Review Article

American Diagnostic Radiology Residency and Fellowship Programmes

Carol Masters Rumack,[1] *MD, FACR*

Abstract

American Diagnostic Radiology Residency and Fellowship programmes are Graduate Medical Education programmes in the United States (US) equivalent to the Postgraduate Medical Education programmes in Singapore. Accreditation Council for Graduate Medical Education (ACGME) accredited diagnostic radiology residency programmes require 5 years total with Post Graduate Year (PGY) 1 year internship in a clinical specialty, e.g. Internal Medicine following medical school. PGY Years 2 to 5 are the core years which must include Radiology Physics, Radiation Biology and rotations in 9 required subspecialty rotations: Abdominal, Breast, Cardiothoracic, Musculoskeletal, Neuroradiology, Nuclear and Paediatric Radiology, Obstetric & Vascular Ultrasound and Vascular Interventional Radiology. A core curriculum of lectures must be organised by the required 9 core subspecialty faculty. All residents (PGY 2 to 4) take a yearly American College of Radiology Diagnostic In-Training Examination based on national benchmarks of medical knowledge in each subspecialty. Because the American Board of Radiology (ABR) examinations are changing, until 2012, residents have to take 3 ABR examinations: (i) ABR physics examination in the PGY 2 to 3 years, (ii) a written examination at the start of the PGY 5 year and (iii) an oral exam at the end of the PGY 5 year. Beginning in 2013, there will be only 2 examinations: (i) the physics and written examinations after PGY 4 will become a combined core radiology examination. Beginning in 2015, the final certifying examination will be given 15 months after the completion of residency. After residency, ACGME fellowships in PGY 6 are all one-year optional programmes which focus on only one subspecialty discipline. There are 4 ACGME accredited fellowships which have a Board Certification Examination: Neuroradiology, Nuclear, Paediatric and Vascular Interventional Radiology. Some ACGME fellowships do not have a certifying examination: Abdominal, Endovascular Surgical Neuroradiology and Musculoskeletal Radiology. One year unaccredited fellowships can also be taken in Breast, Cardiothoracic or Women's Imaging.

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American Diagnostic Radiology Residency and Fellowship Programmes Structure

American diagnostic radiology residency and fellowship programmes are accredited by the Accreditation Council for Graduate Medical Education[1] (ACGME) with specific programme requirements written by the ACGME Diagnostic Radiology Residency Review Committee. In the past, these programmes were purely an apprenticeship model where the resident followed the attending radiologist and learned from clinical experience. Now each rotation typically includes 1 to 3 months of educational experience focused on only one specialty with a structured core curriculum of planned lectures that repeats every 2 years, a core set of expected clinical procedural experiences and interactive conferences. These Graduate Medical Education (GME) programmes are equivalent to the Postgraduate Medical Education Programmes in Singapore. In the United States, this training occurs after the medical student graduates and receives the Doctor of Medicine (MD) degree. There are 2 reasons why all American residency and most fellowship programmes are ACGME accredited. First, the hospital will be only be reimbursed for the resident's salary through the US Federal Medicare[2] Center for Medicare Services (CMS) payment system if they are in an accredited programme. Second, the resident is only eligible to take American Board of Radiology (ABR) certification examinations if he or she has completed an ACGME accredited programme.

As a prerequisite to any ACGME accredited American

[1] University of Colorado Denver School of Medicine
Address for Correspondence: Dr Carol M Rumack, University of Colorado Denver School of Medicine, 13001 East 17th Place, Bldg 500, Box C293, Room N4223, Aurora, CO 80045.
Email: carol.rumack@ucdenver.edu

radiology residency programme, after new physicians complete medical school and receive their MD, they must first spend one clinical year in a basic clinical residency programme which is called the Post Graduate Year 1 or PGY 1. The options for this year include an internship in a Transitional Year (rotating internship) or in Emergency Medicine, Family Medicine, Internal Medicine, Neurology, Obstetrics & Gynaecology, Paediatrics or Surgery. American radiology residency and fellowship programme plan are shown in Table 1. The maximum allowed time in radiology for the PGY 1 is 2 months with the goal of learning the maximum clinical knowledge during the 10 months on clinical services in the internship's specialty.

