

Goals and Objectives for an Integrated, Graduated Curriculum in Abdominal Radiology

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The Residency Review Committee of the American Council of Graduate Medical Education has designated abdominal radiology as one of the subspecialty areas required for radiology residency training. Because it spans both gastrointestinal and genitourinary organ systems and multiple modalities, a graduated, integrated abdominal radiology curriculum, which is based on the General Competencies, was developed.

Key Words: Resident education; general competencies; abdominal radiology.

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Radiology departments vary widely in their subspecialty organization; some are organ-based, others are modality-based, and still others are hybrid or have virtual subspecialty sections. For purposes of diagnostic radiology residency program accreditation by the American Council of Graduate Medical Education (ACGME), the Residency Review Committee requires that the abdominal radiology subspecialty area integrate gastrointestinal (GI) and genitourinary (GU) organ systems and several modalities (1). These include GI/GU plain radiography, GI/GU fluoroscopy, abdominal computed tomography (CT), and abdominal magnetic resonance imaging (MRI). The combination of GI and GU with multiple modalities underscores the need for an integrated curriculum to guide resident learning and self-assessment as well as preparation by the resident for the American Board of Radiology examination sections in GI and GU radiology. Ultrasound represents a separate subspecialty area under the Residency Review Committee guidelines.

In addition to the need to amalgamate GI and GU radiological education, residency training programs have also had to restructure their goals and objectives and resident assessments based on the General Competencies developed by the ACGME and implemented in late 2003 (2). The goals and objectives need to be longitudinally linked, and reflect the expectation for progressively advanced performance in achieving the goals and objectives as the resident progresses

from early to advanced rotations. This includes growth in both the range and depth of medical knowledge and other areas of the General Competencies.

An integrated, graduated curriculum in abdominal radiology, with Goals and Objectives based on the General Competency categories, was created which could serve as a template for other programs wishing to formulate their own curriculum. The curriculum was developed with input from the coauthors and our residents, and follows the General Competency organizational structure used by other subspecialties such as the Society of Thoracic Radiology for its chest radiology curriculum (3). Although specific medical knowledge goals and objectives are included in the curriculum, more comprehensive topic lists are also included as appended website links to the curriculum (4,5). These lists of topics, and in some cases specific skills, were developed by the Society of Gastrointestinal Radiology (2003) and the Society of Uroradiology (2006) as a guide for residents. Both website links list many disease entities about which the resident must be knowledgeable. The Society of Uroradiology document goes further and delineates knowledge-based and technical skill benchmarks by year of training, but does not address the General Competency categories in this fashion. The disease topics in both curricula are well structured, and are sorted by organ system, which should help the resident focus his or her reading and online research, and dovetails well with our proposed curriculum.

The curriculum is meant to be a living document that can be modified as new knowledge, skills, or behaviors develop within the competency-based framework. Evolution of the curriculum could be achieved in a variety of ways through ongoing resident and faculty dialogue or as part of a formal annual review of the program by the faculty and residents, which occurs each year in our department and is an ACGME

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requirement. If used by programs other than our own, the curriculum may be customized to reflect local expertise and unique learning opportunities/resources.

GOALS: EARLY LEVEL ROTATIONS

After completion of the early abdominal CT/MRI and GI/GU rotations (approximately 8–10 weeks), the resident should be able to:

1. Demonstrate learning of the organ-based medical knowledge objectives cited below.
2. After determining the appropriateness of the examination and collecting the background clinical information, protocol a simple abdominal CT.
3. Understand the indications for body CT versus body MRI of the abdomen.
4. Describe the indications and contraindications for intravascular (iodine-based and gadolinium), oral, and rectal contrast.
5. Understand basic safety principles for CT and MRI.
6. After determining the appropriateness of the examination and collecting the background clinical information, protocol a simple GI or GU fluoroscopic exam (such as to rule out a postoperative GI or GU perforation or "leak").
7. Understand the standard positioning and views needed for simple GI and GU fluoroscopic procedures.
8. Show sensitivity to fluoroscopic and CT dose.
9. Dictate accurate, concise, and timely radiology reports on simple abdominal radiographs, fluoroscopic procedures, and CT scans after these have been reviewed by the faculty with only minimal assistance or editing by the faculty.
10. Effectively communicate simple instructions to technologists and findings to the referring physician staff and house staff.
11. Demonstrate professionalism and a responsible work ethic.
12. Participate in Quality Assessment/Quality Improvement (QA/QI) conferences and regularly bring basic abdominal cases to the departmental case conference(s).
13. Perform at an appropriate level on national or departmental in-service exams.

