routine foot scan  
Routine elbow scan  
Routine wrist/hand scan

## **MSK PROCEDURES**

Routine wrist/hand scan  
Routine shoulder scan  
Routine elbow scan  
Routine knee scan  
Routine ankle scan  
Routine foot scan

### **Two years for the second rotation (R3 & R4) (see competency list for clinical rotations regarding MRI in APPENDIX 8):**

- Advanced MR physics;
- Understand postprocessing techniques including MIP and MPR;
- Functional MR;
- Preparation for the administration of IV contrast media;
- Understand the role of IV contrasting agents, including dose calculation;
- Knowledge of patient-monitoring devices including cardiac gating, respiratory compensation, and peripheral-pulse gating;
- Understand contrast-enhanced MR angiography;
- Knowledge of image quality and image evaluation;
- Troubleshooting;
- Complete the following exams under indirect supervision (in accordance with the clinical rotation competency checklist provided for all exams, adults, and pediatric patients):

## **BODY PROCEDURES (ABDOMEN & PELVIS)**

Routine liver scan  
Liver Primovist scan  
Routine MRCP scan  
MRCP living-hepatic-donor  
Adrenal mass  
Adrenal cancer  
Pancreas (pancreatitis, mass, and cholangiocarcinoma)  
Renal mass  
Urinary-bladder cancer staging

Prostatic-cancer staging  
Screening for undescended testes  
Seminal vesicles  
Penile  
Uterine enlargement  
Müllerian-duct anomalies  
Ovarian mass  
Endometrial/cervical mass  
Oncology surveillance  
Enterography  
Rectal-cancer staging  
Rectal-cancer staging (pelvis only)  
Perianal fistula  
Defecogram and pelvic floor  
Vascular malformation

### **NEURO & ENT PROCEDURES**

Routine brain scan (infants, children, and adults)  
Brain metastasis  
Brain MS  
Posterior fossa  
Pituitary  
Temporal lobe epilepsy  
Pineal gland/midline lesion  
Orbits/PNS  
Temporal bone, cerebellopontine angle of IAM  
MRA of brain  
MRV of brain  
MRA of carotid artery  
Head and neck (nasopharynx, oral cavity, tongue, and parotids)  
Routine (cervical, thoracic, and lumbar) spine scan  
Scoliosis

### **PEDIATRIC BODY PROCEDURES (ABDOMEN & PELVIS)**

Liver  
MRCP  
Adrenal  
Pancreas  
MRA of abdominal aorta  
Renal MRA  
Renal mass  
Infant body tumor  
Infant liver  
Enterography  
Urography  
Testes  
Pelvic mass  
Uterus  
Malformations

## **PEDIATRIC MSK PROCEDURES**

- Infections: osteomyelitis
- Mass
- AVN of hips
- Knee meniscus/trauma
- Routine shoulder scan
- Arthrogram of shoulder
- Routine ankle scan
- Routine foot scan
- Routine elbow scan
- Routine wrist/hand scan
- Brachial plexus
- Tumor
- Axilla
- Sternum
- Malformation of vessels

## **MSK PROCEDURES**

- Tumor
- Routine wrist/hand scan
- Synovitis in wrist/hand
- Routine shoulder scan
- Synovitis in shoulder
- Arthrography of shoulder
- AVN of hips
- Synovitis in hips
- Routine elbow scan
- Sacroiliac joint
- Routine knee scan
- Synovitis in knee
- Routine ankle scan
- TMJ
- Routine foot scan
- Diabetic foot with Synovitis
- Morton's neuroma
- Whole body scan
- Myositis

## **BODY PROCEDURES (ABDOMEN & PELVIS)**

- MRA of abdominal aorta
- Renal MRA
- Peripheral MRA
- Noncontrast MRA
- Liver iron overload (iron quantification)

## **NEURO & ENT PROCEDURES**

- Functional MRI (fMRI)
- Single-voxel spectroscopy
- Multi-voxel spectroscopy
- 3D spectroscopy
- Contrast-enhanced perfusion ASL
- Tractography
- Fetus
- CSF flow imaging

## **CARDIAC PROCEDURES**

All cardiac procedures, including chest MRA, iron overload (iron quantification), 3D coronary, and perfusion for adults and pediatric patients.

## **BREAST PROCEDURES**

Tumor Implants

---

## NUCLEAR MEDICINE (NM)/PET IMAGING

### Training Program

#### Objectives:

Provide RT&MI residents with the capability to master all NM scans.

#### Acquired Skills:

- Knowledge of Saudi Arabian regulatory frameworks related to the practice of radionuclide radiology;
- Knowledge of NCCN guidelines for the regulation of PET/CT practice indications;
- Understand and master NM physics and principles.

#### Program Duration:

- Three months in the first part of the program (second year, R2);
- Two years for subspecialty in the second part of the program (third and fourth year, R3 and R4).

#### Training Rotation Plan:

##### Three months for the first rotation (R2) (see competency list for clinical rotations regarding NM in APPENDIX 9):

- Management of radiation accidents related to radionuclide radiology;
- Recognize different pharmaceuticals;
- Radiation dose from radiopharmaceuticals;
- General NM physics and principles;
- Principles of quality assurance in radiopharmacy;
- Role of comparative imaging tests;
- Radiation protection issues regarding tracer choice.
- Role of PET/CT in the staging of malignancies;
- Complete the following exams under indirect supervision (in accordance with the clinical rotation competency checklist provided for all exams, adults, and pediatric patients):

#### BONE SCAN

Metastasis  
Osteomyelitis  
Stress fracture/shin splint  
Prosthesis evaluation (osteomyelitis versus loosening)  
AVN of bones

#### RENAL SCAN

Obstruction/function (MAG 3)  
Transplanted kidney (MAG 3)  
DMSA scan of cortical scar

DMSA scan of pyelonephritis  
DMSA scan of absolute split renal function  
Testicular imaging with flow

### **ENDOCRINE IMAGING**

MIBI scan of parathyroid adenoma  
Thyroid uptake scan (I-123)  
Thyroid nodule evaluation (I-123)  
WBS of thyroid carcinoma (I-123)  
Thyroid scan with <sup>99m</sup>TcO<sub>4</sub>  
Adrenal Imaging of cortex/medulla

### **Two years for the second rotation (R3 & R4) (see competency list for clinical rotations regarding NM in APPENDIX 10):**

- Knowledge of advanced NM physics and principles;
- Knowledge of principles of single-photon emission tomography (SPECT),
- Proficiency in all routines and advanced procedures;
- Knowledge of computer data analysis;
- Knowledge of radiation protection;
- Assessment of imaging procedures;
- Departmental management;
- Work as independent technologist;
- Work without supervision;
- Complete the following exams under indirect supervision (in accordance with the clinical rotation competency checklist provided for all exams, adults, and pediatric patients):

### **BONE SCAN**

Metastasis  
Osteomyelitis  
Stress fracture/shin splint  
Prosthesis evaluation (osteomyelitis versus loosening)  
AVN of bones

### **RENAL SCAN**

Obstruction/function (MAG 3)  
Transplanted kidney (MAG 3)  
DMSA scan of cortical scar  
DMSA scan of pyelonephritis  
DMSA scan of absolute split renal function  
Testicular imaging with flow

### **ENDOCRINE IMAGING**

MIBI scan of parathyroid adenoma  
Thyroid uptake scan (I-123)  
Thyroid nodule evaluation (I-123)  
WBS of thyroid carcinoma (I-123)



Thyroid scan with  $^{99m}\text{TcO}_4$   
Adrenal imaging of cortex/medulla

## HEPATOBIILIARY SCINTIGRAPHY

HIDA scan of gallbladder ejection fraction  
HIDA scan of acute cholecystitis  
HIDA scan of biliary atresia  
RBC study of liver hemangioma  
Liver and spleen imaging

## INFECTION IMAGING

WBC-labelled scan (whole body)  
FDG PET/CT (whole body)  
Gallium-67 scan

## PULMONARY IMAGING

Lung V/Q scan  
Quantitative differential study

## THERAPEUTIC PROCEDURES

Grave's disease therapy (I-131)  
Thyroid carcinoma therapy (I-131)  
MIBG therapy (I-131)  
Zevalin therapy for NHL  
Y-90 joint injection  
Lu-177 DOTATOC therapy for NET  
Y-90 microspheres for HCC

## ONCOLOGY IMAGING

PET/CT (FDG) for:  
Distinguishing benign from malignant diseases;  
Assessing the stage of a disease;  
Assessing whether there is a recurrent or residual disease;  
Determine the site of the disease when tumor markers are rising;  
Establishing response to therapy;  
Identifying the primary site of a biopsy in a large tumor;  
PET/CT  $^{68}\text{Ga}$ -DOTATOC scan for NET;  
PET/CT  $^{68}\text{Ga}$ -PSMA scan for prostate cancer;  
MIBG scan (I-123).

## BRAIN IMAGING

PET/CT for:  
Benign versus malignant diseases;  
Search for dementia causes;

Search for epileptic foci (Interictal);  
CSF flow imaging;  
CSF shunt evaluation;  
CSF leakage detection;  
Vascular flow and SPECT.

## **GI IMAGING**

Gastroesophageal reflux study/Milk scan for children  
Meckel's scan  
Gastric-emptying study  
Acute GI bleeding  
GI protein loss  
Salivary-gland function study  
Urea breath test (C-14)

## **CARDIAC IMAGING**

Myocardial perfusion scintigraphy (stress/rest)  
Myocardial viability scan  
Multi-gated acquisition (MUGA)  
Cardiac shunt detection  
Myocardial viability with FDG PET

---

## COMPUTER TOMOGRAPHY (CT)

### Training Program

#### Objective:

Provide RT&MI residents with the capability to master all CT scans.

#### Acquired Skills:

- Understand and master CT physics and principles;
- Perform imaging-related CT procedures;
- Knowledge of indications, techniques, and risks of CTs.

#### Program Duration:

- Three months in the first part of the program (second year, R2).
- Two years for subspecialty in the second part of the program (third and fourth year, R3 and R4).

