SOCIETY OF URORADIOLOGY GUIDELINES FOR RESIDENT CURRICULUM AND TRAINING IN GENITOURINARY RADIOLOGY

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SUR RESIDENT CURRICULUM COMMITTEE

1. MISSION STATEMENT

The Society of Uroradiology (SUR) advances genitourinary tract imaging, image guided interventions, and the study of the normal and abnormal genitourinary tract as a clinical specialty. The Society therefore has specific interest in all aspects of the practice of genitourinary tract imaging, including the training of physicians for such clinical practice. SUR members have made significant contributions to imaging diagnosis of the genitourinary tract through teaching, research, and peer reviewed publications. The Society provides a unique repository of knowledge and experience relevant to the training of residents in the practice of imaging diagnosis and treatment of genitourinary tract disorders.

The mission of the SUR Resident Curriculum Committee is to provide Radiology Residency Program Directors, Residency Training Coordinators and all relevant educators in Radiology with a set of recommendations for the education of Radiology residents in genitourinary imaging during residency training. Though drawn from the subspecialty expertise and perspective of the SUR, these recommendations are intended to address the requisites for competent practice of genitourinary imaging in clinical Radiology practice.

Along with aspects specific to genitourinary imaging, diagnosis, and treatment, these recommendations include general elements of radiology residency education (such as professional conduct, ethics, communication and consultation skills, quality improvement, cost effectiveness etc). Basic anatomic and pathophysiologic understanding of genitourinary disorders, technical skills, and optimum selection, performance and interpretation of imaging studies appropriate for such disorders are emphasized. It is not the intention to create a textbook, but rather a guide for the necessary and sufficient fund of knowledge for training, and a repository of resource materials that are current and updated and in keeping with this mission.

The goal of these recommendations will be to assist educators in the effective training and preparation of residents for the practice of clinical genitourinary tract imaging diagnosis. We aim to provide a solid fund of knowledge and learning skills needed to engage in lifelong learning. In so doing, the educators are simultaneously preparing their trainees for standardized testing of competence including the American Board of Radiology written and oral examinations. The result should be to elevate the qualifications of each candidate by virtue of this fund of knowledge and proficiency.

The recommendations of the committee are to be codified in a living document that must be continuously revised to reflect new developments in genitourinary imaging. These recommendations may include but may not be limited to: basic principles of genitourinary tract function and disease, imaging methods and the details of performance necessary for accurate genitourinary tract diagnosis and treatment, methods for assessment of the medical literature, activities that should be learned and performed in
residency and afterward, and preparation for continuous medical education following residency training.

2. GUIDELINES FOR EVALUATION OF COMPETENCY

CORE RESIDENCY

1. Patient care

Residents should provide patient care through safe, efficient, appropriately utilized and quality-controlled diagnostic and/or interventional radiology techniques.

This should include:

a. Training and clinical experience in the acquisition and interpretation of conventional radiography, computed tomography, magnetic resonance imaging, ultrasonography, angiography, and nuclear radiology examinations of the genitourinary tract in adults and children
b. Training and clinical experience in the performance, interpretation, and management of complications related to vascular and non-vascular interventional procedures
c. Effective and timely communication of results
d. Maintenance of current basic life-support (BLS) certification. Advanced cardiac life-support (ACLS) training is recommended.

2. Medical knowledge

Residents should be familiar with evolving biomedical, clinical, epidemiological and social behavioral sciences, as well as the application of this knowledge to patient care. A core didactic curriculum in genitourinary radiology should be repeated at least every 2 years.

This should include:

a. Anatomy, physiology, disease processes, and imaging for all ages
b. Diagnostic radiologic physics, instrumentation, and radiation biology
c. Patient and medical personnel safety (radiation protection) and MRI safety
d. Biologic and pharmacologic actions of materials administered in diagnostic and therapeutic procedures
e. Fundamentals of molecular imaging
f. Appropriate imaging utilization (proper sequencing; cost-benefit analysis)
g. Radiologic/pathologic correlation (ACR or American Institute for Radiologic Pathology (AIRP) course or at the trainee’s institution)
h. Use of needles, catheters, and other devices employed in invasive image based diagnostic and therapeutic procedures
i. Socioeconomics of radiologic practice
j. Professionalism and ethics
3. Practice based learning and improvement

Residents must demonstrate the ability to investigate and evaluate their care of patients, to appraise and assimilate scientific evidence, and to continuously improve patient care.

Residents should be able to:

a. Apply acquired knowledge to new situations
b. Recognize limitations in personal knowledge and skills
c. Demonstrate initiative in correcting errors in interpretation and reporting
d. Demonstrate application of outside reading to daily practice
e. Assimilate evidence from scientific studies related to their patients’ health problems
e. Obtain follow-up on studies interpreted and recommendations made
f. Attend QA and case discussion conferences
g. Actively participate in a practice quality improvement project

4. Interpersonal and communication skills

Residents must demonstrate interpersonal and communication skills that result in the effective exchange of information and collaboration with patients, their families and health professionals.