SPECIFIC OBJECTIVES/BENCHMARKS: EARLY ROTATIONS

A. Patient Care

At the end of the early rotations in abdominal radiology, the resident will demonstrate that he or she can:

1. Determine at a basic level if an abdominal CT or MRI scan is appropriate to answer the clinical question and if that scan has been ordered appropriately.
2. Protocol straightforward CT cases and direct the technologists to perform appropriate/additional/delayed views as needed.

3. Recognize variations of CT anatomy such as anomalous vessels, retro-aortic renal vein, inferior vena cava duplication, malrotation of the GI tract, ectopic kidneys.
4. Recognize adequate versus inadequate studies resulting from artifacts such as motion or inadequate oral or intravenous contrast on CT.
5. Recognize the majority of the entities in Section B of Medical Knowledge with moderate accuracy.
6. Assist in performance of abdominal biopsy/drainage procedures.
7. Review history of the patient for whom a fluoroscopic procedure has been ordered and determine the appropriateness of the study requested with assistance of the faculty in some cases.
8. Select the appropriate contrast agents to use for fluoroscopic procedures with assistance of the faculty in some cases.
9. Perform esophagrams, barium swallowing function studies, single contrast upper GI, double-contrast upper GI with no assistance. Identify obvious abnormal findings at the time of fluoroscopy, but not subtle findings without help of the radiology faculty. Perform barium enema with assistance by faculty.
10. Perform hysterosalpingogram (HSG) or cystogram with little assistance. Identify obvious abnormal findings at the time of fluoroscopy, but not subtle findings without help of the radiology faculty.
11. Demonstrate sensitivity to fluoroscopic dose by recording fluoroscopy times in the fluoroscopy wet reading log.
12. Screen patients and identify those at risk from iodinated contrast or gadolinium-based contrast. Make further recommendations after significant input from the faculty.

B. Medical Knowledge

At the end of the early rotations in abdominal radiology, the resident will demonstrate that he or she has learned:

1. At least one third of the medical knowledge topics identified in the attached the website links in addition to the following.
2. Common plain abdominal bowel gas patterns, normal and abnormal solid organ shadows, calculi versus other causes of calcification, abnormal gas collections.
3. Cross-sectional anatomy including the hepatic lobes/segments, pancreatic anatomy, major abdominal/retroperitoneal compartmental anatomy, bowel, vascular anatomy, kidneys/renovascular pedicle, gynecologic organs, enhancement patterns of normal structures.
4. Basic physics of helical (multirow) CT image acquisition and MRI acquisition.
5. Intravenous contrast material use in abdominal CT including.
 - Principles for contrast administration: the importance of peak contrast enhancement, the portal venous phase, avoidance of equilibration, pancreatic phase, nephrographic phase, excretory phase.

- Use of computer assisted techniques for optimizing contrast timing.
- 6. Basic abdominal CT protocol design.
 - Tailoring contrast enhancement to the specific type of exam.
 - Selection of scan parameters such as mAs and kVp, use of automatic dose modulation.
 - The general principles of As Low As Reasonably Achievable dose (ALARA).
- 7. Elements of a CT report: including proper descriptive terms for simple abnormalities.
- 8. Typical CT appearance of common abnormalities.
 - Hepatic metastases.
 - Pancreatic cancer.
 - Pancreatitis.
 - Diverticulitis.
 - Appendicitis.
 - Nephrolithiasis/ureterolithiasis/hydronephrosis/hydro-nephrosis.
 - Adenopathy.
 - Differentiation of simple renal cysts from solid renal tumors.
 - Major organ injury (liver, spleen, kidney, GI tract, pancreas, bladder, urethra).
- 9. The different barium and water soluble preparations used for single- and double-contrast examinations of the GI tract.
- 10. How to operate the department's fluoroscopy equipment.
- 11. Risk factors for developing a contrast reaction, potential treatments for minor contrast reactions, other deleterious effects of iodinated and gadolinium-based contrast.
- 12. The rationale for the standard views and positions for single- and double-contrast fluoroscopic imaging of the GI tract.
- 13. The appearance of normal gastric bypass anatomy, perforation or free "leak" after gastric bypass, large gastric tumors, esophageal carcinoma, small bowel obstruction, large colon carcinomas.
- 14. The varied appearances of renal calculi on pre- and post-lithotripsy images.
- 15. Normal anatomy of the renal collecting structures, ureter, bladder, and urethra as seen on retrograde examinations.
- 16. MRI signal characteristics of major abdominal organs on pre- and post-contrast T1-weighted images and T2-weighted images, typical normal appearance of magnetic resonance cholangiopancreatography, MRI appearance of hemangioma of the liver, renal cysts, hydronephrosis, and straightforward solid renal tumors.
- 17. Perform at an appropriate level on national or departmental in-service exams.