### Training Rotation Plan

#### Three months for the first rotation (R2) (see competency list for clinical rotations regarding CT in APPENDIX 11):

- Knowledge of patient preparation for CT examinations;
- Safely move the patient from chair and trolley to the CT table;
- Explain the examination to the patient;
- Ensure safety of the patient and attached equipment, e.g., IV-line, oxygen, monitors.
- Knowledge of contrast media used in the department and recording contrast reactions;
- Knowledge of contrast media (IV and oral) volumes to be used for different CT examinations (adults and pediatric patients);
- Operate IV contrast injectors;
- Knowledge of proper infection control techniques;
- Knowledge of radiation protection for patients and staff;
- Positioning the patients properly for different studies;
- Operate machines independently and perform daily warm-ups and calibrations;
- Perform all requested CT examinations as ordered by the attending physician or supervisor;
- Deal with CT machine faults and report them to the biomedical engineer;
- Coordinate with other staff members to ensure appropriate patient care is provided;
- Knowledge of basic cross-sectional abdomen, chest, head, and neck anatomy;
- Complete the following exams under indirect supervision (in accordance with the clinical rotation competency checklist provided for all exams, adults, and pediatric patients):

### ABDOMEN PROCEDURES

Anatomy  
CAP protocol  
Abdomen–pelvis protocol  
Renal-stones protocol

## NEURO & ENT PROCEDURES

Anatomy  
Brain (adult) exam  
Brain (pediatric) exam  
Sinuses  
Head and neck  
Cervical spine  
Thoracic spine  
Lumbar spine

## THORAX

Anatomy  
Routine chest scan without IV contrast media  
Routine chest scan with IV contrast media

### **Two years for the second rotation (R3 & R4) (see competency list for clinical rotations regarding CT in APPENDIX 12)**

- Organize and execute the daily patient schedule;
- Perform all CT scan examinations with related 2D and 3D reformations;
- Increasing awareness regarding patient preparation and patient care;
- Knowledge of major pathologies and relating them to the appropriate protocols;
- Work efficiently and cope with emergency situations;
- Proficient case discussions with nurses, patients, physicians, and radiologists;
- Function as full team member during working shifts or on-call;
- Complete the following exams under indirect supervision (in accordance with the clinical rotation competency checklist provided for all exams, adults, and pediatric patients):

## ABDOMEN PROCEDURES

Anatomy  
CAP protocol  
Abdomen–pelvis protocol  
Dynamic liver protocol  
Dynamic renal protocol  
Trauma protocol  
GI bleeding protocol  
Adrenal-mass protocol  
Pancreatic-mass protocol  
Renal-stones protocol  
Renal-mass protocol  
Bowel ischemia protocol  
Appendicitis protocol  
IV line

## NEURO & ENT PROCEDURES

Anatomy  
Brain (adult) exam

Brain (pediatric) exam  
Parotid gland  
Orbits  
Sinuses  
Temporal bones  
TMJ  
Skull and facial bone  
Mandible  
Head neck  
Neck  
Dental scan  
Cervical spine  
Thoracic spine  
Lumbar spine

## **THORAX**

Anatomy  
Routine chest scan without IV contrast media  
Routine chest scan with IV contrast media  
High-resolution chest scan  
Pediatric scan  
Protocol selection  
Protocol adjustment  
Dose monitoring  
GA cases  
Limb measurement  
DDH protocol  
CAP  
AP  
Chest  
IV line

## **CT ANGIOGRAPHY**

Anatomy  
Thoracic angiogram  
Abdominal angiogram  
Liver donor  
Colonography  
Pulmonary embolus  
Renal donor  
Brain and neck angiogram  
Brain perfusion  
Stereotactic exam  
3D process  
MSK and DDH procedure

## **PEDIATRIC EXAM**

- Biopsy, FNA, and RF ablation procedures
- Coronary artery angiogram
- Pediatric coronary artery angiogram
- TAVI protocol
- Fontan protocol
- caBIG protocol
- Congenital cardiac protocol
- Dynamic trachea protocol
- Thoracic aortogram
- Liver segmentation
- Upper- and lower-extremity angiogram
- Dual-energy technique
- GSI technique

---

## ULTRASOUND (US)

### Training Program

#### Objective:

Provide RT&MI residents with the ability to master all US scans.

#### Acquired Skills:

- Basic understanding of US artifacts;
- Understand and master US physics and principles;
- Perform imaging-related US procedures;
- Knowledge of indications, techniques, and risks of US.

#### Program Duration:

- Three months for the first part of the program (second year, R2);
- Two years for the second part of the program (third and fourth year, R3 and R4).

### Training Rotation Plan

#### Three months for the first rotation (R2) (see competency list for the clinical rotations regarding US in APPENDIX 13):

- Explain procedure to patient;
- Knowledge of basic scanning technique for the abdomen;
- Optimize imaging resolution and document images;
- Deal with patients on beds and emergency cases;
- Prioritize different US requests;
- Correlate clinical data with scanning techniques;
- Interpret US findings;
- Recognize and document normal and abnormal findings;
- Write report on scan findings;
- Analyze clinical data of patients;
- Complete the following exams under indirect supervision (in accordance with the clinical rotation competency checklist provided for all exams, adults, and pediatric patients):

### ABDOMEN PROCEDURES

Upper GI tract  
Liver/biliary tract  
Pancreas/spleen  
Renal/urinary system

### SMALL-PARTS PROCEDURES

Abdominal wall  
Thyroid

**Two years for the second rotation (R3 & R4) (see competency list for the clinical rotations regarding US in APPENDIX 14):**

- Knowledge of advanced scanning techniques for Doppler US;
- Intermediate knowledge of Doppler physics;
- Optimize image resolution and document images;
- Knowledge of Doppler artifacts and their solutions;
- Modify scanning technique according to abnormal findings;
- Recognize normal and abnormal findings of Doppler study;
- Document normal and abnormal findings;
- Participate in academic activities of US unit;
- Knowledge of basic scanning techniques for newborn and pediatric patients;
- Optimize image resolution and document images;
- Deal with portable US and NICU patients and observe precautions;
- Interact with patients effectively;
- Correlate clinical data with scanning techniques;
- Write a report on scan findings;
- Complete the following exams under indirect supervision (in accordance with the clinical rotation competency checklist provided for all exams, adults, and pediatric patients):

**ABDOMEN PROCEDURES**

Aorta  
Appendix/intussusception  
GI tract  
Inferior vena cava (IVC)  
Liver/biliary tract  
Pancreas/spleen  
Renal/urinary system  
Transrectal US  
Vasculature

**OB & GYNECOLOGY PROCEDURES**

First trimester  
Second/third trimester  
High-risk OB  
Placenta  
Gestational age  
Complications  
Amniotic fluid/amniocentesis  
Fetal demise  
Fetal abnormalities  
Fetal biophysical profile  
UGR protocols  
Coexisting disorders  
Follicular study  
Ovaries and adnexa  
Pediatrics  
Pelvic pathology  
Postmenopausal pathology



Transvaginal US  
Uterus and adnexa  
Nuchal translucency

### **INTERVENTIONAL PROCEDURES**

Aspiration  
Biopsy  
Drainage  
Intraoperative procedure  
Laparoscopy

### **NEONATAL PROCEDURES**

Congenital abnormality  
Neonatal head

### **NEUROSONOLOGY PROCEDURES**

Enlargement/displacement  
Cranial hemorrhage  
Atrophic lesions  
Spinal lesions  
Inflammatory lesions  
Brain swelling/edema  
Spinal tethering  
Trauma

### **SMALL-PARTS PROCEDURES**

Abdominal wall  
Breast  
Hematoma  
vasculature anatomy  
Musculoskeletal parts  
Scrotum and testes  
Superficial masses  
Thyroid  
Noncardiac chest

### **VASCULAR US PROCEDURES**

Color Doppler  
Digital acquisition systems  
Diameter for percentage of stenosis  
PW and/or CW for percentage of stenosis  
TCD  
PVR (arms and legs)  
IPG (arms and legs)  
Resistive Index (RI)

Pulsatility Index (PI)  
Power Doppler  
Segmental pressures  
PVR  
Abdominal aorta, IVC  
Abdominal Doppler  
Carotid Doppler  
SMA, celiac, renal US  
Hepatic, splenic US  
Arterial graft duplex  
Arterial supply to upper extremities  
Venous supply to upper extremities  
Arterial supply to lower extremities  
Venous supply to lower extremities  
Penile Doppler  
Plethysmography for fingers and toes  
Vein mapping

## **ECHOCARDIOGRAM PROCEDURES**

Transthoracic echocardiogram  
Transesophageal echocardiogram (TEE)  
Holter monitoring  
EKG  
Bubble studies  
Adults  
Newborns  
Pediatric patients  
2D and M mode  
Exercise and pharmacological stress (dobutamine)  
Pulsed Doppler  
Color Doppler  
Treadmill exercise test  
ECG  
Stress

### ***Universal Topics (10%)***

These are high-value interdisciplinary topics of utmost importance for the trainee. The reason for teaching these topics centrally is to ensure that every trainee receives high-quality teaching and develops essential core knowledge. These topics are in common for all specialties.

#### **The included topics meet one or more of the following criteria:**

- Impactful: topics that are common or life-threatening;
- Interdisciplinary: topics that are difficult to teach within a single discipline;
- Orphan: topics that are poorly represented in the undergraduate curriculum;
- Practical: topics that trainees will encounter during hospital practice.

## Development and Delivery:

The core-topic content for the postgraduate 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, can modify the learning outcomes.

These topics will be didactic with a focus on practical aspects regarding patient care. The topics will comprise more content than workshops and other interactive face-to-face sessions. The suggested duration of each topic is 90 min.

The topic content will be delivered in a modular fashion. At the end of each learning unit, a formative online assessment will be conducted. Further, a combined summative assessment in the form of a context rich MCQ will be done after the completion of all topics. All trainees must attain at least a specified minimum level in the summative assessment. Alternatively, the topics can be worked off in a summative manner along with the specialty examination.

### 1) Hospital-Acquired Infections (HAI):

At the end of the learning unit, the RT&MI resident should be able to:

- a) Discuss the epidemiology of HAIs with special reference to Arabia;
- b) Recognize HAIs as one of the major emerging threats in healthcare;
- c) Identify the common sources HAIs;
- d) Describe the risk factors of common HAIs, such as ventilator-associated pneumonia, MRSA, Central Line-associated Bloodstream Infection CLABSI, and vancomycin-resistant enterococcus (VRE);
- e) Identify the role of healthcare workers in the prevention of HAIs;
- f) Determine appropriate pharmacological (e.g., selected antibiotics) and nonpharmacological (e.g., removal of indwelling catheter) measures in the treatment of HAIs;
- g) Propose a plan to prevent HAIs in workplaces.

### 2) Abnormal ECG:

At the end of this learning unit, the RT&MI resident should be able to:

- a) Recognize common and important ECG abnormalities;
- b) Institute immediate management, if necessary.

### 3) Care of the Elderly:

At the end of this learning unit, the RT&MI resident should be able to:

- a) Describe the factors that need to be considered while planning patient care for the elderly;
- b) Recognize and include the needs and well-being of caregivers;
- c) Identify the local and community resources available for the care of the elderly;
- d) Develop an individualized care plan for an elderly patient by including ideas from other healthcare professionals.

### 4) Occupational Hazards of Healthcare Workers (HCWs):

At the end of this learning unit, the RT&MI resident should be able to:

- a) Recognize common sources and risk factors of occupational hazards among HCWs;
- b) Describe common occupational hazards in workplaces;
- c) Develop a familiarity with legal and regulatory frameworks governing occupational hazards with respect to HCWs;

- d) Develop a proactive attitude to promote workplace safety;
- e) Protect yourself and colleagues against potential occupational hazards in workplaces.

**5) Patient Advocacy:**

At the end of this learning unit, the RT&MI resident should be able to:

- a) Define patient advocacy;
- b) Recognize patient advocacy as a core value governing medical practice;
- c) Describe the role of patient advocates in patient care;
- d) Develop a positive attitude towards patient advocacy;
- e) Be a patient advocate in conflicting situations;
- f) Be familiar with local and national patient advocacy groups.

**6) Ethical Issues: Treatment Refusal, Patient Autonomy:**

At the end of this learning unit, the RT&MI resident should be able to:

- a) Predict situations in which a patient or family is likely to decline a prescribed treatment;
- b) Describe the concept of a rational adult in the context of patient autonomy and treatment refusal;
- c) Analyze key ethical, moral, and regulatory dilemmas regarding treatment refusal;
- d) Recognize the importance of patient autonomy in the decision-making process;
- e) Counsel patients and families declining medical treatment in the best interests of patients.

**By RT&MI Residents Selected Topics (20%)**

1. RT&MI residents from each specialty can choose any topic that fits their needs;
2. All topics must be planned and cannot be random.
3. All topics need to be approved by the local education committee.
4. Institutions can work with RT&MI residents to determine the topics as well.