Residents should be able to:

a. Communicate clearly and effectively with all attending and trainee radiologists, technologists, nurses and administrative personnel
b. Create reports that are grammatically correct, easy to understand, informative and concise using appropriate imaging terminology avoiding acronyms and abbreviations
c. Report appropriate recommendations for follow up or further imaging
d. Communicate findings and recommendations effectively to referring providers and document this communications in medical records or imaging reports
e. Directly communicate urgent and unexpected findings with referring providers and document this communications in medical records or imaging reports as needed and complying with individual institution guidelines
f. Demonstrate skills in obtaining written and verbal informed consent
g. Participate in multidisciplinary conferences and radiological case presentations

5. Professionalism

Residents must demonstrate a commitment to carrying out professional responsibilities, adherence to ethical principles, and sensitivity to diversity.
Residents should be able to:

a. Demonstrate altruism, compassion, integrity and a commitment to excellence
b. Be honest, ethical and interact civilly with others
c. Avoid conflicts of interest when accepting gifts in the work context
d. Interact with others without discriminating on the basis of religious, ethnic, cultural, or socioeconomic differences and without employing sexual or any other types of harassment
e. Show sensitivity to issues of impairment (i.e. physical, mental and alcohol and substance abuse) and awareness of obligations for impaired physician reporting, and resources available for their care
f. Adhere to codes of confidentiality with all information related to a patient’s health care record
g. Practice positive work habits, including punctuality, reliability and professional appearance
h. Know and apply the broad principles of biomedical ethics and regulations regarding the use of human subjects in research

6. System Based Practice

Residents must demonstrate an awareness and responsiveness to the larger context of the health system care and the ability to effectively call on infrastructure resources to provide optimal care.

Residents should be able to:

a. Actively seek out information and practice cost effective care plans based on scientific evidence and consensus statements of best practices
b. Understand the sources financing U.S. health care including Medicare, Medicaid, the Veteran’s Affairs and Department of Defense, public health systems, employer-based private health plans, and individual private funding
c. Appreciate the goals and guidelines of the national, regional and local physician societies applicable to his or her practice
d. Recognize the roles and rulings of the major regulatory entities including the institutional credentialing committee, the state medical licensing authority, Centers for Medicaid and Medicare Services (CMS), Food and Drug Administration (FDA), Office for Human Research Protections and the Joint Commission for the Accreditation of Healthcare Organizations (JCAHO)

Evaluation of competencies

1. Objective assessment required during or after each rotation using multiple evaluators, including faculty, staff, peers, nurses, technicians, allied health professionals and patients with documentation.
2. Documentation of progressive resident performance, appropriate to year of training.
### General competencies

<table>
<thead>
<tr>
<th></th>
<th>Global faculty evaluation</th>
<th>360° evaluation</th>
<th>Other</th>
</tr>
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<tbody>
<tr>
<td>Patient care</td>
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<td></td>
<td>Case/procedure log</td>
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<tr>
<td>Medical knowledge</td>
<td>Yes</td>
<td></td>
<td>Documentation of conferences, courses, meetings attended and yearly examination</td>
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<tr>
<td>Practice based learning and improvement</td>
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<td>Annual resident self-assessment and learning plan</td>
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<td>Documentation of participation in QA and case discussion conferences</td>
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<tr>
<td>Interpersonal and communication skills</td>
<td>Yes</td>
<td>Yes</td>
<td>Formal evaluation of reports</td>
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<tr>
<td>Professionalism</td>
<td>Yes</td>
<td>Yes</td>
<td>Compliance with institutional and national policies</td>
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<tr>
<td>Systems-based practice</td>
<td>Yes</td>
<td></td>
<td>Documentation of a learning activity that involves deriving a solution to a systems related problem at the departmental, institutional, local or national level</td>
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<tr>
<td>Scholarly activity</td>
<td></td>
<td></td>
<td>Documentation of publications, presentations, research</td>
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Source: ACGME Accessed Dec 26, 2011


http://www.acgme.org/acWebsite/RRC_420/420_prIndex.asp

### 3. BENCHMARKS BY YEAR OF TRAINING

Introduction:
The Genitourinary (GU) Radiology residency training program spans a minimum of 4 academic years. The curriculum is designed to achieve graded responsibility and an increasing fund of knowledge in GU Radiology. The goal is for each resident to achieve independent competency and to acquire the tools with which to continue self-education and life-long learning techniques. Furthermore, the level of practice should be consistent with national community standards as outlined in the American College of Radiology (ACR) Practice Guidelines.
It is difficult to isolate the practice of GU Radiology into packets of skills and knowledge for each year and each clinical rotation that can be used in the varied environments and institutions that provide residency training. What follows is a general guide for residents and program directors for meeting the expectation thresholds for each academic year. Sometimes the order in which these skills are acquired will vary. For example, learning about CT or MRI might precede training in fluoroscopy or radiography. However, all of these benchmarks should be met by the time of completion of residency training.