C. Practice-based Learning and Improvement

At the end of the early rotations in abdominal radiology, the resident will demonstrate that he or she can:

1. Appropriately use the Picture Archiving and Communication System (PACS) to mark studies as read documenting the resident's participation in the case.
2. Engage the faculty in discussion about the resident's own preliminary interpretation of the case and analyze discordant readings and why they occurred.
3. Document any potential procedural or other complications in the medical record and through the appropriate hospital risk-management system after consulting with the faculty (also applies to Professionalism).
4. Bring cases to show other residents as unknowns for the departmental case conference(s), and be prepared to discuss the findings with a specific focus on "why the case was personally challenging".
5. Participate in the department's QA/QI conference.

D. Interpersonal and Communications Skills

At the end of the early rotations in abdominal radiology, the resident will demonstrate that he or she can:

1. Communicate with the technologist about any special or additional views that should be obtained to demonstrate the pathology identified.
2. Generate a coherent, logical report reflecting the review session and discussion with the radiology faculty for most cases without assistance. In cases in which there are complex findings, it is expected that the early rotation resident will need some assistance with choosing proper wording of the report.
3. Communicate to the referring physician on the day of the exam any significant or unexpected abnormalities identified on the examination AND document in the report who was called and the date and time.
4. Comply with hospital and departmental policy for reporting critical test results.
5. Discuss the findings and literature for relatively simple cases at the departmental case conference(s).
6. Explain simple procedures to patients and their families and obtain informed consent with the faculty.

E. Professionalism

At the end of the early rotations in abdominal radiology, the resident will demonstrate that he or she can:

1. Arrive on time and fulfill the clinical and educational tasks necessary as part of the daily routine. This includes looking up relevant articles, completing background reading, and attending all intradepartmental conferences and those interdepartmental conferences relevant to the abdominal radiology services.
2. When consulting with referring physicians or house staff, recognize his or her own limitations and seek input from radiology faculty.
3. Obtain informed consent for an invasive procedure (if this is consistent with specific departmental policy for that

procedure), including doing so compassionately and without ethnic, religious, or sexual bias, explaining the procedure's risks, benefits, alternatives, and addressing all of the patient's concerns.

4. Comply with the provisions of the Health Insurance Portability and Accountability Act (HIPAA) and all state confidentiality rules.
5. Comply with all Institutional Review Board (IRB) rules (if the resident has become involved in research during their early rotation).
6. With guidance from the faculty, record cases for the teaching file.

F. Systems-based Practice

At the end of the early rotations in abdominal radiology, the resident will demonstrate that he or she can:

1. Join at least one of our professional organizations American College of Radiology (ACR), American Roentgen Ray Society (ARRS), or Radiological Society of North America (RSNA).
2. Attend the teaching sessions (and quiz if applicable) of the local radiology society.
3. Identify systems-based operational challenges within the department and engage the faculty in discussions how to affect changes that would be beneficial in abdominal radiology or the department as a whole.

GOALS: MID-LEVEL ROTATIONS

After completion of the mid abdominal CT/MRI and GI/GU rotations (approximately 11-20 weeks), and in addition to those goals listed for the early level rotations, the resident should show increasing sophistication and be able to:

1. Demonstrate learning of the organ-based medical knowledge objectives cited below.
2. After determining the appropriateness of the examination and collecting the background clinical information, protocol the vast majority of all abdominal CTs and most abdominal MRI scans.
3. Understand more advanced safety principles for CT and MRI including administration of iodine-based contrast and gadolinium-based contrast to patients with varying degrees of renal failure.
4. Protocol all fluoroscopic studies.
5. Take proactive steps to reduce fluoroscopic dose and limit CT dose.
6. Dictate accurate, concise, and timely radiology reports on all cases including complex abdominal radiographs, fluoroscopic procedures, and CT scans after reviewing the findings with the faculty.
7. Participate in QA/QI conferences and regularly bring increasingly advanced abdominal cases to the departmental case conference(s).