Table 1. American Radiology Residency and Fellowship Programme Plan (New for Residents Starting as of July 2010)

Post Graduate Year (PGY) 1 **Prerequisite Preliminary Clinical Year can be in 8 programmes:**	
Transitional (rotating) Internship	Emergency Medicine
Family Medicine	Internal Medicine
Neurology	Obstetrics & Gynaecology
Paediatrics	Surgery
Post Graduate Year (PGY) 2 to 6	
Programmes	**Post Graduate Year (PGY Yr)**
Diagnostic Radiology	PGY 2 – Core
Diagnostic Radiology	PGY 3 – Core
Diagnostic Radiology	PGY 4 – Core
Diagnostic Radiology	PGY 5 – 1 to 3 subspecialty rotations per year
Subspecialty Radiology Fellowships	PGY 6

Presently, in the 4 years of the accredited diagnostic radiology residency programme, all residents rotate to the 9 different subspecialty services and get a similar breadth of experience. However, because of changes to the ABR[3] examination plan, those residents who started in July 2010 will now do only 3 years (PGY 2 to 4) of core radiology rotations in the 9 specific subspecialties and a very different final year (PGY 5). In 2014, each resident will choose 1 to 3 subspecialty rotations depending on their interest, the number of residents and the number of possible subspecialty rotations.[4,5] In organising this future training, programme directors will need to consider the effects on other residents so that there are sufficient cases for both junior and senior residents if more than one resident is rotating on any service. The balancing of residents across the subspecialties will be an important goal for each programme. Because the Medicare funding of resident stipends requires that they be at the site supporting their salary, it is going to be uncommon for residents to do rotations outside of their key participating sites.

Table 2. Eleven Procedure Case Logs Required per Radiology Resident

Chest X-rays	MRI knee
CTA/MRA	MRI brain
Mammograms	Bone scans
CT abdomen/pelvis	PET scans
US abdomen/pelvis	Body MRI
Image guided biopsy/drainage	

ACGME Diagnostic Radiology Residency Programme requirements at, www.acgme.org, state that to have a qualified radiology residency programme in the United States, the programme must perform at least 7000 examinations per resident per year. Within these guidelines, each resident must keep procedure case logs of specific procedures identified by the Radiology Review Committee as representative of each modality in which they are being trained to ensure that the residents have a broad education with at least minimum case experience in all subspecialties and modalities. Resident Procedure Case Logs — Number of Procedures dictated by each resident is shown in Table 2. Presently, there are no set national benchmarks and the ACGME Radiology Residency Review Committee (RRC) is collecting data with the plan to eventually set benchmarks. The RRC may give the programme a citation if there are markedly fewer of any of the subspecialty procedures per resident dictated compared to data from other programmes.

The American Clinical Radiology Rotations include all of the subspecialty rotations: Abdominal, Breast, Cardiothoracic, Musculoskeletal, Neuroradiology, Nuclear Radiology (PET & cardiac), Paediatric Radiology, Ultrasound (OB & vascular) and Vascular & Interventional Radiology. In each of the required subspecialty areas, typically 3 to 4 months is spent in each rotation, which may be done as a block but is usually scheduled as 1 month each year with progressive responsibility given each year in that discipline. The maximum time that can be spent in any subspecialty is 18 months. Specifically required education in procedures for every resident includes gastrointestinal and genitourinary fluoroscopic procedures and interventional radiology (IR) basic skills. Advanced IR skills are expected only if the resident does an extra year in a fellowship after the residency. Breast imaging must include 12 weeks minimum with 240 mammograms in the final 2 years of training so that the resident qualifies to read mammograms under the United States Federal Law termed Mammography Quality Standards Act (MQSA).[6] Nuclear radiology requirements are also specific to the United States certification requirements. The resident must spend at least 80 hours in didactics and/or laboratory training. This requires 4 months of rotations in nuclear radiology (700 hours) supervised by a faculty member who is an

authorised user by the Nuclear Regulatory Commission.[7] Residents must have training in physics and radiation safety and hands-on training in radioactive material safety. They must also perform 3 Iodine-131 Therapy procedures. In order to get a license to handle isotopes, one must become an authorised user so all residents are required to meet this specific training to qualify.