Emphasis throughout the four-year residency program should be on understanding the pathophysiology of diseases and disorders, and its appearance across all appropriate imaging modalities.

**Year 1**
Goal: To prepare the resident to be able to safely practice with supervision during the week days and independently while on call by the end of the first year.

Objectives:

**Contrast Material:**

1. Understand the physical properties of iodinated contrast media and the physiologic mechanisms of contrast media excretion.
2. Learn to screen patients who are at risk from injection of intravascular radiographic contrast material. Understand the classification, symptoms, and signs of contrast reactions and clinical management including appropriate use of pharmacologic agents and their mode of administration and doses after appropriate patient assessment. Understand the risk factors for contrast nephrotoxicity and the methods to minimize its incidence.
   b. Be prepared to answer patient and staff questions concerning when contrast media should or should not be utilized and how to treat contrast reactions.
3. Understand the indications for premedication and the appropriate regimen to premedicate contrast sensitive patients including dosages, and dose scheduling.

**Knowledge Based Objectives:**

1. Review the anatomy of the male and female genitourinary systems.
2. Understand the appearance of GU structures on the basic imaging modalities using not only plain film radiography such as intravenous urography (IVU), voiding cistourethrography (VCUG), retrograde ureterography (RUG), but also in ultrasound, computed tomography (CT), and magnetic resonance imaging (MRI), including dedicated CT urography and MR urography examinations.
3. Learn conventional imaging protocols of the urinary tract e.g. IVU, RUG, VCUG, retrograde urethrography (RUG), and hysterosalpingography (HSG). For IVU, the resident should know:
   a. indications and contraindications for use of abdominal compression.
b. routine views and additional films required to achieve the tailored urogram

4. Be able to interpret, identify and/or manage the following with imaging:
   a. plain abdominal films for bowel gas pattern and recognition of masses and calcifications
   b. basic cross sectional urinary tract anatomy on CT/CT Urography and MRI/MR Urography and recognition of below pathology using multimodality imaging
   c. renal colic and renal stone disease
   d. hydronephrosis and ureteral obstruction
   e. urothelial abnormalities including collecting system, ureter, and bladder
   f. renal cysts and tumors
   g. medullary sponge kidney
   h. benign prostatic hyperplasia
   i. bladder diverticula, bladder rupture, neurogenic bladder
   j. urethral strictures, urethral diverticula
   k. cancer of the cervix, uterus, and ovaries; hysterosalpingographic appearance of intravasation, hydrosalphinx, salpingitis isthmica nodosum, uterine synechiae, filling defects such as polyps and submucosal leiomyomas, the endometrial cavity exposed to diethylstilbestrol (DES), and congenital anomalies

5. Understand the relationship between contrast administration and pathophysiology of diseases/conditions including:
   a. dynamic contrast enhancement on cross sectional imaging studies and IVU
   b. dynamic contrast enhancement CT or MR used for tumor diagnosis and post treatment effect
   c. dynamic contrast enhancement for arteriovenous shunt diagnosis
   d. parenchymal phase imaging CT/MR for inflammatory manifestations of renal parenchyma
   e. tissue viability and revascularization in trauma

6. Learn that imaging during the different phases of contrast excretion offers not only information about morphology but also function (e.g. disparity in the phases between the two kidneys indicating either obstruction or abnormal perfusion with IVU, CT, MRI, angiography, etc.

**Technical Skills:**
1. Interview patients prior to radiographic contrast injection
2. Be familiar with fluoroscopic techniques and safe operation of the fluoroscopic unit.
3. Learn to perform IVU, VCUG and routine cystography, and RUG
4. Learn to compose a concise GU dictated report. Begin to function as a consultant to referring physicians and patients involved in GU studies.
5. Learn the importance of calling the referring physician with significant and/or unexpected findings, as well as document all verbal communications.

References for 1st year

**Year 2**

Goal: To add to the residents’ fund of knowledge of GU disease and imaging modalities while gaining more confidence.

**Objectives:**

1. Review the general developmental anatomy of the GU system.
2. Refine the technique and performance of IVU, VCUG and routine cystography, and RUG.
3. Expand the understanding of the causes and effects of renal colic, renal stone disease, and hydronephrosis.
4. Expand the understanding of renal cysts and tumors to include:
   a. the Bosniak Classification system (or another similar system) for evaluating cystic renal masses and implications for management of complex renal cysts.
   b. the imaging and staging of malignancies of the genitourinary organs including renal, urothelial, prostate, endometrial, cervical, and ovarian cancers.
   c. the multi-cystic renal diseases including genetic syndromes such as autosomal dominant adult polycystic renal disease.
5. Recognize a large variety of congenital abnormalities of the GU tract, especially those which are most common e.g. fusion anomalies (such as horseshoe kidney, crossed fused renal ectopia, ectopic kidneys including pelvic and thoracic), partial and complete duplications of the collecting systems, renal tubular ectasia (medullary sponge kidney or MSK), renal agenesis, and diverticula.
6. Understand use of conventional GU imaging and transrectal ultrasound of the prostate (TRUS) to image the lower GU tract, especially the
   a. zonal anatomy of the prostate as seen on TRUS
   b. technique of TRUS, diagnosis, basic principles of the pathophysiology, and management of prostate cancer, prostatic intraepithelial neoplasia, benign prostatic hyperplasia, and prostatitis.
   c. A basic understanding of Gleason grading of prostate cancer and of prostate cancer staging.
7. Understand diagnosis, classification, and management of GU trauma and principles of imaging, including
a. identification of the bulbomembranous urethral junction on urethrography, as well as common abnormalities including urethral trauma, rupture, and strictures
b. bladder, ureteral, and renal injuries
c. techniques of retrograde urethrography, conventional cystography, and CT (including CT cystography) in patients with suspected urethral or bladder trauma