**2) Practice-Based Learning (PBL)**

The activities listed below prepare and encourage RT&MI residents to independently conduct RT&MI practice and health service research.

Practice-Based Learning	Objective	CanMEDS Competencies
Journal club	<ul style="list-style-type: none"> <li>• Journal articles are preselected, and the activity is prepared and discussed by residents under supervision to:                             <ul style="list-style-type: none"> <li>○ Promote continuing professional development;</li> <li>○ Stay up-to-date with recent literature;</li> <li>○ Learn and practice critical appraisal skills.</li> </ul> </li> </ul>	Radiology Technology & Medical Imaging expert Scholar Health Advocate

Tutorial	<ul style="list-style-type: none"> <li>• Tutorials provide a foundation for a good quality of knowledge regarding radiological interpretations;</li> <li>• Discuss and review imaging appearances and approaches for the diagnosis of various radiological conditions;</li> <li>• Develop confidence in handling clinical discussions.</li> </ul>	Manager Radiology Technology & Medical Imaging expert Professional Scholar
Discussion (cases logbook)	<ul style="list-style-type: none"> <li>• List all problems identified in RT&amp;MI examinations;</li> <li>• Develop a proper solution for each problem.;</li> <li>• Present a follow-up of the problem.</li> </ul>	Manager Radiology Technology & Medical Imaging expert Professional Scholar
Guest speaker Joint specialty meeting	<ul style="list-style-type: none"> <li>• Increase medical-imaging and resident knowledge and skills, and improve patient care;</li> <li>• Understand and apply current practice guidelines in medical imaging;</li> <li>• Describe the latest advances in the field of medical imaging and research;</li> <li>• Identify and explain areas of arguments in the field of medical imaging.</li> </ul>	Radiology Technology & Medical Imaging expert Professional
Academic half-day	<ul style="list-style-type: none"> <li>• Provide the knowledge, technical skills, and experience necessary for residents to interpret and correlate clinical findings;</li> <li>• Promote effective communication and sharing of expertise with peers and colleagues;</li> <li>• Promote the development of investigative and technical skill processes for individual patients and patient populations;</li> <li>• Advise colleagues from his or her and other specialties with regard to problems related to medical imaging.</li> </ul>	Radiology Technology & Medical Imaging expert Scholar Health Advocate Professional

## WORK-BASED LEARNING (WBL)

Work-Based learning	Objectives	CanMEDs
On-call-based learning	<ul style="list-style-type: none"> <li>• Perform the basic procedures necessary for imaging and management;</li> <li>• Appropriately perform required radiological examinations;</li> <li>• Recognize imaging techniques and initial findings;</li> <li>• Perform basic postprocessing procedures and image analyses.</li> </ul>	Radiology Technology & Medical Imaging expert Scholar Health Advocate Professional
Clinic-based learning	<ul style="list-style-type: none"> <li>• Obtain history of patients and conduct physical examinations;</li> <li>• Present briefly the initial findings or notes to attending radiologists;</li> <li>• Discuss differential and management plans with colleagues;</li> <li>• Discuss the need for special procedures with attending radiologists;</li> <li>• Supervise resident notes and orders; interpret and discuss report results with attending radiologists.</li> </ul>	Radiology Technology & Medical Imaging expert Communicator Health Advocate

### Courses

Several courses will be organized for RT&MI residents to augment their training in various important aspects.

### Radiological Physics Course

#### Goals:

- Gain professional competence in radiation and applied physics and their clinical applications in RT&MI;
- Knowledge of various fundamentals of imaging modalities and their concept variations;
- Knowledge of basic imaging-related mathematics and calculations as well as dosimetry applications;
- Clearly understand radiation principles in order to properly deal with radiation hazards, and implement radiation protection measures according to international guidelines and recommendations;
- Differentiate between modality-specific imaging chains and associated technology;
- Recognize technical parameters that can affect image quality and radiation dose;
- Knowledge of principles and practice of digital-image processing techniques;
- Recognize modality-specific image artifacts;
- Be up-to-date on the impact of emerging technologies on current practices;
- Knowledge of salient aspects of radiobiology and safe practice of radiation protection principles.

**Training Methods:**

- Annual four-week course in imaging-related physics that must be attended by all RT&MI residents; the required curriculum is listed below in the course content list;
- Discussion with radiology staff during case readout and tutorial sessions on applied physical principles that influence image quality and patient and staff safety;
- Training centers can optionally provide additional lectures or activities to their residents.

**Evaluation:**

- Attendance rate of four-week physics course will be incorporated into the annual overall performance evaluation score;
- Incorporation of radiological knowledge, skills, and safety aspects in rotation evaluations;
- Annual promotion exams.

**Course Content**

**Radiation Physics—PART ONE (R1)**

- Diagnostic Radiology
  - Conventional and digital X-ray imaging
  - Introduction to X-ray production
  - Particulate radiation
  - Interactions of particulate radiation with matter
  - Characteristic X-rays
  - Brems radiation
- X-Ray Generators
  - Transformers and production of high voltages
  - 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 tubes
  - Line focus principle
  - Heel effect
  - Heat units and rating charts
- X-Ray Beam: Radiation Quantities and Units
  - Beam intensity and exposure
  - 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 and Brems 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 scattering and absorption
- Effects of kVp, mA, and Filtration on Transmitted Spectra
  - Absorption edges and contrast media
- X-Ray Image: Basics
  - Subject contrast
  - Effects of scattering 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)
- Angiography with 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
- Equipment Design Considerations
- X-Ray Tube and Geometry
- Grid
- AEC
- Screen/Film Processing Considerations

## **Radiation Physics—PART ONE (R2)**

### **Computed Tomography (CT)**

- CT Image Formation
- CT Scan Configuration
- Source Detector Configuration
- Multi-Row Detector versus Single-Row Detector
- Axial Scanning versus Helical Scanning
- Detectors
- X-Ray Tube
  
- CT Image Quality
  - Noise
  - Low-contrast detectability
  - High-contrast resolution
  - Field of View (FOV)
  
- CT Scan Artifacts

### **Ultrasound Physics**

- Characteristics of Sound Waves
- Interactions of US with Matter
- Introduction to Image Acquisition
- U/S Components
- Transducers
- Image Properties and Qualities
- Spatial Resolution (axial, lateral, and elevational)
- Image Formation (e.g., transmission power, gain, TGC, frame rate)
- Discussion of Artifacts (all types of US artifacts) and Diagnosis

### **Magnetic Resonance Imaging (MRI)**

- Introduction and Principles of MRI
- Image Weighting
- Parameters
- Pulse Sequences
- Artifacts
- MRI Safety

## Nuclear Medicine Physics (NM)

- Principles of NM Physics
- Radioactive Decay
- Atomic and Nuclear Structures
- Interaction of Radiation with Matter
- Production of Radioisotopes
- Principles of Mo-99/Tc-99m Generators
- Components of Gamma Cameras

## Radiation Biology

- Linear Energy Transfer (LET) and Relative Biologic Effectiveness (RBE)
- Direct and Indirect Effects of Radiation
- Types of Radiation Effects
- Types of Radiation Exposure
- Radiation Protection Quantities and Units
- Justification
- Optimization
- Dose/Risk Optimization
- Protection of Pregnant Workers/Patients

## Radiation Physics—PART TWO (R3 & R4)

- Radiation
- Definition
- Forms
  - Electromagnetics
    - Wave model
    - Photon model
      - ❖ Frequency
      - ❖ Wavelength
      - ❖ Energy
      - ❖ Spectrum
  - Particulate Radiation
    - Mass—energy equivalence
- Atom
- Structure
  - Orbit 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
    - ❖ Isomeric transition
  - Decay scheme
  - Decay law
  - Half-life
- Gamma rays
- Internal-conversion electrons
- Nuclear Binding Energy and Mass Defect
- Nuclear Fission and Fusion
- Interactions of Radiation with Matter
  - Energy transfer
  - Scattering
  - Interactions of particulate radiation
    - Electron interaction
    - Positron annihilation
    - Neutron interaction
    - Alpha
    - Proton
  - Interactions of X-rays and gamma rays (photons)
    - Coherent or Rayleigh scattering
    - Compton scattering
    - Photoelectric effect
    - Pair production

## 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, Chemicals
- 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 Eye Lens

- Doses for Different Deterministic Effects
- Acute Radiation Syndromes
- Stochastic Effects
- Cancer Induction
- Hereditary Effects
- Early and Late Effects of Radiation
- Lethal Dose of LD 50/30
- 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 exposure
  - Public exposure
  - Medical exposure
- 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 the Public
- Conventional Radiography
- Fluoroscopy and Interventional Radiology
- CT
- Mammography
- Radiation Protection in NM
- Sources of Exposure in NM: Staff, Patients, and the 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 the 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, NM, and Radiation Therapy
- Rationale for New ICRP Recommendations
  - Objectives
  - Phases
- Types of Exposure Regarding New Recommendations
  - Planned exposures
  - Existing exposures
  - Emergency exposures
- New Dose Limits
  - Pregnancy
  - Eye dose
- Dose Constraints and Reference Levels
- Radiation Weighting Factors
- Protection of Environment
- New IAEA Basic Safety 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, and 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 NM
- Diagnostic Procedures
- Therapeutic Procedures
- Fetal Dose

### **Computed Tomography (CT)**

- CT versus Radiography
- CT Image Formation

- CT Scan Configuration
- Source Detector Configuration
- Multi-Row Detector versus Single-Row Detector
- Axial Scanning versus Helical Scanning
- Detectors
- X-Ray Tube
- Tissue Characterization
  - CT number (in Hounsfield units)
  - Definition of tissue contrast in CT images
- CT Image Quality
  - Noise
  - Low-contrast detectability
  - High-contrast resolution
  - FOV
- CT Dosimetry
  - CT dose index (CTDI)
    - ❖ CTDI<sub>100</sub>
    - ❖ CTDI<sub>w</sub>
    - ❖ CTDI<sub>vol</sub>
    - ❖ 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 US with Matter
- Impedance
- Reflection
- Refraction
- Scattering
- Attenuation
- Introduction to Image Acquisition
- U/S Components
- Pulse Echo Imaging
- Transducers
- Image Properties and Qualities
- Near versus Far Field; Fresnel Zone
- Spatial Resolution (axial, lateral, and elevational)

- Distance Measurements
- Contrast
- More on Image Acquisition
- Image Formation (e.g., transmission power, gain, TGC, frame rate)
- Clinical US Lecture
- Doppler
- Harmonic Imaging
- 3D
- Discussion of Artifacts (all types of US artifacts) and Diagnosis

### **Magnetic Resonance Imaging (MRI)**

- Introduction to NMR Theory
- Historical Background
- Atomic Structure
- MR Active Nuclei
- 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
- Repetition Time (TR) and Echo Time (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 Fields
- Hazards from Switched Gradient Fields

- Hazards from RF 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
- GRE-Based Sequences
- Spoiled GRE Sequences
- Steady-State FLASH Sequences
- Steady-State Free-Precession Sequences
- Image Contrast in GRE Sequences
- Echo Planar Imaging (EPI)
- Imaging Techniques and Applications
- 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
- Artifact Classification
- Chemical Shift Artifacts
- Magnetic Susceptibility Artifacts
- Aliasing and Wrap-Around Artifacts
- Cross-Excitation and Cross-Talk Artifacts
- Truncation Artifacts
- Phase Mismatching Artifacts
- External Artifacts