Curriculum

A core series of didactic lectures must be organised into a core curriculum planned by the programme director that is repeated every 2 years. The 9 Core Faculty are required to organise the core lectures in their specialty. Nine core radiology faculties required are shown in Table 3. Within that lecture series, radiation physics,[8] radiation biology, radiation protection and MRI safety are required. Molecular imaging, being a frontier of radiology, is specifically emphasised. Radiology pathology correlation is required and 97% of all United States programmes have sent their residents for this training to the Armed Forces Institute of Pathology in Washington, DC. As of 2011, this training will be done by the new American Institute of Radiologic Pathology (AIRP) which is now administered by the American College of Radiology. Appropriate image utilisation regarding the use of all the modalities is taught with particular attention to relative radiation dose and the cost of imaging. Invasive procedure techniques and approaches are part of the lecture series and required for all residents. The general radiology (non-interpretive skills) lectures required include: socioeconomics, professionalism and ethics.

Conferences

The curriculum is expected to include didactic, interactive and interdisciplinary conferences. There must be at least 5 hours per week protected conference time for residents when attendings cover the clinical services.

Table 3. Nine Core Radiology Faculties Required

No.	Core Radiology Faculty
1.	Abdominal Radiology
2.	Breast Imaging
3.	Cardiothoracic Radiology
4.	Musculoskeletal Radiology
5.	Neuroradiology
6.	Nuclear Radiology (PET & Cardiac)
7.	Paediatric Radiology
8.	Ultrasound (OB & Vascular)
9.	Vascular & Interventional Radiology

Programme Director Role

One programme director is required for each radiology training programme. The programme director must be certified by the ABR in diagnostic radiology and hold an active medical license. Programme directors select the teaching and core faculty with the Chair of Radiology and plan the clinical rotations so that each resident gets an equivalent educational experience. Programme directors must meet with each resident at least 2 times a year (semi-annually) to formally discuss their progress in the programme-based on evaluations by faculty on each rotation and by multiple sources including medical students, technologists, nurses and patients. Programme director resources can be found through the Association of Program Directors in Radiology (APDR).[9]

For rotations outside of the primary institution, there must be a site director, a faculty member who agrees to oversee the supervision, education and evaluation of the residents. There must be specific goals and objectives defined for residents during that rotation. The programme director must write a Program Letter of Agreement (PLA) with the site director and it must be cosigned by the Designated Institutional Official (DIO).[10]

The programme director is charged with compliance with the institutional oversight of the residency programme, resident selection, evaluation, promotion and disciplinary policies. They must obtain approval from the Institutional Graduate Medical Education Committee (GMEC) of the sponsoring institution for any changes in rotation sites and the number of residents.

Role of Faculty

Nine core faculty are the designated subspecialty faculty leaders who work with the teaching faculty. These faculty are defined as spending at least 50% clinical time in that specialty and being subspecialty boarded or have significant credentials in that discipline. They are expected to help plan the core curriculum lectures and are assigned to give some of these lectures. The faculty are expected to allow the resident time to preview the clinical examinations alone, review the case with faculty and dictate a report. Then, dictated reports are signed by resident and faculty. Each faculty evaluates each resident based on their assessment of the 6 general competencies: medical knowledge, patient care, practice-based learning and improvement, interpersonal and communication skills, professionalism and systems-based practice. Six ACGME Competencies is shown in Table 4.

Table 4. Six ACGME Competencies

Six ACGME Competencies	Assessment Beyond Faculty Evaluations
Medical Knowledge	Annual ACR In-Training Examination, ABR Examinations
Patient Care	ACGME procedure case logs
Interpersonal & Communication Skills	Evaluated by students, technologists, patients
Professionalism	Evaluated by students, technologists, patients
Systems-based Practice	Evaluations of M&M, interactive case conferences
Practice-based Learning and Improvement	Morbidity & Mortality conferences

Six General Competencies: How to Teach?