8. Understand ultrasound imaging diagnosis, management, and prognosis of testicular and extratesticular disorders.

9. Understand US and MR techniques and diagnosis of female pelvic disorders including
   a. pelvic inflammatory disease - e.g. tuboovarian abscess, endometriosis
   b. ovarian cysts and malignant masses
   c. uterine fibroids and adenomyosis

10. Understand the protocol for performance of loopograms, vaginograms, and retrograde ureteropyelograms, and the postoperative anatomy of the continent diversion, loop diversion, repaired urethral strictures, and artificial urinary sphincters

11. Understand the importance of the timing of the scans for dedicated contrast enhanced CT and MR imaging of the kidneys to include the corticomedullary, nephrographic, and excretory phases.

12. Be aware of the approximate patient radiation doses of GU radiographic x-ray procedures, especially IVU, renal stone CT, conventional CT, and CT urography

13. Further refinement of dictation skills, so that dictations are becoming concise but complete.

References for 2nd year

Year 3:
Goal:
Add to general knowledge acquired in the first two years and learn more advanced and less common techniques and disorders.

Objectives:
Knowledge Based Objectives

1. Learn about the different types of renal and ureteral injuries and their classification as well as the recommended non-surgical and surgical management and injury prognosis.

2. Understand the anatomy of urinary diversions and reservoirs and how they differ.

3. Increase awareness of the CT manifestations of genitourinary tract disease.
   a) Knowledge of different types of renal neoplasms (including subtypes of renal cancer) and their CT appearances
   b) Understand the technique of CT urography and be able to recognize the CT urographic appearances of a variety of malignant and benign urinary tract abnormalities.

4. Understand normal MRI findings of the adrenals, kidneys, bladder, prostate, and female pelvic organs and MRI spectroscopic findings in the normal prostate.

5. Learn the anatomy and disorders of the retroperitoneum, including
   a) retroperitoneal fibrosis
   b) lymphoma
   c) liposarcoma and other mesenchymal tumors
   d) extra renal angiomyolipoma as distinguished from retroperitoneal liposarcoma

6. Understand and learn diagnosis of the multiple manifestations of renal and retroperitoneal inflammatory disease as seen on US, CT / CT Urography, MR / MR Urography and their clinical management including
   a) acute pyelonephritis
   b) renal and perirenal abscess
   c) xanthogranulomatous pyelonephritis
   d) emphysematous pyelitis and pyelonephritis

7. Understand patterns of genitourinary differential diagnosis such as for renal masses, uni- or bilateral renal enlargement, filling defects, ureteral deviation (both medial and lateral), bladder enlargement, bladder displacement, etc.

8. Understand the various options for treatment of renal neoplasm, including open surgery, laparoscopic nephrectomy, partial nephrectomy, and percutaneous ablation, including awareness of selection and exclusion criteria for and commonly encountered complications of percutaneous
ablations, as well as findings on follow up imaging studies that indicate successful ablation versus recurrent tumor.

9. Understand patterns of genitourinary differential diagnoses, such as for renal masses, uni- or bilateral renal enlargement, filling defects, ureteral deviation (both medial and lateral), bladder enlargement, bladder displacement, etc.

10. Begin to correlate diagnostic genitourinary imaging with other radiologic subspecialties, particularly angiography and interventional radiology. Be able to move from diagnostic GU imaging to recommendations for angiography (for example, in renal vascular injury or post-biopsy hemorrhage), interventional GU procedures (such as percutaneous nephrostomy or nephrostolithotomy), and drainage procedures (such as for renal or perirenal abscess). In some institutions, these skills may be learned directly during genitourinary imaging rotations while in others they may be taught separately; regardless, the resident must begin to synthesize all subspecialties and modalities to image and treat the whole patient.

Technical Skills
1. Learn the technique and indications for performing saline infusion sonohysterography.

2. Become familiar with ultrasound guided prostate biopsy. Learn about the technique for performing ultrasound guided prostate biopsy.

3. Become more familiar with the indications for and utility of renal mass biopsy, including limitations of biopsy in differentiating among various renal neoplasms. Learn about the technique for performing both random and targeted renal biopsies under US and CT guidance.