8. Perform and track an appropriate number of invasive procedures done under the supervision of the abdominal imaging faculty.
9. Show improvement in performance on national or departmental in-service exams.

SPECIFIC OBJECTIVES/BENCHMARKS: MID-LEVEL ROTATIONS

A. Patient Care

At the end of the mid-level rotations in abdominal radiology, the resident will demonstrate that he or she can:

1. For most cases, determine if an abdominal CT or MRI scan is appropriate to answer the clinical question and if that scan has been ordered appropriately. Discuss with clinical teams alternative imaging techniques that may be needed.
2. Protocol all but the most complex abdominal CT cases and direct the technologists to perform appropriate/additional/delayed views as needed.
3. Recognize more subtle variations of anatomy for example renal pseudotumors, pseudo-intussusception, transient hepatic attenuation differences in the liver.
4. Recognize subtle artifacts or physiological variations such as the effect of contrast phase on organ/abnormality visualization (eg, lack of medullary enhancement of the kidney before the nephrographic phase, absence of significant hepatic enhancement in the hepatic arterial phase).
5. Recognize the majority of the entities in Section B of Medical Knowledge with a high degree of accuracy including their variations.
6. Perform abdominal biopsy/drainage procedures with supervision.
7. Review history of the patient for whom a fluoroscopic procedure has been ordered and determine the appropriateness of the study requested with rare assistance from the faculty.
8. Select the appropriate contrast agents to use for fluoroscopic procedures with rare assistance of the faculty.
9. Perform esophagrams, barium swallowing function studies, single contrast upper GI, double-contrast upper GI with no assistance. Identify subtle abnormal findings at the time of fluoroscopy, without help of the radiology faculty in most circumstances.
10. Perform HSG or cystogram with no assistance from the supervising faculty. Identify obvious abnormal findings at the time of fluoroscopy, but not subtle findings without help of the radiology faculty.
11. Perform barium enemas and retrograde urethrograms with minimal assistance from the faculty.
12. Demonstrate sensitivity to fluoroscopic dose by recording fluoroscopy times in the fluoroscopy wet reading log and taking proactive steps to reduce patient dose through proper technique.

13. Screen patients and identify those at risk from iodinated contrast or gadolinium-based contrast. Make further recommendations as to alternatives or steps for preventing contrast-induced nephropathy with minimal assistance from the faculty.
14. Recognize and treat subcutaneous contrast extravasation.
15. Be able to create multiplanar reformats of GI and GU structures using the PACS or independent workstations.

B. Medical Knowledge

At the end of the mid-level rotations in abdominal radiology, the resident will demonstrate that he or she has mastered all knowledge of an early-level resident in addition to:

1. At least two thirds of the medical knowledge topics identified in the attached website links in addition to the following.
2. Show further understanding of anatomy such as a deeper understanding of anatomic concepts of compartmental anatomy, pancreatic anatomy such as pancreas divisum, renal pseudotumors, pathways of spread of infection and metastatic disease.
3. More advanced physics of helical (multirow) CT image acquisition including the concept of pitch, use of gating for vascular studies, and MRI acquisition including pulse sequences such as fast spin echo and steady-state acquisition.
4. Expanded knowledge of principles for contrast administration and protocol design for scanning the liver, pancreas, kidney, abdominal vessels (computed tomographic angiography), the importance of the portal venous phase, avoidance of equilibration, biphasic scanning for hypervascular hepatic tumors, the nephrographic phase as part of CT urography for exclusion of renal cell carcinoma, the pancreatic phase for exclusion of pancreatic adenocarcinoma, and the excretory phase for exclusion of transitional cell carcinoma.
5. Expanded ALARA knowledge to understand difference between CT dose index (CTDI_w and CTDI_{vol}), dose length product, effective dose, reference values, and automatic tube modulation as they pertain to protocol design and individual patient's radiation dose estimate.
6. Elements of an advanced CT report, including proper descriptive terms for more complex abnormalities than would be used by an early rotation resident.
7. Expanded recognition of variations in the CT appearance of common abnormalities such as:
 - Hepatic metastases.
 - Pancreatic cancer.
 - Pancreatitis.
 - Diverticulitis.
 - Appendicitis.
 - Nephrolithiasis/ureterolithiasis/hydronephrosis/nephrosis.
 - Adenopathy.
 - Differentiation of simple renal cysts from solid renal tumors.
 - Major organ injury.
8. Recognition of other lesions such as:
 - Hepatic hemangioma, focal nodular hyperplasia, adenoma, hepatocellular carcinoma.
 - Budd-Chiari.
 - Portal hypertension.
 - Biliary obstruction.
 - Gallbladder disease.
 - Primary sclerosing cholangitis.
 - Cholangiocarcinoma.
 - Complications of pancreatitis.
 - Small bowel and colonic pathology, inflammatory bowel disease, ischemia, neoplasms.
 - Primary gastric malignancies and metastases.
 - Renal tumors, renal cell carcinoma, transitional cell cancer.
 - Pyelonephritis (acute focal bacterial nephritis or diffuse), renal vein thrombosis.
 - Pelvic masses, gynecologic malignancy.
 - Subtle organ injury and delayed complications after trauma, such as pseudoaneurysm formation.
9. How the different contrast preparations for GI and GU radiology affect radiographic appearances.
10. How to troubleshoot the department's fluoroscopy equipment and optimize images using parameters under control of the fluoroscopist such as collimation, frame rate, and use of automatic brightness control.
11. How to use pretreatment to prevent contrast reactions, potential treatments for major contrast reactions, pretreatment for other nonallergic deleterious effects of iodinated and gadolinium-based contrast. Clinical settings that put patients at risk for development of nephrogenic fibrosis.
12. How to customize the standard views and positions for single- and double-contrast fluoroscopic imaging of the GI tract to better see pathology in individual patients.
13. The appearance of subtle contained perforations or "leaks" following gastric bypass, leaks following fundoplication surgery, laparoscopic band placement follow-up, gastric sleeve resection, subtle/infiltrative gastric tumors, esophageal adenocarcinoma, achalasia, GI stromal tumors, carcinoid tumors, colon carcinomas.
14. To detect subtle residual stones and stricture and potential complications of lithotripsy on post-lithotripsy images.
15. Abnormal findings on retrograde ureterogram (including ureteropelvic junction obstruction, renal or ureteral calculi, staghorn calculi, transitional cell carcinoma, papillary necrosis, medullary sponge kidney/medullary nephrocalcinosis, sequelae of infection, variations of backflow/extravasation), cystogram (including bladder tumors, bladder rupture and infiltrative processes involving the bladder), and urethrogram (traumatic injury and post-inflammatory stricture).

16. MRI signal characteristics and resulting appearances of major abdominal disease processes such as benign and malignant hepatic tumors, cirrhosis, pancreatic cancer, pancreatitis, renal cell carcinoma (with or without renal vein/inferior vena cava invasion), adrenal adenomas versus malignant adrenal tumors, retroperitoneal adenopathy versus fibrosis, uterine and ovarian benign and malignant processes such as fibroids, cervical and endometrial cancer, endometriosis, compartmental/peritoneal disease, and aorto/iliac/mesenteric/renal vascular abnormalities.
17. HSG findings including fallopian tube obstruction, uterine synechiae, salpingitis, uterine anomalies, submucosal fibroids, and adenomyosis.
18. The adenoma to carcinoma sequence in colorectal cancer and the importance and goals of screening for colorectal cancer.
19. Improved performance on national or departmental in-service exams.

C. Practice-based Learning and Improvement

At the end of the mid-level rotations in abdominal radiology, the resident will demonstrate that he or she can:

1. Engage the faculty in more advanced discussion about the resident's own preliminary interpretation of the case and, conjointly with the faculty attending, involve other attendings for second opinions.
2. Document with increasing sophistication any potential procedural or other complications in the medical record and through the appropriate hospital risk management system with minimal/occasional need for assistance from the faculty (applies to Professionalism also).
3. Bring cases to show other residents as unknowns for the departmental case conference(s). Be prepared to discuss the findings with a specific focus on "why the case is challenging to most of us" and play an active role in instructing the more junior residents.
4. Participate in the department's QA/QI conference by actively suggesting and discussing cases with a moderate degree of sophistication.
5. Maintain a procedure log detailing all invasive procedures performed by the resident including his or her role, complications, preceptor name, and date.

D. Interpersonal and Communications Skills

At the end of the mid-level rotations in abdominal radiology, the resident will demonstrate that he or she can:

1. Communicate with the technologist about any special or additional views that should be obtained to demonstrate the pathology identified.
2. Generate a coherent, logical report reflecting the review session and discussion with the radiology faculty for most cases without assistance.