### **Nuclear Medicine (NM) Physics**

- Radionuclide Production
- Nuclear Reactor-Produced Radionuclides
  - Neutron activation
  - Fission
- Cyclotron-Produced Radionuclides
- Considerations in the Production of Radionuclides
- Radionuclide Generators
- Principles of Generators
- Mo-99/Tc-99m Generators
- Quality Control of Generators
- Radiopharmaceuticals



- Radionuclide Characteristics
- Chemical Selection
- Quality Control of Radiopharmaceuticals
- Radiation Detectors
- Gas-Filled Detectors
- Ionization Chambers
- Proportional Chambers
- Geiger–Müller Counter
- Dose Calibrators
- Principles
- Quality Control
- Scintillation Detectors
- Scintillators
- Sodium Iodide (NaI)
- Advantages of NaI
- Disadvantages of NaI
- Photomultiplier (PM) Tube
- Preamplifiers
- Amplifiers
- 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
  - Chi-square test
  - t-test
- Scintillation Cameras
- Components of Gamma Cameras
- Collimators
- Types and Characterization
- Performance
- NaI Crystal (TI)
- Description
- Specifications
- Light guide
- Photomultiplier Tubes (PMTs)

- Description
- Performance
- Position Electronics
- Computer
- Characteristics of Scintillation Cameras
- Uniformity
- Spatial Resolution
- Linearity
- Energy Resolution
- Sensitivity
- Quality Control
- Important Tests and their Frequencies
- Image Characteristics and Quality
  - Spatial resolution
  - Contrast
  - Image quality (noise)
- Digital Imaging in NM
- Single-Photon Emission CT (SPECT)
- Review
- Filtered Back Projection (FBP)
- Iterative Reconstruction
- Advantages and Disadvantages of SPECT
- Image Quality in SPECT
- Resolution
- 3D
- Number of Views
- Noise
- Orbits
- 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
- 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

### **Examples of useful reading material**

- The Essential Physics of Medical Imaging, 3<sup>rd</sup> Edition, by Jerrold T. Bushberg et al.
- Review of Radiologic Physics, 4<sup>th</sup> Edition, by Walter Huda.
- ICRP Publication 103, Good Reference for International Radiation Protection Standards, 1<sup>st</sup> Edition, by ICRP.

---

---

## OTHER COURSES

Residents are required to present “Certificates of Completion” for the following courses from an accredited training center:

- Basic Life Support (BLS): during the years of training;
- Infection Control: during the years of training.

Residents are advised to coordinate with their program director to fulfill these courses.

### Quality Improvement (QI)

#### General Objective:

RT&MI residents receive training in the basic principles of QI. The training is implemented in a dedicated course and/or a comprehensive rotation.

#### Goals:

- Familiarization 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.);
- Familiarization with the workflow of a radiology department and other departments (surgery, medicine, and emergency medicine) and quality assurance (QA) systems; participation in QI activities of hospital;
- Understand and apply audit procedures, including problem identification, action planning, and reassessment;
- Familiarization with tools for quality management of radiology services;
- Understand how performance improvements relate to patient safety in radiology;
- Complete a mentored research project and present the results at departmental QI rounds;
- Participate in departmental and hospital QI activities by attending committee meetings;
- Participate in hospital QA committee and departmental morbidity and mortality (M&M) meetings;
- Knowledge of current research topics on quality in radiology; initiate and complete a project and participate in ongoing departmental QA audits;
- Acquire the necessary skills for scientific presentations and public discussions;
- Recognize opportunities for improvement regarding the radiology department functions.

The elective part includes online learning sessions with a list of independent study material given to each RT&MI resident. Some examples are given below:

<http://www.ihi.org/>  
[www.patientsafety.va.gov](http://www.patientsafety.va.gov)  
[www.RMF.org](http://www.RMF.org),  
[www.jointcommission.org](http://www.jointcommission.org),  
[www.apiweb.org](http://www.apiweb.org).

## Specific Objectives:

### 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 medication use and ensure that all medications, medication containers, and other solutions are labeled on and off the sterile field in perioperative and other procedural settings;
- Minimize the risk of healthcare-associated infections;
- Safe procedures and patient safety QI project topics that are particularly relevant to radiology include the following:
  - safe use of iodinated contrast materials,
  - radiation safety,
  - MRI safety.

The appropriate completion of these courses will be considered in the annual overall evaluation scores.

### Workshop

The RT&MI residents are encouraged to attend at least two workshops a year. These workshops will be conducted during the training program, locally and internationally and should be related to the RT&MI field. An approval of the choice by the program director is required. The major tracks of the symposium and workshop can constitute but **are not limited to**:

- Appropriateness criteria for radiology: awareness, utilization, implementation, and impact;
- Diagnostic reference levels in MI: protocol optimization and patient dose reduction;
- MRI: basics and safety;
- Quality control in CT scanners: ACR testing;
- Quality control of SPECT systems;
- Radiotherapy treatment planning;
- Radiation safety officer course;
- 3D printing in radiation medicine.

### Self-Directed Learning

Item	Objectives	CanMEDs
Self-Directed Learning	<ul style="list-style-type: none"> <li>• Maintenance of personal portfolio (self-assessment, reflective learning, and personal development plan);</li> <li>• Achieving personal learning goals beyond the essential and core curriculum;</li> <li>• Reading (includes web-based material);</li> <li>• Auditing and conducting research projects;</li> <li>• Attending national and international conferences.</li> </ul>	Professional Radiology Technology & Medical Imaging expert Scholar

---

## SUGGESTED REFERENCE BOOKS:

### General books

- Getting Started in Clinical Radiology: From Image to Diagnosis, Paperback, 2005, by George W. Eastman. Thieme.
- Radiologic Science for Technologists: Physics, Biology, and Protection, Hardcover, 11<sup>th</sup> edition, by Stewart C. Bushong. Mosby.
- Radiography: Technology, Environment, Professionalism. Paperback, 1998, by Frances E. Campeau. Lippincott Williams & Wilkins.
- The Practice of Radiology Education: Challenges and Trends. Hardcover, 2009, by Teresa van Deven. Springer-Verlag Berlin Heidelberg.
- The Essential Physics of Medical Imaging, Hardcover, 3rd Edition, by Jerrold T. Bushberg. Lippincott Williams & Wilkins.
- Patient Care in Radiography: With an Introduction to Medical Imaging, Paperback, 9th Edition, by Ruth A. Ehrlich. Mosby.

### CT books

- Computed Tomography for Technologists: A Comprehensive Text, 2018, by Lois E. Romans. Lippincott Williams & Wilkins.
- Computed Tomography: Physical Principles, Clinical Applications, and Quality Control. Paperback, 3rd Edition, by Euclid Seeram. Saunders.
- Computed Tomography, Paperback, 1<sup>st</sup> edition, by Stewart C. Bushong. McGraw-Hill Education.
- Computed Tomography for Technologists: Exam Review. Paperback, 1<sup>st</sup> edition, by Lois E. Romans. Lippincott Williams & Wilkins.
- CT & MRI Pathology: A Pocket Atlas. Paperback, 1<sup>st</sup> edition, by Michael L. Grey and Jagan M. Ailiani. McGraw-Hill Education.

### X-ray books

- Bontrager's Handbook of Radiographic Positioning and Techniques. Spiral-bound, 8<sup>th</sup> edition, by Kenneth L. Bontrager. Mosby.
- Clark's Positioning in Radiography. Hardcover, 13<sup>th</sup> edition, by Stewart Whitley. CRC Press.
- Radiographic Pathology for Technologists. Paperback, 6<sup>th</sup> edition, by Nina Kowalczyk. Mosby.

### MRI books

- Handbook of MRI Technique. Paperback, 4<sup>th</sup> edition, by Catherine Westbrook. Wiley-Blackwell.
- MRI in Practice, Paperback, 5<sup>th</sup> edition, by Catherine Westbrook. Wiley-Blackwell.
- Handbook of MRI Scanning. Spiral-bound, 1<sup>st</sup> edition, by Geraldine Burghart Mosby.
- MRI Parameters and Positioning, Paperback, 2<sup>nd</sup> edition, by Torsten B. Möller. TPS.
- CT & MRI Pathology: A Pocket Atlas. Paperback, 1<sup>st</sup> edition. by Michael L. Grey. McGraw-Hill.

### **US books**

- Ultrasound Scanning: Principles and Protocols. 4<sup>th</sup> edition, by Betty Bates Tempkin. Saunders.
- Workbook for Textbook of Diagnostic Sonography paperback, 8<sup>th</sup> edition, by Sandra L. Hagen-Ansert. Mosby.
- Sonography: Introduction to Normal Structure and Function. Paperback, 4<sup>th</sup> edition, by Betty Tempkin and Reva Arnez Curry. Saudners.

### **NM books**

- Nuclear Medicine and PET/CT: Technology and Techniques. Hardcover, 7<sup>th</sup> edition, by Paul E. Christian. Mosby.
- Nuclear Medicine Physics: The Basic. Paperback, 7<sup>th</sup> edition, by Ramesh Chandra. Lippincott Williams & Wilkins.
- Fundamentals of Nuclear Pharmacy. Hardcover, 7<sup>th</sup> edition, by Gopal B. Saha. Springer.
- PET/MRI: Methodology and Clinical Applications. Paperback, 1<sup>st</sup> edition, by Ignasi Carrio, and Pablo R. Ros. Springer.

### **Radiology learning websites**

<https://radiopaedia.org/>

<https://www.radiologymasterclass.co.uk/>

<http://www.radiologyassistant.nl/>

---

## ASSESSMENT

### 1. Purpose of Assessment

Assessment plays a vital role in the success of postgraduate training. Assessment will guide trainees and trainers to achieve the targeted learning objectives. In addition, reliable and valid assessments will provide excellent means for training improvement as it will inform the following aspects: curriculum development, teaching methods, and quality of learning environment.

Assessment can serve the following purposes:

- a. **Assessment for learning:** Trainers will use information from trainees' performances to inform their learning in order to improve.
- b. **Assessment as learning:** As assessment criteria will drive trainees' learning.
- c. **Assessment of learning:** As assessment outcomes will represent a quality metrics that can improve the learning experience.

For the sake of the organization, assessment will be further classified into two main categories: *Formative* and *Summative*.

### 2. Formative Assessment

#### 2.1 General Principles

Trainees, as adult learners, should strive for feedback throughout their journey of competency from "novice" to "mastery" levels. *Formative assessment* (also referred to as continuous assessment) is the component of assessment that is distributed throughout the academic year, aiming primarily to provide trainees with effective feedback. Input from the overall formative assessment tools will be utilized at the end of the year to make the decision of promoting each individual trainee from current-to-next training level. Formative assessment will be defined based on the scientific committee recommendations (usually updated and announced at the start of the academic year). According to the executive policy on continuous assessment (available online: [www.scfhs.org](http://www.scfhs.org)), formative assessment will include the following features:

- a. Multisource: minimum four tools.
- b. Comprehensive: covering all learning domains (knowledge, skills, and attitude).
- c. Relevant: focusing on workplace-based observations.
- d. Competency-milestone oriented: reflecting trainee's expected competencies that match trainee's developmental level.

Trainees should play an active role seeking feedback during their training. Furthermore, trainers are expected to provide timely and formative assessment. SCFHS will provide an e-portfolio system to enhance communication and analysis of data arising from formative assessments.