4. Begin to use the independent workstation for image reformatting and reconstruction, particularly for CT, CTU, and CT angiography (CTA), as well as MR, MRU, and MR angiography (MRA).

References for 3rd year:
Body MRI, Siegelman ES
Practical Guide to Abdominal and Pelvic MRI
John R. Leyendecker, Jeffrey J. Brown
Lippincott Williams & Wilkins; 1 edition (February 18, 2004)

Year 4
Goal:
Review all the knowledge and skills accumulated in the first three years and
fill in the gaps in knowledge. Focus on getting as much case management experience as possible.

Objectives:

Knowledge Based Objectives

1. Understand congenital anomalies, inflammatory, and neoplastic conditions as they appear on hysterosalpingography, US, CT, and MR.

2. Understand effects of vasculitic conditions of the kidneys as they appear on CT, MR, and angiography.

3. Learn the imaging work up and eligibility criteria for living renal donors.

4. Become familiar with the normal postoperative appearance of renal transplants on US, CT, and MR. Also learn the normal early and late postoperative appearance of renal transplants as well as the appearance of postoperative complications such as urinomas, lymphoceles, abscesses, hydronephrosis, renal artery stenosis, rejection, etc.

5. Increase knowledge regarding the indications for MR imaging evaluation of the lower genitourinary tract, including the bladder, urethra, vagina, penis, and scrotum.

6. Understand the technique and interpretation of MR imaging of pelvic floor disorders.

7. Increase knowledge regarding the application of more advanced MR imaging techniques to GU radiology including diffusion weighted imaging (DWI) for renal and pelvic masses, dynamic contrast enhancement (DCE) for oncology applications and functional imaging and MR spectroscopy for prostate cancer.

8. Review cases in the ACR teaching file and peer reviewed teaching files available on the internet. The best sites should present as unknown cases, asking for you to make a diagnosis and suggest recommended imaging and clinical management, summarizing the correct diagnosis and management at the end.

9. Attend, and, if possible, participate in available department case conferences or other didactic presentations, including interdepartmental conferences, grand rounds, guest lecturers, etc.

10. Emphasize independent thinking before seeking direct staff supervised patient management.

11. Understand the basic principles of radiofrequency ablation, thermocoagulation, and other minimally invasive procedures, along with the appropriate imaging guidance and post treatment surveillance.
Technical Skills

1. Develop proficiency at image reconstruction and reformatting for CT, CTU, CTA, MR, MRU, MRA, etc.

References for 4th Year


4. Safety: Patient Care, Radiation Protection and Safety, Contrast Media, Contrast Reactions

PATIENT SAFETY

Quality Assurance:
Adverse healthcare events are a leading cause of death and injury. While controversial, it has been estimated that at least 44,000 and perhaps as many as 98,000 Americans die each year because of medical errors. [1-3] Effective guidelines are required to reduce the
likelihood of harm to the patient or the healthcare provider. It is necessary to establish a quality assurance program that includes teaching residents principles of quality assurance with special emphasis on patient safety.

The following principles apply for Radiology residency training programs.

1. Create a culture of safety. Promote a culture that encourages the reporting of any situation that threatens or potentially threatens the safety of patients or caregivers.
2. Teach the appropriate use of personal protective equipment such as gloves, masks, gowns, surgical caps, eye protection and face shields in accordance with OSHA regulations.
3. Provide training in radiation safety, magnetic resonance and ultrasound safety and the risks/benefits related to contrast media.
4. Ensure that results of a study are communicated in a timely manner, in a clearly understandable form and when appropriate, acknowledged by the healthcare provider that he/she understands the results provided.
5. Provide training in establishing, implementing and participating in effective systems for detecting and appropriately managing errors. Minimizing the incidence and extent of active errors requires reliable reporting mechanisms coupled with policies that define mechanisms of case review and management. Educational programs, morbidity and mortality meetings, and a comprehensive and respected root cause analysis process are also essential components of this comprehensive approach. [4]
6. Provide training and certification of Health Insurance Portability and Accountability Act (HIPAA) training to ensure the integrity and confidentiality of patient information, and understand the implication of unauthorized uses or disclosure of such information i.e., non-compliance. [5-7]
7. Provide training in the technical optimization of imaging studies and in clinical practice guidelines and appropriateness criteria so that trainees can guide referring physicians and patients about diagnostic imaging techniques, eg. how to use them appropriately and cost-effectively.

The Understanding and Proper Use of ACR Appropriateness Criteria: (ACRAC):
The ACR Appropriateness Criteria contains clinical practice guidelines for appropriateness criteria using the modified Delphi technique to arrive at a consensus. It is intended to guide radiologists, referring physicians, and patients in making initial decisions about diagnostic imaging techniques, both to use them appropriately and cost-effectively.
The majority of ACRAC guidelines represent approaches to solving specific clinical problems. For every one of the several diagnoses, an expert panel produced an annotated list of imaging studies that might be used to work-up patients presenting with these problems. The annotation to each listed procedure consists of numbers ranging from 1 to
9 which are used to quantify appropriateness. A higher number denotes a procedure that is more appropriate.