3. Maintain his or her commitment to communicate to the referring physician on the day of the exam any significant abnormalities identified on the examination AND document in the report who was called and the date and time.
4. Discuss the findings and literature for complex cases at the departmental case conference(s), and teach the more junior residents.
5. Explain all procedures to patients and their families and obtain informed consent with minimal assistance from the faculty for all but the most complex invasive procedures (if this is consistent with specific departmental policy for that procedure).
6. Confidently determine if the clinical situation/scenario for specific patients warrants the study requested, and offer alternatives after discussion with the faculty.
7. Accurately, logically, and concisely present findings at Tumor Board or other multidisciplinary interdepartmental conferences, and answer questions with some assistance from the radiology faculty in attendance.
8. Continue reporting critical test results.

E. Professionalism

At the end of the mid-level rotations in abdominal radiology, the resident will demonstrate that he or she can:

1. Arrive on time and fulfill the clinical and educational tasks necessary as part of the daily routine. This includes looking up relevant articles, completing background reading, attending all intradepartmental conferences and representing the department at those interdepartmental conferences relevant to the abdominal radiology services.
2. When consulting with referring physicians or house staff, recognize his or her own limitations and seek input from radiology faculty.
3. Obtain informed consent for an invasive procedure with greater independence than an early rotation resident (if this is consistent with specific departmental policy for that procedure) including doing so compassionately and without ethnic, religious, or sexual bias, explaining the procedure's risks, benefits, alternatives, and addressing all of the patient's concerns.
4. Comply with HIPAA and all state confidentiality rules.
5. Comply with all IRB rules (if the resident has become involved in research by their mid-level rotation).
6. Be proactive in collecting information for all multidisciplinary conferences such as the institutional Tumor Board and the Armed Forces Institute of Pathology.
7. Proactively contribute cases to the teaching file.

F. Systems-based Practice

At the end of the mid-level rotations in abdominal radiology, the resident will demonstrate that he or she can:

1. Begin using the resources of our professional organizations ACR, ARRS, or RSNA.

2. Attend the teaching sessions (and win the resident quiz if applicable) of the local radiology society.
3. Identify systems-based operational challenges within the department and engage the faculty in discussions how to affect changes that would be beneficial in abdominal radiology or the department as a whole and work on a specific project that will benefit operations in the department or operations within the hospital, or which benefits organized radiology.

GOALS: ADVANCED LEVEL ROTATIONS

After completion of the advanced abdominal CT/MRI and GI/GU rotations (approximately 20-30 weeks), and in addition to those goals listed for the early and mid-level rotations, the resident should show further progression with the need for little supervision, and be able to:

1. Demonstrate learning of the organ-based medical knowledge objectives cited below.
2. After determining the appropriateness of the examination and collecting the background clinical information, protocol all abdominal CT's and abdominal MRI scans.
3. Understand more advanced safety principles for CT and MRI including administration of iodine-based contrast and gadolinium-based contrast to patients with varying degrees of renal failure.
4. Protocol all fluoroscopic studies.
5. Produce acceptably low dose fluoroscopic exams and play an active role in producing low dose CT exams in young patients or those that may be pregnant.
6. Pre-dictate accurate, concise, and timely radiology reports on all including complex abdominal radiographs, fluoroscopic procedures, CT scans, and MRI scans before faculty review.
7. Participate in QA/QI conferences and regularly bring increasingly advanced abdominal cases to the departmental case conference(s) and play an active role in instructing the more junior residents and informing the senior residents and faculty.
8. Perform and track invasive procedures performed with the abdominal imaging faculty reflecting increasing numbers and/or complexity compared to a mid-level resident.
9. Perform at the average or better on national in-service exams or the clinical/written exam administered by the American Board of Radiology.
1. Even for the most complex cases, determine if an abdominal CT or MRI scan is appropriate to answer the clinical question and if that scan has been ordered appropriately. Discuss with clinical teams alternative imaging techniques that may be needed and work with colleagues within radiology to optimize those studies.
2. Protocol all abdominal CT cases and direct the technologists to perform appropriate/additional/delayed views as needed. Examples of advanced protocols would be use of delayed views to identify cholangiocarcinoma or "wash-out" of contrast from hepatocellular carcinoma. Understand the concepts of iodine dose and iodine flux as they pertain to dosing and injection rate considerations for individual patients.
3. Recognize all common anatomic variants and pseudotumors of the GI and GU tract.
4. Recognize subtle artifacts or physiological variations and the implications of those artifacts on diagnostic scan quality (eg, inability to detect subtle hypovascular hepatic lesions in the arterial phase, medullary renal tumors in the corticomedullary phase, or hypovascular metastases in a liver with significant fatty replacement), and take steps to correct these deficiencies.
5. Recognize the all of the entities in Section B of Medical Knowledge with a high degree of accuracy including their variations.
6. Perform abdominal biopsy/drainage procedures with supervision, but with minimal direction by the faculty.
7. Review history of the patient for whom a fluoroscopic procedure has been ordered and determine the appropriateness of the study requested with no assistance from the faculty.
8. Select the appropriate contrast agents to use for fluoroscopic procedures with no assistance of the faculty.
9. Perform esophagrams, barium swallowing function studies, single-contrast upper GI, double-contrast upper GI with no assistance. Identify subtle abnormal findings at the time of fluoroscopy, without help of the radiology faculty.
10. Perform and HSG or cystogram with no assistance from the supervising faculty. Identify significant abnormal findings, at the time of fluoroscopy without help of the supervising radiology faculty.
11. Perform barium enemas, retrograde urethrograms, loopograms, and GI fistulograms with no assistance from the supervising radiology faculty.
12. Demonstrate sensitivity to fluoroscopic dose by recording fluoroscopy times in the fluoroscopy wet reading log and producing appropriately low-dose exams.
13. Screen patients and identify those at risk from iodinated contrast or gadolinium-based contrast. Make further recommendations for alternative exams or modifications of the exam protocol with no assistance from the radiology faculty.
14. Comfortably correlate abdominal CT and positron emission tomography/CT findings in almost all instances.

SPECIFIC OBJECTIVES/BENCHMARKS ADVANCED-LEVEL ROTATIONS

A. Patient Care

At the end of the advanced-level rotations in abdominal radiology, the resident will demonstrate that he or she can:

15. Be able to create sophisticated volume-rendered views or fly-through images using the PACS or independent workstations.

B. Medical Knowledge

At the end of the advanced-level rotations in abdominal radiology, the resident will demonstrate that he or she has mastered all knowledge of a mid-level resident in addition to:

1. All of the medical knowledge topics identified in the attached website links in addition to the following;
2. Further understanding of anatomy and the anatomic spaces compared to a mid-level resident.
3. More advanced physics of helical (multirow) CT image acquisition than a mid-level resident and advanced MRI acquisition techniques such as parallel imaging and diffusion weighted imaging.
4. Expanded knowledge of principles for contrast administration and protocol design allowing customization of exams in all circumstances the resident may encounter.
5. Expanded ALARA knowledge for CT so the resident may calculate and interpret the significance of effective dose from the displayed exam parameters such as dose-length product or CTDIvol.
6. Elements of an advanced CT report, including proper descriptive terms for complex and all abnormalities.
7. Expanded recognition of variations in the multimodality appearance of all abdominal abnormalities described for the early- and mid-level rotations in addition to:
 - Multisystem diseases that affect the GI and GU tracts such as collagen vascular, infectious, and other systemic diseases.
 - Retroperitoneal tumors.
 - Hepatic, renal, and pancreatic transplant complications.
 - Staging of GI tumors.
 - Neuroendocrine tumors of the GI tract.
 - Differential diagnosis of nodular lesions in the cirrhotic liver.
 - Complications of inflammatory bowel disease.
 - Complications of and diseases which mimic primary sclerosing cholangitis.
 - Complex cystic renal masses and the Bosniak classification.
 - Variations of pyelonephritis such as xanthogranulomatous pyelonephritis.
 - Staging of GU tract tumors.
 - CT and MRI differentiation of adrenal masses.
 - Congenital anomalies of the GU tract such as crossed-fused ectopia, renal collecting system duplications, and renal tubular ectasia.
 - Surgical treatments for renal cell carcinoma and transitional cell carcinoma of the upper or lower tract.
 - Pelvic floor anatomic and functional disorders as seen on cystography or GI fluoroscopy/defecography.

- Uterine anomalies and their fertility implications and relationships to other GU tract anomalies.
8. Typical findings and appearances of colonic polyps and other lesions on CT colonography.
 9. Perform at the average or better on national in-service exams or the clinical/written exam administered by the American Board of Radiology.