#### 2.2 Formative Assessment Tools

Residents' performance will be evaluated jointly by the respective staff members by applying the following:

- A. In-training evaluation reports (ITER)  
The CanMEDS-based competencies "In-training Evaluation Report (ITER)" form (APPENDIX 2) must be completed (preferably in electronic format), with signatures of at least two senior technologists, within two weeks after the end of each rotation. The



program director discusses the evaluations with RT&MI residents, if necessary. The evaluation form is submitted to the SCFHS training supervisory committee within four weeks of the conclusion of the rotation. The ITERs should at least be conducted three times, covering nine training months per year.

- B. Workplace Assessment:
- Performance of RT&MI resident during daily work;
  - Performance in a direct observational assessment of 10–20 min regarding trainee–patient interactions;
  - Direct observation of procedural skills (DOPS): Diagnostic and therapeutic procedural skills; Timely and specific feedback from trainer to RT&MI residents is mandatory after each procedure.
- C. The end-of-year examination will be limited to R1, R2, and R3 residents. The number of examinations, eligibility, and the passing score are established in accordance with the commission training and examination rules and regulations. Examination details are published on the commission website, [www.scfhs.org.sa](http://www.scfhs.org.sa).
- A. The format shall include at least 120–150 multiple-choice questions (MCQ) in which the best four options must be chosen (or A-type).
- B. The examination shall contain K1 and K2 cognitive-level questions (recall and comprehension), usually delivered as questions with scenarios (interpretation, analysis, decision making, reasoning, and problem solving) in accordance with a test blueprint.
- C. The examination shall include questions from basic medical sciences, including anatomy, physiology, pathology, and physics. The questions shall be related to basic science with respect to imaging practices and fill up to 50% of the examination.
- D. Other assessment formats involve:
- OSCE,
  - Structured oral exam (SOE),
  - Research activity,
  - Academic Activity participation: Performance and participation in academic activities (see “Evaluation of the presenter by staff supervisor” in APPENDIX 3)
  - International examinations

In summary, formative assessment aims to ensure that RT&MI residents fulfill the CanMEDS competency requirements at the end of each training rotation and for the academic year evaluation. Academic and clinical assignments should be documented on an electronic tracking system (e-logbook when applicable) on an annual basis (Appendix 1). Evaluations are based on accomplishment of the minimum requirements of the procedures and clinical skills, as determined by the program.

### 3. Summative Assessment

#### 3.1 General Principles

*Summative* assessment is the component of assessment that aims primarily to make informed decisions on trainees’ competency. In comparison to the formative one, *summative assessment* does not aim to provide constructive feedback. For further details on this section please refer to general bylaws and the executive policy of assessment (available online: [www.scfhs.org](http://www.scfhs.org)). In order to be eligible to sit for final exams, a trainee should be granted a “*Training-Completion Certificate*.”

### 3.2 Principles of RT&MI Examination (Saudi Board Examination: Part I):

It is a written exam that permits the trainee to be promoted from “junior” to “senior” level of training.

This examination is conducted in a written MCQ format and held at least once per year. The number of examinations, eligibility, and the passing score are established in accordance with the commission training and examination rules and regulations (available online: [www.scfhs.org](http://www.scfhs.org)). Examination details and a blueprint are published on the commission website.

### 3.3 Training-Completion Certificate

In order to be eligible to sit for the final specialty examinations, each trainee is required to obtain a “Training-Completion Certificate.” Based on the training bylaws and executive policy (please refer to [www.scfhs.org](http://www.scfhs.org)) trainees will be granted a “Training-Completion Certificate” once the following criteria are fulfilled:

- a. Successful completion of all training rotations.
- b. Final In-Training Evaluation Report (FITER)/Comprehensive Competency Report (CCR) (APPENDIX 4): the program directors prepare a FITER for each RT&MI resident at the end of year R4. Clinical or oral examinations or completion of other academic assignments can be involved. Completion of training requirements as outlined by the scientific council/committee of each specialty (e.g., logbook, research, others).
- c. Clearance from SCFHS training affairs to ensure compliance with tuition payments and completion of universal topics.

The “Training-Completion Certificate” will be issued and approved by the local supervisory committee or its equivalent according to SCFHS policies.

### 3.4 Final RT&MI Board Examination (Saudi Board Examination: Part II):

Final specialty examination is the summative assessment component that grants trainees the specialty’s certification. It has two elements:

- A. Final written exam: in order to be eligible for this exam, trainees are required to have the “Training-Completion Certificate.” This examination assesses the theoretical knowledge (including recent developments) and problem-solving abilities of the trainee regarding his or her specialty. The examination is delivered in the multiple-choice question format and held at least once a year. The number of exams, exam format, eligibility, and passing score will be in accordance with the commission training and examination rules and regulations. More details on the examination and blueprints are published on the commission website: [www.scfhs.org.sa](http://www.scfhs.org.sa).
- B. Clinical examination:  
This examination assesses a broad range of clinical high-level skills including data gathering, patient management, communication, and counseling. This examination is held at least once every year and preferably as an OSCE regarding patient management problems (PMPs). Trainees will be required to pass the final written exam in order to be eligible to sit for the final clinical exam. Eligibility and the passing score are evaluated in accordance with the commission training and examination rules and regulations.

Examination details and a blueprint are published on the commission website, [www.scfhs.org.sa](http://www.scfhs.org.sa).

Format:

Station number: 12–15 stations;

Stations: mixture of skill stations and patient management format;

for further details on final exams, please refer to the general bylaws and executive policy of assessment (available online: [www.scfhs.org](http://www.scfhs.org)).

- 3.5 Certification:** The certificate for training completion will be awarded to RT&MI residents only upon successful fulfillment of all program requirements. Candidates need to pass both written and clinical examinations independently (i.e., there is no compensation for unsatisfactory results). Candidates passing all components of the final specialty examination are awarded the “Saudi Board of Radiology Technology & Medical Imaging” certificate.

## EXAM BLUEPRINTS

### First Year (R1)

Domains					Section
Investigation	Management	Diagnosis	Medical Science	Proportions	
10%	10%	20%	15%	50%	X-Ray
2%	5%	5%	5%	15%	Angiography
3%	5%	10%	10%	35%	Fluoroscopy
15%	20%	35%	30%	100%	Totals

### Second Year (R2)

Domains					Section
Investigation	Management	Diagnosis	Medical Science	Proportions	
2%	2%	6%	15%	25%	US
2%	2%	6%	15%	25%	MRI
2%	2%	6%	15%	25%	CT
2%	2%	6%	15%	25%	NM
8%	8%	24%	60%	100%	Totals

### Third Year (R3)

Domains					Section
Investigation	Management	Diagnosis	Medical Science	Proportions	
10	10	50	30	100%	Chosen Modality
10%	10%	50%	30%	100%	Totals

### Fourth Year (R4)

#### Ultrasound Blueprint R4

Section Domains						Total Percentage	Total Number	Sections	No.
Interpretation	Indications and Exam Preparation	Technique and Procedures	Equipment and Principles	Anatomy	Physics				
0%	0%	40%	40%	0%	20%	8%	10	Physics & Artifacts	1
20%	20%	20%	10%	30%	0%	8%	10	Upper & lower Abdomen	2
20%	20%	20%	10%	30%	0%	7%	7	Thyroid	3

EXAM BLUEPRINTS

20%	20%	20%	10%	30%	0%	14%	16	Scrotum & Trans-rectal Prostate	4
20%	20%	20%	10%	30%	0%	8%	10	Abdominal vasculature	5
20%	20%	20%	10%	30%	0%	16%	20	Peripheral Vasculature	6
20%	20%	20%	10%	30%	0%	8%	10	Cerebrovascular	7
20%	20%	20%	10%	30%	0%	8%	10	Neonatal Cranial	8
20%	20%	20%	10%	30%	0%	5%	5	Breast	9
20%	20%	20%	10%	30%	0%	5%	6	OB & GYN	10
20%	20%	20%	10%	30%	0%	5%	6	MSK	11
0%	0%	0%	0%	0%	0%	8%	10	Others (PACS, management, research, communication, Ethics)	12
						100%	120	Total	

Nuclear Medicine Blueprint R4

Total Percentage	Total Number	Sections	No.
23%	28	Radiopharmacy	1
23%	28	Physics	2
6%	7	Artifacts	3
5%	6	Radiation Safety	4
8%	10	Cardiac/Pulmonary	5
11%	13	GI/GU	6
4%	5	Endocrine	7
4%	5	Oncology	8
2%	2	Brain	9
3%	4	Bone/Infections/Lymph	10
3%	4	Therapy	11
8%	10	Others (PACS, management, research, communication, Ethics)	12
100%	120	Total	

EXAM BLUEPRINTS

MRI & CT Blueprint R4

Section Domains						Total Percentage	Total Number	Sections	No.
Interpretation	Indications and Exam Preparation	Technique and Procedures	Equipment and Principles	Anatomy	Physics				
0%	0%	40%	40%	0%	20%	8%	10	Techniques	1
20%	20%	20%	10%	30%	0%	8%	10	Brain	2
20%	20%	20%	10%	30%	0%	8%	10	Spine	3
20%	20%	20%	10%	30%	0%	8%	10	Body	4
20%	20%	20%	10%	30%	0%	8%	10	Advanced Techniques	5
20%	20%	20%	10%	30%	0%	8%	10	Safety	6
20%	20%	20%	10%	30%	0%	8%	10	Vascular imaging	7
20%	20%	20%	10%	30%	0%	8%	10	MSK	8
20%	20%	20%	10%	30%	0%	8%	10	Postprocessing	9
20%	20%	20%	10%	30%	0%	8%	10	Image artifacts	10
20%	20%	20%	10%	30%	0%	8%	10	Breast	11
20%	20%	20%	10%	30%	0%	8%	10	Others (PACS, management, research, communication, Ethics)	12
						<b>100%</b>	<b>120</b>	<b>Total</b>	

---

## REFERENCES

1. Kern DE, Thomas PA, Hughes MT. Curriculum Development for Medical Education: A Six-Step Approach. Baltimore, MD, USA: Johns Hopkins University Press; 2009.
2. Saudi Commission for Health Specialties. Postgraduate Resident Training Curriculum Template. Riyadh, Saudi Arabia: Saudi Commission for Health Specialties.
3. CanMEDS [cited November 10, 2017]. Available from: <http://www.royalcollege.ca/portal/page/portal/rc/public>.
4. The CanMEDS 2014 Objectives of Training in the Specialty of Diagnostic Radiology. Ottawa, ON, Canada: The Royal College of Physicians and Surgeons of Canada; 2014.
5. Baerlocher MO, Asch MR. The Interventional Radiologist as "Clinician": What Does It Mean? CanMEDS for the interventional radiologist. *CARJ* 57:25–29; 2006.
6. Bandiera G, Sherbino J, Frank JR. The CanMEDS Assessment Tools Handbook. An Introductory Guide to Assessment Methods for the CanMEDS Competencies. Ottawa, ON, Canada: The Royal College of Physicians and Surgeons of Canada; 2006.
7. Frank JR. The CanMEDS 2005 Physician Competency Framework. Better Standards, Better Physicians, Better Care. Ottawa, ON, Canada: The Royal College of Physicians and Surgeons of Canada; 2005
8. Saudi Commission for Health Specialties. Introduction to Clinical Research for Residents. Riyadh, Saudi Arabia: Saudi Commission for Health Specialties; 2014.
9. Saudi Commission for Health Specialties. General Exam Rules and Regulations. Vol. 14.0. Riyadh, Saudi Arabia: Saudi Commission for Health Specialties; 2014.
10. Saudi Commission for Health Specialties. Saudi Board Medical Imaging Curriculum. Riyadh, Saudi Arabia: Saudi Commission for Health Specialties; 2015.
11. Saudi Commission for Health Specialties. Saudi Board Internal Medicine Curriculum. Riyadh, Saudi Arabia: Saudi Commission for Health Specialties; 2015.