The ACR Appropriateness Criteria are available electronically on the ACR web page at www.acr.org/ac-pda and as a PDA application for hand held computers.

**Discordant Film Interpretation:**
The trainee must learn the process of addressing issues related to discordant film interpretation. Several factors can result in radiology errors. The errors may be related to the patient, technical quality of the study, film identification, transcription errors, environmental factors such as ambient light, interruptions, background noise, adherence to protocol or lack thereof, reading without old films, tunnel vision etc. Discordant film interpretations and radiology errors can be addressed by periodic lectures and conducting morbidity and mortality conferences as related to the genitourinary tract to discuss the medico-legal and ethical issues.

**Correcting Errors of Cognition, Practice, and Discordance:** Reduction of medical and diagnostic errors is an important goal that can reduce morbidity and mortality. Types of diagnostic errors include no-fault errors, system errors that could be due to technical failures, organization failures, or cognitive failures.

Cognitive errors, especially those associated with failures in perception and biases, collectively have been referred to as “Cognitive Disposition to Respond”. These errors may be due to inadequate knowledge, faulty data gathering, faulty information processing or faulty meta-cognition etc., and may result in diagnostic errors. Cognitive training to improve meta-cognition, promote active open-mindedness, use of second opinions and use of clinical decision support systems can potentially reduce cognitive errors substantially. The radiology residency-training program should include formal lectures and cognitive debiasing techniques to reduce diagnostic errors in an effort to minimize diagnostic errors.

A few examples of cognitive debiasing strategies include decreased reliance on memory in favor of the use of clinical practice guidelines, algorithms and hand held computers. Simulation techniques utilizing clinical training videos contrasting incorrect (biased) approaches with the correct (debiased) approach are helpful. Rapid and reliable feedback should be provided so that errors are immediately appreciated, understood, and corrected.

The trainee should be able to remember, apply, analyze, evaluate and recognize different terminologies, definitions, and methodologies and principles as they apply to the imaging findings. [6, 8]

**Guidelines for communication:**
The trainee must be instructed about the value and significance of timely communication of important radiologic findings and documentation thereof. The radiology report should
be dictated according to the ACR guidelines. The Diagnostic Radiology Report must include the demographics of the patient with relevant clinical information. The body of the report should include the description of the study and/or procedure, and relevant findings, related to the clinical question and findings of the case. Finally, the report should end with an impression or conclusion of the relevant findings. A differential diagnosis should be given when appropriate, with the most likely diagnosis listed first. It is advisable to document that the referring health care provider has been notified and has acknowledged important findings, or clinically relevant results, even if the study is "negative" and this “negative” will alter management or insure continuation of appropriate therapy eg. patient does NOT have retroperitoneal bleed so may continue on current anticoagulation regimen.

**Informed Consent:**
The purpose of obtaining informed consent is to provide to the patient, (and when appropriate, to the family), every opportunity to understand any treatment or procedure they receive, and to have all questions answered and to fully consent to the treatments and procedures.

The resident must be familiar with the process of obtaining informed consent, both in written and oral form. It is important for the physician to understand that informed consent is a process and not the simple act of signing a formal document. The trainee should understand the obligation to inform patients of all the important aspects, risks, and benefits of a treatment and/or procedure.

The resident physician must understand that failure to obtain adequate informed consent renders the physician liable for negligence or battery, and likely constitutes medical malpractice.

The process of informed consent for any invasive radiologic procedure should include:

1. Patient and site identification and verification.
2. The purpose/nature of the procedure or treatment. Asking the patient to recall establishing understanding, where possible adding additional stimuli, such as multimedia presentations, educational pamphlets, check lists and providing written information.
3. The method by which the procedure or treatment will be performed.
4. The risks, complication, and expected benefits or effects of such procedures/treatment.
5. The risk of not accepting the procedure.
6. Any alternatives and their risks and benefits, in general principles.
7. The right to refuse to consent.
8. Documentation should include the name of the person performing procedure.
9. Note in the medical record that a discussion was held and that informed consent was obtained and should include date and time.
10. The patient must be competent and an adult (18 years of age or older). Consent by telephone (documentation and witnessed) may be obtained from the responsible next of kin or legal custodian for the patient.
11. Emergency procedures. The resident physician must be
familiar with the protocol of treating patients in situations in which a patient is unable to give informed consent

**Verification and Site/Sidedness:**
The resident must learn to establish proper verification processes prior to start of the procedures to ensure proper patient identification eg. “time out verification procedure”. Pertinent documents must be reviewed and should be deemed consistent. The resident must have a clear understanding of the site/sidedness requirement prior to any procedure.

**Variants and Pitfalls in Genitourinary Imaging:**
Variations of genitourinary anatomy and development as well as technical artifacts inherent to the different imaging techniques may potentially present diagnostic problems and pitfalls. Correct recognition of anatomic landmarks and their variants are essential to avoid misinterpretation, errors in diagnosis, and mismanagement of patients. Therefore, familiarity with the normal anatomy and embryology is essential to avoid such mistakes. Common renal anatomic variants include persistent fetal lobulation, junctional parenchymal defects, renal hilar lip, column of Bertin etc. Recognition of congenital anomalies can be challenging. Familiarity with their diverse presentation is essential to avoid misinterpretation.