C. Practice-based Learning and Improvement

At the end of the advanced-level rotations in abdominal radiology, the resident will demonstrate that he or she can:

1. Engage the faculty in more advanced discussion about the resident's own preliminary interpretation of the case and, conjointly with the faculty, involve other abdominal faculty members for second opinions.
2. Document with increasing sophistication any potential procedural or other complications in the medical record and through the appropriate hospital risk-management system.
3. Bring cases to show other residents as unknowns for the departmental case conference(s), and be prepared to discuss the findings with a specific focus on "why the case is challenging to most of us" so as to stimulate discussion at the level of the advanced residents and faculty.
4. Participate in the department's QA/QI conference by actively suggesting and discussing cases with a high level of sophistication.
5. Continue to maintain a procedure log detailing all invasive procedures performed by the resident including his or her role, complications, preceptor name, and date, showing an increasing number or complexity as compared to a mid-level resident.

D. Interpersonal and Communications Skills

At the end of the advanced-level rotations in abdominal radiology, the resident will demonstrate that he or she can:

1. Communicate with the technologist about any special or additional views that should be obtained to demonstrate the pathology identified.
2. Pre-dictate a coherent, logical report which agrees with the faculty's findings discussed in the review session for almost all cases without assistance of the supervising faculty.
3. Maintain his or her commitment to communicate to the referring physician on the day of the exam any significant abnormalities identified on the examination AND document in the report who was called and the date and time.
4. Discuss the findings and literature for complex cases at the departmental case conference(s), and teach all levels of residents and faculty.
5. Explain all procedures to patients and their families and obtain informed consent independently from the faculty for all invasive procedures (if this is consistent with specific departmental policy for that procedure).

6. Confidently determine if the clinical situation/scenario for specific patients warrants the study requested, and if not, logically be able to communicate other alternatives including advanced imaging studies such as CT, MRI, positron emission tomography/CT, single photon emission CT/CT or other advanced imaging studies.
7. Accurately, logically, and concisely present findings at Tumor Board or other multidisciplinary interdepartmental conferences, and answer questions with no assistance from the radiology faculty in attendance.
8. Continue reporting critical test results.

E. Professionalism

At the end of the advanced rotations in abdominal radiology, the resident will demonstrate that he or she can:

1. Arrive on time and fulfill the clinical and educational tasks necessary as part of the daily routine. This includes looking up relevant articles, completing background reading, attending all intradepartmental conferences and representing the department at those interdepartmental conferences relevant to the abdominal radiology services.
2. When consulting with referring physicians or house staff, recognize his or her own limitations and seek input from radiology faculty.
3. Obtain informed consent for an invasive procedure with greater independence than a mid-level resident (if this is consistent with specific departmental policy for that procedure) including doing so compassionately and without ethnic, religious, or sexual bias, explaining the procedure's risks, benefits, alternatives, and addressing all of the patient's concerns.
4. Comply with HIPAA and all state confidentiality rules.
5. Comply with all IRB rules.
6. Play an expanded role in interdepartmental multidisciplinary conferences and conferences such as for medical and surgical house staff educational sessions.
7. Continue to contribute teaching file cases.

8. Complete all Chief Resident assignments relevant to abdominal imaging or the department as a whole.

F. Systems-based Practice

At the end of the advanced-level rotations in abdominal radiology, the resident will demonstrate that he or she can:

1. Comfortably use the resources of our professional organizations ACR, ARRS, or RSNA.
2. Continue to attend the teaching sessions (and win the resident quiz more than once if applicable) of the local radiology society.
3. Complete a systems-based practice project.
4. Attend a national meeting such as the Association of University Radiologists or ACR where educational, administrative, or economics issues are reviewed.

Web site links containing complete listing of additional medical knowledge objectives follow.

Society of Gastrointestinal Radiology Curriculum: <http://www.apdr.org/directors/upload/Gastrointestinal.pdf>

Society of Uroradiology Curriculum: <http://www.apdr.org/directors/upload/Genitourinary.pdf>

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2. Collins J, Rosado de Christenson M, Gray L, et al. General competencies in radiology residency training: definitions, skills, education, and assessment. *Acad Radiol* 2002; 9:721-726.
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4. Society of Gastrointestinal Radiology Curriculum. Available at: <http://www.apdr.org/directors/upload/Gastrointestinal.pdf>. Accessed January 15, 2009.
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