---

---

## APPENDICES

### APPENDIX 1/logbook

#### SCOPE OF THE LOGBOOK:

- Maintain records and document all academic activities (e.g., procedures, lectures, meetings, training courses, workshops, symposia, and presentations) undertaken during the training program;
- Assist the RT&MI resident in identifying his or her deficiencies in specific areas;
- Assist the program director/evaluator in documenting the contributions and evaluation of RT&MI residents;
- Provide the evaluator with guidance regarding appropriate and fair assessment of RT&MI residents;
- Provide the program director with guidance regarding deficiencies in training.

#### GUIDELINES FOR RT&MI RESIDENTS:

- RT&MI residents are required to maintain logbooks during the entire training period;
- Logbook entries concerning recorded activities should be completed on the day on which the activities occur;
- All entries must be signed by a mentor within one week after completion;
- RT&MI residents should discuss their training progress, as indicated in the logbook, with the mentor and/or program director every month;
- RT&MI residents should submit their completed logbooks to the program director at the end of rotations and training sessions for a subsequent submission to the regional supervisory committee;
- If a logbook is not signed by the program director, the RT&MI resident will be ineligible for the end-of-training certification and final examinations.

Example of an RT&MI Logbook				
Comments			Activity	Date



## APPENDIX 2

## In-training Evaluation Report (ITER) FORM

Not applicable	Exceeds expectations (4)	Clear Pass (3)	Borderline case (2)	Clear failure (1)	
					<b>A. Radiology Technology &amp; Medical Imaging expert</b>
					<b>Clinical &amp; Technical Knowledge</b>
					1. Understands the technical and clinical sciences in RT&MI.
					2. Understands the clinical presentation and natural history of common pathologies seen via imaging.
					3. Demonstrates expertise in all technical and clinical aspects and management of common radiological procedures.
					4. Avoids unnecessary or harmful investigations or management.
					5. Provides care.
					6. Demonstrates appropriate knowledge, skills, and attitude.
					7. Formulates appropriate differential RT&MI techniques.
					8. Develops an appropriate plan of RT&MI investigations and interprets the results.
					<b>Procedural skills</b>
					9. Understands the indications, contraindications, and complications of specific RT&MI procedures.
					10. Demonstrates mastery of specific RT&MI procedure techniques.
					<b>B. Communicator</b>
					11. Records appropriate progress notes.
					12. Communicates with medical staff in an appropriate manner.

					13. Communicates with patients in an appropriate manner.
					14. Communicates with patient families in an appropriate manner.
					15. Delivers understandable information to patients and their families.
					16. Maintains professional relationships with other healthcare providers.
					17. Provides clear and complete records, reports, and informed and written consent.
					<b>C. Collaborator</b>
					18. Works effectively in a team environment.
					19. Is able to work with allied healthcare staff.
					20. Is able to work with nursing staff.
					21. Is able to work with attending and junior medical staff.
					22. Consults effectively with other physicians and healthcare providers.
					<b>D. Manager</b>
					23. Participates in activities that contribute to the effectiveness of healthcare organizations and systems.
					24. Manages his or her practice and career effectively.
					25. Allocates finite healthcare resources appropriately.
					26. Serves appropriately in administration and leadership roles.
					27. Uses information technology to optimize patient care, lifelong learning, and other activities.
					<b>E. Health advocate</b>
					28. Is attentive to preventive measures.
					29. Demonstrates adequate patient education regarding compliance and medication.
					28. Is attentive to issues in public health policy.
					29. Recognizes important social, environmental, and biological determinants of health.

					30. Ensures that patients have access to appropriate support, information, and services.
					31. Offers advocacy on behalf of his or her patients and general population levels
					<b>F. Scholar</b>
					32. Attends and contributes to rounds, seminars, and other learning events.
					33. Discusses and presents selected topics in an appropriate manner.
					34. Demonstrates adequate ability to conduct a literature search.
					35. Demonstrates efforts to increase knowledge.
					36. Accepts and acts on constructive feedback.
					37. Is informed about patient cases and takes an evidence-based approach to management problems.
					38. Contributes to the education of patients, house staff, students, and other health professionals.
					39. Contributes to the development of new knowledge.
					<b>G. Professional</b>
					40. Recognizes his or her own limitations and seeks advice and consultation when necessary.
					41. Understands the professional, legal, and ethical obligations of physicians.
					42. Delivers evidence-based care with integrity, honesty, and compassion.
					43. Demonstrates appropriate insight into his or her own strengths and weaknesses.
					44. Shows initiative within the limits of his or her knowledge and training.
					45. Discharges duties and assignments responsibly and in a timely and ethical manner.
					46. Reports facts accurately, including his or her own errors.
					47. Maintains appropriate boundaries in work and learning situations.
					48. Respects diversity in race, age, gender, disability, intelligence, and socioeconomic status.

Total score = _____ x 25 =100% Number of evaluated items=	TOTAL SCORE
--	-------------

Program Director: \_\_\_\_\_

Comments:

\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

I certify that I have read all parts of this evaluation report and discussed the report with the evaluators.

Resident name: \_\_\_\_\_ Signature: \_\_\_\_\_

Evaluator name: \_\_\_\_\_ Signature: \_\_\_\_\_

Evaluator name: \_\_\_\_\_ Signature: \_\_\_\_\_

Program Director: \_\_\_\_\_ Signature: \_\_\_\_\_

**APPENDIX 3**

**RT&MI Resident Presentation Evaluation by Staff Supervisor**

RT&MI Resident name: \_\_\_\_\_ Level: \_\_\_\_\_

Staff Supervisor: \_\_\_\_\_

Date of Presentation: \_\_\_\_\_ Topic: \_\_\_\_\_

Very Good (5)	Good (4)	Acceptable (3)	Weak (2)	Very Weak (1)	<b>Radiology Technology &amp; Medical Imaging expert</b>
					Demonstrated thorough knowledge of the topic
					Presented at an appropriate level and with adequate details
					Comments (optional)
					<b>Communicator</b>
					Provided objectives and an outline
					Clear and organized presentation
					Used clear, concise, and legible materials
					Used effective methods and presentation style
					Established good rapport with audience
					<b>Collaborator</b>
					Included comments from learners and led discussions
					Worked effectively with staff supervisor in the session preparation
					Comments (optional)
					<b>Health advocate</b>

					Managed time effectively
					Addressed preventive aspects of care when relevant
					Comments (optional)
					Scholar
					Posed appropriate learning questions
					Accessed and interpreted relevant literature
					Comments (optional)
					<b>Professional</b>
					Maintained patient confidentiality when clinical material was used
					Identified and managed relevant conflicts of interest
					Comments (optional)

## APPENDIX 4

Final In-Training Evaluation Report (FITER)/Comprehensive Competency Report (CCR)		
RT&MI Resident name:		
SCFHS number:		
NO	YES	<b>Evaluation covering the last year of the resident:</b> According to the committee of the fellowship program, the aforementioned trainee has acquired competencies in pediatric hematology/oncology as prescribed by the training objectives. The resident is able to practice as a specialist. (Please tick the appropriate box.)
The following information sources were used for the evaluation:		
NO	YES	Items
		Written exams
		Clinical rotations
		Feedback from healthcare professionals
		Completion of scholarly project
		Other evaluations
Note: If, during the period between the date of the signature of this document and the completion of the training, the residency program committee judges that the demonstrated competencies of the candidate are inconsistent with the present evaluation, the residency program committee can declare the document null and void and replace it with an updated FITER. In that case, eligibility for the examination depends on the updated FITER.		
Comments:		
Name of Program Director:		
Date:		Signature:
I certify that I have read this document.		
Name of Resident:		
SCFHS number:		
Date:		Signature:
Resident Comments:		

**APPENDIX 5**

**X – RAY Clinical Rotation  
Competency Checklist R1**

NAME: \_\_\_\_\_ TODAY'S DATE: \_\_\_\_\_

ACTIVE SCHS #: \_\_\_\_\_

TYPES OF EXAMS PERFORMED: Please put "X" next to your level of skills and experience as X- Ray Technologist.

**PROFICIENT RATINGS:**  
(1) No Clinical Experience, (2) Observed and Assisted,  
(3) Limited Experience, (4) Competent, (5) Very Proficient

CHEST & THORAX	No Clinical → Proficient				
	1	2	3	4	5
Chest Routine					
Chest AP (Wheelchair / Stretcher)					
Chest Lateral Decubitus					
Ribs					
Sternum					
Upper Airway (Soft-Tissue Neck)					
UPPER EXTREMITY	1	2	3	4	5
Thumb or Finger					
Hand					
Wrist					
Scaphoid					
Forearm					
Elbow					
Humerus					
Shoulder					
Trauma: Shoulder (scapular Y, or Axillary) *					
Clavicle					
Scapula					
AC Joints					
Trauma: Upper Extremity Non-shoulder					
LOWER EXTREMITY	1	2	3	4	5
Femur					
Knee					
Knee - Trauma					
Patella					
Tibia - Fibula					
Ankle					
Foot					
Fore Foot					
Toe					
Calcaneus					
ABDOMEN	1	2	3	4	5
Abdomen Supine (KUB)					
Abdomen Upright					
Abdomen Decubitus					



**X – RAY Clinical Rotation  
Competency Checklist R1**

<b>PELVIS</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
Pelvis					
Hip					
Hip (cross-table lateral)					
Hip Jaudette					
Sacroiliac Joints					
<b>SPINE</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
Cervical Spine					
Cervical Spine Trauma (cross table lateral)					
Cervical Spine Oblique's					
Cervical Spine Flexion / Extension					
Thoracic Spine					
Scoliosis Series					
Lumbar Spine					
Sacrum and / or Coccyx					
<b>HEAD</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
Skull					
Paranasal Sinuses					
Facial Bones					
Orbits					
Nasal Bones					
Mandible					
<b>PEDIATRICS (age 6 or younger)</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
Chest Routine					
Upper Extremity					
Lower Extremity					
Abdomen					
Pelvis					
Mobile Study					
<b>SURGICAL PROCEDURES C-ARM</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
C-Arm Procedure (Orthopedic)					
C-Arm Procedure (non- Orthopedic)					
<b>GENERAL PATIENT CARE</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
Transfer of patient					
Care of patient medical equip (oxygen tank, IV tubing)					
				<b>YES</b>	<b>NO</b>
<b>I have experience in the following equipment (please list).</b>					
1. Picture Archiving & Communication System (PACS)					
2. SECTRA Radiology Information System (RIS)					
3. ICIS Hospital Information System (HIS)					

This information I have provided in this checklist is true and accurate to the best of my knowledge.