In addition, technical errors and artifacts related to image acquisition or post processing can mask significant pathology. Trainee must learn through clinical experience and/or conferences the commonly encountered artifacts and technical pitfalls of plain film radiography, ultrasonography, CT and MRI. For example, contrast timing issues that occur in CT and MRI, chemical shift artifacts, wrap around artifacts seen at MRI, post processing errors on maximum intensity projections and volume rendered images must be recognized in order to optimize image quality and reduce potential errors in diagnostic interpretation.

**Radiation Safety:**

Urological procedures can involve a substantial amount of ionizing radiation. The resident must be familiar with typical radiation dosages of fluoroscopic procedures.

The trainee must be familiar with the fundamental principles of radiation safety, methods, such as appropriate use of pulsed fluoroscopy as opposed to continuous fluoroscopy, and the appropriate use of equipment required for minimizing radiation exposure in uroradiology such as gonadal shields, collimation devices, lead aprons, etc. General philosophy of radiation protection, shielding and other measures must be provided and covered in the curriculum. The proper use of radiation dosimeters must be taught to
residents at the beginning of their training. Radiation monitoring devices must be monitored and should be routinely worn during fluoroscopic procedures and in the interventional radiology suites. [9-13]

Knowledge of The ACR White Paper on Radiation Dose in Medicine and The ACR Practice Guideline for Imaging Pregnant or Potentially Pregnant Adolescents and Women with Ionizing Radiation is required. [14-16]

Approximate Fetal Doses for CT Procedures ([17-19])

<table>
<thead>
<tr>
<th>Examination</th>
<th>Mean mSv</th>
<th>mrem</th>
<th>Maximum MSv</th>
<th>mrem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abdomen CT</td>
<td>8.0</td>
<td>800</td>
<td>49</td>
<td>4900</td>
</tr>
<tr>
<td>Pelvis CT</td>
<td>25</td>
<td>2500</td>
<td>80</td>
<td>8000</td>
</tr>
</tbody>
</table>

Approximate Fetal Doses from Radiographic and/or Fluoroscopic Procedures ([17-19])

<table>
<thead>
<tr>
<th>Examination</th>
<th>Mean mSv</th>
<th>mrem</th>
<th>Maximum MSv</th>
<th>mrem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abdomen</td>
<td>1.4</td>
<td>140</td>
<td>4.2</td>
<td>420</td>
</tr>
<tr>
<td>Intravenous urogram; lumbar spine</td>
<td>1.7</td>
<td>170</td>
<td>10</td>
<td>1000</td>
</tr>
<tr>
<td>Pelvis</td>
<td>1.1</td>
<td>110</td>
<td>4</td>
<td>400</td>
</tr>
<tr>
<td>KUB</td>
<td>2.5</td>
<td>250</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Hysterosalpingo-gram</strong></td>
<td>10</td>
<td>1000</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Approximate Whole Body Fetal Doses from Common Nuclear Medicine Procedures ([17-19])

<table>
<thead>
<tr>
<th>Examination</th>
<th>Activity (MBq)</th>
<th>Activity (mCi)</th>
<th>Early Pregnancy (mSv)</th>
<th>Early Pregnancy (mrem)</th>
<th>9 Months (mSv)</th>
<th>9 Months (mrem)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tc-99m Bone Scan</td>
<td>750</td>
<td>20</td>
<td>4.7</td>
<td>470</td>
<td>1.8</td>
<td>180</td>
</tr>
<tr>
<td>Renal DTPA</td>
<td>300</td>
<td>8</td>
<td>9.0</td>
<td>900</td>
<td>3.5</td>
<td>350</td>
</tr>
</tbody>
</table>

**Pregnancy during Residency:**
Trainees must be familiar with the guidelines of occupational exposure of the pregnant resident. Though medical centers have general policies on housestaff maternity leave, there is not yet a formal guideline or consensus for radiation exposure to the pregnant resident. [9, 13, 14, 20]

There is a proposed program guideline for radiation exposure and work responsibilities for pregnant residents from a joint project sponsored by the American Association of Women Radiologists and the Association of Program Directors in Radiology that emphasizes minimizing risk to the pregnant resident, outlines safety guidelines, and details the responsibilities of both the pregnant resident and the training program.[21]

**Recognition and Treatment of Contrast Reactions:**

The residents in training must be thoroughly familiar with the following:

A. Pathogenesis of contrast media induced adverse effects and different types of contrast reactions.

B. Risk-factors that predispose patients to having contrast reactions and a knowledge of how to screen patients and identify those at high risk for and developing contrast reactions.

C. Pre-medication protocols for patients who have a risk of contrast reactions or a history of previous reactions.

D. Signs and symptoms of major forms of contrast reactions and the specific management required for
each acute contrast media reaction.