1. Patient Care

This can be taught by several methods including: (i) Formal report experience — usually having the resident preview the case before dictation with the faculty. As they are given progressive responsibility, residents can predictate the case before review by faculty and signing; review by faculty must occur within 24 hours for more senior residents, (ii) Direct observation of procedures with the faculty or senior residents observing the resident after showing them how the procedure is done, (iii) Recording of all invasive procedures including complications and the supervising faculty.

2. Medical Knowledge

Radiology faculty typically give unknown case conferences which require the resident to describe the abnormal film findings, discuss a good differential diagnosis, describe a management scheme and give their final diagnosis. Teaching files are developed and used by residents and faculty. Many programmes have purchased the ACR digital teaching files on specific subspecialty disciplines.

3. Practice-based Learning and Improvement

Most programmes use Morbidity and Mortality (M&M) conferences to review adverse events and determine what can be done to improve patient care so that the problem does not occur again. All programmes use journal club to teach evidence-based learning of critical thinking skills where the faculty chooses journal articles for residents to discuss.

4. Interpersonal and Communication Skills

Attending faculty are expected to review all radiology resident reports for the quality of communication and give feedback on how to make the findings more clearly understood and prioritised in regard to the critical and urgent findings. Due to the US Medicare rules for reimbursement, residents do not read independently without attending supervision. Internal moonlighting is often used for extra work in very busy service areas. Typically, fellows who are already board certified will dictate reports on cases that are not in their subspecialty area of training. Role modeling occurs by faculty on informed consent for invasive procedures and for giving bad news.

5. Professionalism

Attending faculty are role models for respecting patient autonomy and cultural diversity. They give feedback to residents on their behaviour with patients, faculty and staff.

6. Systems-based Practice

Residents use M&M conferences to learn how to get changes made to effect best patient care based on presentation of the system errors. Root cause analysis may be done if there are major issues. All residents may need to be involved in a departmental or personal quality improvement project to learn the cycle of improvement.

Six Core Competencies: How to Assess?

The programme director monitors the educational programme and makes changes where weaknesses are found such as loss of faculty in an area of expertise or at a specific rotation site. The programme director oversees supervision of the night call schedule to assure that there is always adequate backup for vacation and emergencies and that faculty supervision is available at all times. Every resident is formally reviewed by the programme director every 6 months in person and a written summary of that meeting is kept in the resident's file. The programme director writes a formal final letter that states they have demonstrated sufficient competence to enter practice without direct supervision. Duty hours and moonlighting must be monitored for compliance but is rarely a problem in radiology residency programmes.

Residents are required to keep a learning portfolio which documents the required assessments. Resident learning portfolio is shown in Table 5. For patient care, case logs track the clinical experience of residents. Direct observation of procedure experience is evaluated with rotation evaluations by faculty. All invasive procedures are tracked in a database in most interventional radiology labs by outcome,

complications and attending supervisor. Since procedure reports are a radiologist's most critical communication, the daily evaluation by faculty of the resident dictated reports allows for frequent feedback, ongoing evaluation and improvement. Progressive responsibility for reporting starts in the first year with no preliminary report being sent out until review with the increasing responsibility of the resident leading to preliminary reports beginning with the second year.[11]

For *Medical Knowledge*, assessment is based on yearly In-service exam scores using the American College of Radiology (ACR)[12] Diagnostic In-training Examination and by final ABR pass rates for those residents graduated from the programme. At least 50% of a programme's graduates should pass the oral examination either on the first attempt or, if only one section is failed, should pass that section at the first opportunity.

For *Practice-based Learning and Improvement*, M&M conferences present opportunities for residents to present cases with adverse outcomes and develop an action plan to avoid that outcome in future cases.

For *Interpersonal and Communication Skills*, faculty evaluate each dictated report. Faculty also evaluate resident presentations at conferences. There must be a '360 degree' evaluation by non-physician colleagues including technologists, nurses, medical students and patients.

For *Professionalism*, the '360 degree' evaluations by technologists, nurses and patients are best done with people who see all of the residents for comparison and know what is expected in their role.