\_\_\_\_\_  
Signature/Date

**APPENDIX 6**

**Fluoroscopy & Angiography  
Clinical Rotation Competency  
Checklist R1**

**NAME:** \_\_\_\_\_ **TODAY'S DATE:** \_\_\_\_\_

**ACTIVE SCHS #:** \_\_\_\_\_

**TYPES OF EXAMS PERFORMED:** Please put "X" next to your level of skills and experience as X-Ray Technologist.

**PROFICIENT RATINGS:**  
(1) No Clinical Experience, (2) Observed and Assisted,  
(3) Limited Experience, (4) Competent, (5) Very Proficient

PROCEDURES	No Clinical → Proficient				
	1	2	3	4	5
Upper gastric imaging					
Small bowel series/follow thru					
Air contrast colon					
Arthrography					
<b>QUALITY CONTROL OF:</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
Basic radiographic equipment					
Shielding devices					
<b>ADDITIONAL TASKS</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
Prepare contrast media					
Format/Optimize images					
Ensure radiation safety					
Maintain sterile/isolation precautions					
Insert enema tip					
<b>GENERAL PATIENT CARE</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
Transfer of patient					
Care of patient medical equip (oxygen tank, IV tubing)					
				<b>YES</b>	<b>NO</b>
<b>I have experience in the following equipment (please list).</b>					
1. Picture Archiving & Communication System (PACS)					
2. SECTRA Radiology Information System (RIS)					
3. ICIS Hospital Information System (HIS)					

This information I have provided in this knowledge and skills checklist is true and accurate to the best of my knowledge.

\_\_\_\_\_  
Signature/Date

**APPENDIX 7**

**Magnetic Resonance Imaging  
Clinical Rotation Competency  
Checklist R2**

**NAME:** \_\_\_\_\_ **TODAY'S DATE:** \_\_\_\_\_

**ACTIVE SCHS #:** \_\_\_\_\_

**TYPES OF EXAMS PERFORMED:** Please put "X" next to your level of skills and experience as an MRI Technologist.

**PROFICIENT RATINGS:**  
(1) No Clinical Experience, (2) Observed and Assisted,  
(3) Limited Experience, (4) Competent, (5) Very Proficient

BODY PROCEDURES (ABDOMEN & PELVIS)	No Clinical → Proficient				
	1	2	3	4	5
Routine Liver					
Routine MRCP					
<b>NEURO &amp; ENT PROCEDURES</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
Routine Brain (Infants, Children and Adult)					
Orbits / PNS					
Routine (Cervical, Thoracic and Lumbar) Spine					
<b>PEDIATRIC MSK PROCEDURES</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
Knee Meniscus / Trauma					
Shoulder (Routine)					
Routine Ankle					
Routine Foot					
Routine Elbow					
Routine Wrist / Hand					
<b>MSK PROCEDURES</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
Wrist / Hand (Routine)					
Shoulder (Routine)					
Routine Elbow					
Knee (Routine)					
Routine Ankle					
Routine Foot					
				<b>YES</b>	<b>NO</b>
<b>I have experience in the following equipment (please list).</b>					
1. Picture Archiving & Communication System (PACS)					
2. SECTRA Radiology Information System (RIS)					
3. ICIS Hospital Information System (HIS)					
4.					
5.					

This information I have provided in this knowledge and skills checklist is true and accurate to the best of my knowledge.

\_\_\_\_\_  
Signature/Date

**APPENDIX 8**

**Magnetic Resonance Imaging  
Clinical Rotation Competency  
Checklist R3 & R4**

**NAME:** \_\_\_\_\_ **TODAY'S DATE:** \_\_\_\_\_

**ACTIVE SCHS #:** \_\_\_\_\_

**TYPES OF EXAMS PERFORMED:** Please put "X" next to your level of skills and experience as an MRI Technologist.

**PROFICIENT RATINGS:**  
(1) No Clinical Experience, (2) Observed and Assisted,  
(3) Limited Experience, (4) Competent, (5) Very Proficient

BODY PROCEDURES (ABDOMEN & PELVIS)	No Clinical → Proficient				
	1	2	3	4	5
Routine Liver					
Liver Primovist					
Routine MRCP					
MRCP Living-Hepatic Donor					
Adrenal Mass					
Adrenal Cancer					
Pancreas (Pancreatitis, Mass & Cholangiocarcinoma)					
Renal Mass					
Urinary Bladder Cancer Staging					
Prostatic Cancer Staging					
Screening for Undescended Testes					
Seminal Vesicles					
Penile					
Uterine Enlargement					
Mullerian Duct Anomalies					
Ovarian Mass					
Endometrial / Cervical Mass					
Oncology Surveillance					
Enterography					
Rectal Cancer Staging					
Rectal Cancer Staging (Pelvis Only)					
Perianal Fistula					
Defecogram and Pelvic Floor					
Vascular Malformation					
NEURO & ENT PROCEDURES	1	2	3	4	5
Routine Brain (Infants, Children and Adult)					
Brain Metastasis					
Brain MS					
Posterior Fossa					
Pituitary					
Temporal Lobe Epilepsy					
Pineal Gland / Midline Lesion					
Orbits / PNS					
Temporal Bone, IAM's CP Angle					
MRA Brain					
MRV Brain					
MRA Carotid					
Head & Neck (Nasopharynx, Oral Cavity, Tongue and Parotids)					



**APPENDIX 9**

**Nuclear Medicine Clinical  
Rotation Competency  
Checklist R2**

**NAME:** \_\_\_\_\_ **TODAY'S DATE:** \_\_\_\_\_

**ACTIVE SCHS #:** \_\_\_\_\_

**TYPES OF EXAMS PERFORMED:** Please put "X" next to your level of skills and experience as an MRI Technologist.

**PROFICIENT RATINGS:**  
(1) No Clinical Experience, (2) Observed and Assisted,  
(3) Limited Experience, (4) Competent, (5) Very Proficient

BONE SCAN	No Clinical → Proficient				
	1	2	3	4	5
METASTASIS					
OSTEOMYELITIS					
STRESS FRACTURE/ SHIN SPLINT					
PROSTHESIS EVALUATION (OSTEOMYELITIS VS. LOOSING)					
AVN OF BONE					
RENAL SCAN	1	2	3	4	5
Obstruction / Function (MAG 3)					
Transplanted Kidney (MAG 3)					
Cortical Scar (DMSA)					
Pyelonephritis (DMSA)					
Absolute Split Renal Function (DMSA)					
Testicular Imaging with Flow					
ENDOCRINE IMAGING	1	2	3	4	5
Parathyroid Adenoma(MIBI)					
Thyroid Uptake Scan (I-123)					
Thyroid Nodule Evaluation (I-123)					
WBS For Thyroid Carcinoma(I-123)					
Thyroid Scan With 99m Tco4					
Adrenal Imaging Cortex/Medulla					
				YES	NO
<b>I have experience in the following equipment (please list).</b>					
1. Picture Archiving & Communication System (PACS)					
2. SECTRA Radiology Information System (RIS)					
3. ICIS Hospital Information System (HIS)					
4.					
5.					

This information I have provided in this knowledge and skills checklist is true and accurate to the best of my knowledge.

\_\_\_\_\_  
Signature/Date

**APPENDIX 10**

**Nuclear Medicine Clinical  
Rotation Competency  
Checklist R3 & R4**

**NAME:** \_\_\_\_\_ **TODAY'S DATE:** \_\_\_\_\_

**ACTIVE SCHS #:** \_\_\_\_\_

**TYPES OF EXAMS PERFORMED:** Please put "X" next to your level of skills and experience as an MRI Technologist.

**PROFICIENT RATINGS:**  
(1) No Clinical Experience, (2) Observed and Assisted,  
(3) Limited Experience, (4) Competent, (5) Very Proficient

BONE SCAN	No Clinical → Proficient				
	1	2	3	4	5
METASTASIS					
OSTEOMYELITIS					
STRESS FRACTURE/ SHIN SPLINT					
PROSTHESIS EVALUATION (OSTEOMYELITIS VS. LOOSING)					
AVN OF BONE					
<b>RENAL SCAN</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
Obstruction / Function (MAG 3)					
Transplanted Kidney (MAG 3)					
Cortical Scar (DMSA)					
Pyelonephritis (DMSA)					
Absolute Split Renal Function (DMSA)					
Testicular Imaging with Flow					
<b>ENDOCRINE IMAGING</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
Parathyroid Adenoma(MIBI)					
Thyroid Uptake Scan (I-123)					
Thyroid Nodule Evaluation (I-123)					
WBS For Thyroid Carcinoma(I-123)					
Thyroid Scan With 99m Tco4					
Adrenal Imaging Cortex/Medulla					
<b>HEPATOBIILIARY SCINTIGRAPHY</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
GB Ejection Fraction(HIDA Scan)					
Acute Cholecystitis(HIDA Scan)					
Biliary Atresia (HIDA Scan)					
Liver Haemangioma (RBC Study)					
Liver & Spleen Imaging					
<b>INFECTION IMAGING</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
WBC labelled Scan ( Whole Body)					
FDG PET-CT (WB)					
Gallium -67 scan					
<b>PULMONARY IMAGING</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
Lung V/Q scan					
Pulmonary Quantitative Differential Study					
<b>THERAPEUTIC PROCEDURES</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
I-131 Grave's Therapy.					
I-131 Thyroid Carcinoma Therapy.					
I-131 MIBG Therapy.					
Zevalin For NHL.					

**Nuclear Medicine Clinical  
Rotation Competency  
Checklist R3 & R4**

Y-90 Joint Injection.					
Lu-177 DOTATOC For NET.					
Y-90 Microspheres for HCC					
<b>ONCOLGY IMAGING</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
PET-CT (FDG) for:					
Distinguishing benign from malignant disease.					
Establishing stage of the disease.					
Establishing whether there is recurrent or residual disease.					
Establishing the site of disease when tumor markers are rising.					
Establishing response to therapy.					
Identification for the primary site of biopsy in a large tumor.					
PET-CT 68Ga-DOTATOC scan for NET					
PET-CT 68Ga-PSMA scan for Prostate Cancer					
I-123 MIBG scan					
<b>BRAIN IMAGING</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
PET-CT for:					
Benign Vs malignant disease.					
Look for dementia causes.					
Look for epileptic focus (Intrictal).					
CSF Flow Imaging					
CSF Shunt Evaluation					
CSF Leakage Detection					
Brain Imaging Vasc Flow+ Spect					
<b>GI IMAGING</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
Gastroesophageal Reflux Study Or					
Milk Scan For Children					
Meckal's Scan					
Gastric Emptying Study					
Acute GI Bleed					
GI Protein Loss					
Salivary Gland Function Study					
Urea Breath Test (C-14)					
<b>CARDIAC IMAGING</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
Myocardial Perfusion Scintigraphy (Stress/ Rest)					
Myocardial Viability Scan					
Multigated Acquisition (MUGA)					
Cardiac Shunt Detection					
Myocardial Viability With FDG PET					
				YES	NO
<b>I have experience in the following equipment (please list).</b>					
1. Picture Archiving & Communication System (PACS)					
2. SECTRA Radiology Information System (RIS)					
3. ICIS Hospital Information System (HIS)					

This information I have provided in this knowledge and skills checklist is true and accurate to the best of my knowledge.

\_\_\_\_\_  
Signature/Date



**APPENDIX 11**

**Computed Tomography  
Clinical Rotation Competency  
Checklist R2**

**NAME:** \_\_\_\_\_ **TODAY'S DATE:** \_\_\_\_\_

**ACTIVE SCHS #:** \_\_\_\_\_

**TYPES OF EXAMS PERFORMED:** Please put "X" next to your level of skills and experience as an Ultrasound/Sonographer Technologist.

**PROFICIENT RATINGS:**  
(1) No Clinical Experience, (2) Observed and Assisted,  
(3) Limited Experience, (4) Competent, (5) Very Proficient

	No Clinical → Proficient				
	1	2	3	4	5
<b>ABDOMINAL – PROCEDURE</b>					
ANATOMY					
C.A.P. PROTOCOL					
ABDO PELVIS PROTOCOL					
RENAL STONES PROTOCOL					
<b>NEURO &amp; ENT</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
ANATOMY					
BRAIN (adult) exam					
BRAIN (pediatric)					
SINUSES					
HEAD NECK					
C – SPINE					
T – SPINE					
L – SPINE					
<b>THORACIC</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
ANATOMY					
ROUTINE CHEST WITHOUT IV COMTRAST					
ROUTINE CHEST WITH IV COMTRAST					
<b>I have experience in the following equipment (please list).</b>	<b>YES NO</b>				
PACS (PICTURE ARCHIVING & COMMUNICATION SYSTEM)					
SECTRA SYSTEM					
ICIS SYSTEM					

This information I have provided in this knowledge and skills checklist is true and accurate to the best of my knowledge.

\_\_\_\_\_  
Signature/Date

**APPENDIX 12**

**Computed Tomography  
Clinical Competency Checklist  
R3 & R4**

**NAME:** \_\_\_\_\_ **TODAY'S DATE:** \_\_\_\_\_

**ACTIVE SCHS #:** \_\_\_\_\_

**TYPES OF EXAMS PERFORMED:** Please put "X" next to your level of skills and experience as an Ultrasound/Sonographer Technologist.

**PROFICIENT RATINGS:**  
(1) No Clinical Experience, (2) Observed and Assisted,  
(3) Limited Experience, (4) Competent, (5) Very Proficient

	No Clinical → Proficient				
	1	2	3	4	5
<b>ABDOMINAL – PROCEDURE</b>					
ANATOMY					
C.A.P. PROTOCOL					
ABDO PELVIS PROTOCOL					
LIVER – DYNAMIC PROTOCOL					
RENAL – DYNAMIC PROTOCOL					
TRAUMA PROTOCOL					
GI BLEEDING PROTOCOL					
ADRENALS MASS PROTOCOL					
PANCREATIC MASS PROTOCOL					
RENAL STONES PROTOCOL					
RENAL MASS PROTOCOL					
BOWEL ISCHEMIA PROTOCOL					
APPENDICITIS PROTOCOL					
IV LINE					
<b>NEURO &amp; ENT</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
ANATOMY					
BRAIN (adult) exam					
BRAIN (pediatric)					
PAROTID					
ORBITS					
SINUSES					
TEMPORAL BONES					
T.M.J.					
SKULL & FACIAL BONE					
MANDIBLE					
HEAD NECK					
NECK					
DENTAL SCAN					
C - SPINE					
T - SPINE					
L - SPINE					
<b>THORACIC</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
ANATOMY					
ROUTINE CHEST WITHOUT IV COMTRAST					
ROUTINE CHEST WITH IV COMTRAST					

**Computed Tomography  
Clinical Competency Checklist  
R3 & R4**

HIGH RESOLUTION CHEST					
<b>Pediatric</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
Select protocol					
Adjust protocol					
Monitoring the dose					
GA cases					
Limb measurement					
DDH PROTOCOL					
CAP					
AP					
CHEST					
IV LINE					
<b>CT Angiography</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
ANATOMY					
THORACIC ANGIOGRAMS					
<b>ABDOMINAL ANGIOS</b>					
LIVER DONAR					
COLONOGRAPHY					
PULMONARY EMBOLUS					
RENAL DONAR					
BRAIN, NECK ANGIOGRAM					
BRAIN PERFUSION					
STEREOTACTIC EXAM					
3 DIMENTION PROCESS					
M S K , DDH , PROCEDURE					
<b>Pediatric exam</b>					
BIOPPSY,FNA AND RF ABLATION ROCEURE					
CORONARY ARTERY ANGIOGRAM EXAM					
CORONARY ARTERY ANGIOGRAM PEDIATRIC					
TAVI PROTOCOL					
FONTAN PROTOCOL					
CABIG PROTOCOL					
CONGENITAL CARDIAC					
DYNAMIC TRACHYIA PROTOCOL					
THORACIC AOROTOGRAM					
<b>Liver segmentation</b>					
UPPPER & LOWER EXTREMETY ANGIOGRAM					
DUAL ENERGY TECHNIQUE					
G.S.I TECHNIQUE					
<b>I have experience in the following equipment (please list).</b>				<b>YES</b>	<b>NO</b>
PACS (PICTURE ARCHIVING & COMMUNICATION SYSTEM					
SECTRA SYSTEM					
ICIS SYSTEM					

This information I have provided in this knowledge and skills checklist is true and accurate to the best of my knowledge.

\_\_\_\_\_  
Signature/Date

## APPENDIX 13

### Ultrasound / Sonographer Clinical Rotation Competency Checklist R2

RESIDENT'S NAME: \_\_\_\_\_ TODAY'S DATE: \_\_\_\_\_

ACTIVE SCHS #: \_\_\_\_\_

TYPES OF EXAMS PERFORMED: Please put "X" next to your level of skills and experience as an Ultrasound/Sonographer Technologist.

PROFICIENT RATINGS:					
(1) No Clinical Experience, (2) Observed and Assisted, (3) Limited Experience, (4) Competent, (5) Very Proficient					

	No Clinical → Proficient				
	1	2	3	4	5
<b>ABDOMINAL – PROCEDURE</b>					
APPENDIX/INTUSUSCEPTION					
GI TRACT					
LIVER/BILIARY TRACT					
PANCREAS/SPLEEN					
RENAL/URINARY SYSTEM					
<b>SMALL PARTS – PROCEDURE</b>					
ABDOMINAL WALL					
THYROID					
<b>I have experience in the following equipment (please list).</b>					
1. Picture Archiving & Communication System (PACS)					
2. SECTRA Radiology Information System (RIS)					
3. ICIS Hospital Information System (HIS)					
4.					
5.					

This information I have provided in this knowledge and skills checklist is true and accurate to the best of my knowledge.

 \_\_\_\_\_  
 Signature/Date

**APPENDIX 14**

**Ultrasound / Sonographer  
Clinical Rotation Competency  
Checklist R3 & R4**

**RESIDENT'S NAME:** \_\_\_\_\_ **TODAY'S DATE:** \_\_\_\_\_

**ACTIVE SCHS #:** \_\_\_\_\_

**TYPES OF EXAMS PERFORMED:** Please put "X" next to your level of skills and experience as an Ultrasound/Sonographer Technologist.

**PROFICIENT RATINGS:**  
(1) No Clinical Experience, (2) Observed and Assisted,  
(3) Limited Experience, (4) Competent, (5) Very Proficient

	No Clinical → Proficient				
	1	2	3	4	5
<b>ABDOMINAL – PROCEDURE</b>					
AORTA					
APPENDIX/INTUSUSCEPTION					
GI TRACT					
IVC (INFERIOR VENA CAVA)					
LIVER/BILIARY TRACT					
PANCREAS/SPLEEN					
RENAL/URINARY SYSTEM					
TRANS-RECTAL					
VASCULATURE					
OTHER:					
<b>OB &amp; GYNECOLOGY – PROCEDURE</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
1 <sup>st</sup> TRIMESTER					
2 <sup>nd</sup> /3 <sup>rd</sup> TRIMESTER					
HIGH RISK OB					
PLACENTA					
GESTATIONAL AGE					
COMPLICATIONS					
AMNIOTIC FLUID/AMNIOCENTESIS					
FETAL DEMISE					
FETAL ABNORMALITIES					
FETAL BIOPHYSICAL PROFILE					
UGR PROTOCOLS					
COEXISTING DISORDERS					
FOLICULAR STUDY					
OVARIES AND ADNEXA					
PEDIATRIC					
PELVIC PATHOLOGY					
POSTMENOPAUSAL PATHOLOGY					
TRANS-VAGINAL					
UTERUS and ADNEXA					
NUCHAL TRANSLUCENCY					
OTHER:					
<b>INTERVENTIONAL – PROCEDURE</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
ASPIRATION					
BIOPSIES					
DRAINAGE					

**Ultrasound / Sonographer  
Clinical Rotation Competency  
Checklist R3 & R4**

INTRAOPERATIVE					
LAPAROSCOPIC					
OTHER:					
<b>NEONATAL – PROCEDURE</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
CONGENITAL ABNORMALITY					
NEONATAL HEAD					
OTHER:					
<b>NEUROSONOLOGY – PROCEDURE</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
ENLARGEMENT/DISPLACEMENT					
CRANIAL HEMORRHAGE					
ATROPHIC LESIONS					
SPINAL LESIONS					
INFLAMATORY LESIONS					
BRAIN SWELLING/EDEMA					
SPINAL TETHERING					
TRAUMA					
OTHER:					
<b>SMALL PARTS – PROCEDURE</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
ABDOMINAL WALL					
BREAST					
HAEMATOMAS/VESSELS					
MUSCULOSKELETAL					
SCROTUM AND TESTES					
SUPERFICIAL MASSES					
THYROID					
NON-CARDIAC/CHEST					
OTHER:					
<b>VASCULAR – PROCEDURE</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
COLOR DOPPLER					
DIGITAL ACQUISITION SYSTEMS					
DIAMETER FOR PERCENTAGE OF STENOSIS					
PW &/OR CW FOR PERCENTAGE OF STENOSIS					
TCD					
PVR (ARMS & LEGS)					
IPG (ARMS & LEGS)					
RESISTIVE INDEX					
PULSATILITY INDEX					
POWER DOPPLER					
SEGMENTAL PRESSURES					
PULSE VOLUME RECORDING					
ABDOMINAL AORTA, IVC					
ABDOMINAL DOPPLER					
CAROTID DOPPLER					
SMA, CELIAC, RENALS					
HEPATIC, SPLEENIC					
ARTERIAL GRAFT DUPLEX					
ARTERIAL UPPER EXTREMITIES					
VENOUS UPPER EXTREMITIES					
ARTERIAL LOWER EXTREMITIES					
VENOUS LOWER EXTREMITIES					
PENILE DOPPLER					

**Ultrasound / Sonographer  
Clinical Rotation Competency  
Checklist R3 & R4**

PLETHYSMOGRAPHY FOR FINGERS, TOES					
VEIN MAPPING					
OTHER:					
<b>ECHO – PROCEDURE</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
TRANSTHORACIC					
TRANSESOPHAGEAL (TEE)					
HOLTER MONITORING					
EKG					
BUBBLE STUDIES					
ADULT					
NEONATAL					
PEDIATRIC					
2-D AND M MODE					
EXERCISE PHARMACOLOGICAL (DOBUTAMINE)					
PULSED DOPPLER					
COLOR DOPPLER					
TREADMILL EXERCISE TESTING					
ECG					
STRESS					
<b>POPULATION SERVED FOR TYPES OF ULTRASOUND (check all applicable and indicate level of skills)</b>					
NEONATAL					
INFANT/CHILDREN (0-11)					
ADOLESCENT (12-18)					
ADULT					
GERIATRIC					
<b>EXPERIENCE IN PRIMARY AREAS</b>			<b>YES</b>	<b>NO</b>	
HOSPITALS					
CLINICS					
PHYSICIAN OFFICE					
MOBILE					
SUPERVISORY EXPERIENCE					
<b>I have experience in the following equipment (please list).</b>					
1. Picture Archiving & Communication System (PACS)					
2. SECTRA Radiology Information System (RIS)					
3. ICIS Hospital Information System (HIS)					
4.					
5.					

This information I have provided in this knowledge and skills checklist is true and accurate to the best of my knowledge.

\_\_\_\_\_  
Signature/Date