Table 5. Resident Learning Portfolio

Case/procedure log
Conferences attended
Courses/meetings attended
Self-assessment modules completed
Documentation of compliance with regulatory-based training:
Requirements in nuclear medicine and breast imaging
Documentation of performance on yearly objective examination (ACR-DIXIT)
Annual resident self-assessment and learning plan
Formal evaluation of quality of dictated reports
Documentation of compliance with institutional and departmental policies (e.g. HIPAA,[13] JCO,[14] patient safety, infection control, dress code, etc)
Status of medical license, if appropriate
Documentation of a learning activity that involves deriving a solution to a system problem at the departmental, institutional, local or national level
Documentation of scholarly activity, such as publications, presentations

For *Systems-based Practice*, resident participation in a systems-based problem such as a root cause analysis of major adverse events within the department will allow them to learn the process for fixing systems errors. Review of clinical indicators such as timeliness of reports and reporting critical findings immediately can be a part of these quality improvement (QI) projects as well.

Annual Review of the Residency Programme

Every programme is required to analyse the residency programme annually with written input from residents and faculty. Typically, the programme director, faculty and residents meet together to review the data and look for improvements they can make for the next academic year. Aggregate resident data success on ACR In-Training Exams (DXIT) and ABR scores for the past 5 years are available. The annual ACGME Resident survey given to all residents in accredited programmes is an aggregate report of what the residents see as strengths and weaknesses in the programme. Lectures, conferences and clinical rotations may need to be changed to improve the educational experience.

ACR In-Training Exam (DXIT)

The In-Training exam is given to all residents in radiology as a 4-hour monitored exam on the same date yearly (February). There are now 270 questions with 50% based on images on paper. All scores go to the programme directors. No questions are now reused. The programme director discusses the results with each resident and the aggregate data is used to see what weak areas occur for all of their residents and which residents have specific weak areas. Residents must sign consent to take the test. It now costs $160 per resident. There are 11 subsections: Breast, Cardiac, Chest, Gastrointestinal, Genitourinary, Musculoskeletal, Neuroradiology, Nuclear radiology, Paediatric radiology and Ultrasound. Physics and competency questions are asked within each clinical area. They are scored compared to residents at the same PGY level. It will become an image rich, computer-based examination and the main cost will be paying the companies that run the testing centres.

American Board of Radiology Examinations

Residents starting in 2010 will take a core examination after PGY 2 to 4 years of training (first test will be held in 2013) which includes all basic radiology training with organ systems tests on Breast, Cardiac, Endocrine/Reproductive, GI, MSK, Neuroradiology, Paediatrics, Thoracic, Urinary and Vascular. The test will cover 6 modalities of Radiology/Fluoroscopy, Computed Tomography, Magnetic Resonance, Nuclear/Molecular, Ultrasound and Interventional

Radiology. Residents will take a certifying examination 15 months after the end of residency which will contain 5 modules: (i) Noninterpretive skills, (ii) Essentials of radiology, and (iii) 3 modules chosen by the candidate on general radiology or subspecialty radiology.

Summary and Conclusion

The American Diagnostic Radiology Residency and Fellowship programmes accredited by ACGME have developed from apprenticeships into structured educational experiences based on a core curriculum organised by 9 subspecialty faculty under the direction of the programme director. Each resident rotation includes residents previewing studies, dictating reports under faculty supervision, and performing procedures in that one subspecialty. They have at least 5 hours of protected time per week in core lectures, interactive case conferences, journal clubs and multidisciplinary conferences. Each resident is evaluated on the 6 general competencies: *Medical Knowledge* by inservice exams and daily radiology reporting; *Patient Care* is evaluated by procedures dictated and consultations; *Interpersonal and Communication Skills and Professionalism* are both evaluated by dictated reports, conference performance and evaluations by technologists, peers and patients; and *Systems-based Practice* and *Practice-based Learning and Improvement* are often assessed in interactive case conferences including M&M conferences and journal clubs where residents present difficult cases and literature reviews. Major changes in the structure of the residency have been made to respond to the new ABR examination schedule so that starting with the July 2010 class, residents will cover all of the basic core rotations in PGY 2 to 4. The Core Radiology Examination will cover the basic radiology essentials. PGY 5 will include 1 to 3 subspecialty rotations. The final certifying examination will follow the residency after 15 months. Most residents will take a one-year fellowship in a subspecialty as the trend toward subspecialisation[15] continues in American radiology practice.[16]

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