E. Presenting signs and symptoms of such reactions and be familiar with the location of and proper use of supportive equipment and medications, as well as the dosages in the emergency kits or carts.

F. Basic cardio-pulmonary resuscitation and treatment and how to call for assistance when necessary. (Administer advanced cardiac life support if the resident is able.) [22]

Screening and Prevention of Contrast Induced Nephropathy:
Contrast medium-induced nephropathy may range in severity from asymptomatic, non-oliguric transient renal dysfunction to oliguric severe acute renal failure that necessitates dialysis. The trainee should be familiar with:

A. The definition of contrast media nephropathy, its pathogenesis, risk factors and acute and long-term effects of radiographic contrast media induced nephropathy
B. The basic methods of prevention or amelioration of contrast media induced acute renal failure
C. A basic understanding of use of contrast media as it relates to patients who are on chronic hemodialysis. [23, 24]

Additional Noteworthy literature: [25-27]

Contrast Extravasation:

Extravasation is a well-known complication of intravenous administration of contrast material for radiologic procedures. As part of the training, the resident should be familiar with:

A. Risk factors for extravasation: patient’s advanced age; patients receiving chemotherapy who may develop fragility of the vein wall; compromised venous or lymphatic drainage; low muscular mass and atrophic subcutaneous adipose tissue; the use of metallic cannulas; or multiple attempts at venipuncture.

B. Pathogenesis of extravasation injuries and related factors including: osmolality, cytotoxicity, and the volume of extravasated contrast medium. For example, some types of contrast media such as hyperosmolar contrast media or large extravasated volumes may lead to severe damage to extravascular tissue.

C. Definition of compartment syndrome: a condition characterized by increased pressure within a closed space with potential to cause permanent necrosis and damage to the contents of the closed compartment and the risk factors for compartment syndrome such as power injectors eg. injections under pressure of large volumes of contrast material or intravenous lines located in small compartment such as the hand or wrist.
D. Physical examination of an extremity and recognition of the signs and symptoms of compartment syndrome, skin ulceration, blistering, evidence of altered tissue perfusion and sensory loss.

F. Treatment for extravasated contrast media includes elevation of the limb, cold compression, prevention of secondary infection and observation.

G. Common indications for plastic surgery consultation/intervention including altered tissue perfusion and compartment syndrome.

Referring physician or health care provider caring for the patient must be notified when a patient suffers contrast extravasation. [28-30]

**Venous Air Embolism:**
Venous air embolisms have been associated with central venous catheter insertions. Most complications during CT contrast examinations are related to allergic reactions to contrast material, but iatrogenic intravenous air embolism has been reported. Immediate proper treatment is essential to avoid potentially serious fatal complications, as proper treatment is critical when large volume of air is noted in the central venous system or heart.

The resident must be familiar with signs, symptoms and management of large amount of air in the venous system and potential complications of venous air embolism and adverse effects of paradoxical air embolism.

Paradoxical air embolism in which air emboli from the venous circulation reach the systemic arterial circulation by passing through an abnormal communication between the chambers of the heart, leading to a systemic manifestation such as stroke, kidney infarction or acute limb infarction. The clinical findings of embolism depend on the site of the embolus and on the organ involved. Multi-organ ischemia and infarction can occur. Treatment includes change in position, fluids, vasopressors, increased positive end expiratory pressure and where available hyperbaric oxygen therapy.

**Thyroid Function and Iodinated Contrast Media:**
The radiology resident in training must be familiar with the potential effects of administration of iodinated contrast material upon thyroid function. Patients with Graves’ disease and multi-nodular goiter are at increased risk of thyrotoxicosis. The prevalence of contrast-induced thyrotoxicosis is significantly higher in iodine deficient areas and in the elderly.

It is also recommended that patients undergoing therapy with radioactive iodine should not receive iodinated contrast media for at least two months prior to treatment or the uptake of therapeutic agents may be suboptimal.

Radionuclide isotope imaging of the thyroid should be avoided for 2 months after iodinated contrast injection as they will be unrewarding in a thyroid bed saturated with iodinated contrast material.
To inject iodinated contrast media to patients who manifest thyrotoxicosis is an absolute contraindication. [31]

**Risks and Contraindication to the use of Gadolinium based MR Contrast Media:** [32-36]

**Nephrogenic Systemic Fibrosis**

Gadolinium based contrast agents (GBCA) that increased relaxivity were developed and released for use in the 1980’s initially for enhancement of vascularized lesions, later used for direct visualization of vessels (Magnetic Resonance Angiography MRA). The FDA approved 5 gadolinium based agents for use, initially gadopentetate dimeglumine (Gd-DTPA). All 5 agents were shown to be effective for imaging, well tolerated with lower overall side effects than iodinated contrast, and although excretion was prolonged in those with renal impairment, the GBCA did not cause deterioration of renal function. A previously unrecognized illness was reported in 2000, initially labeled nephrogenic fibrosing dermopathy (NFD), later renamed nephrogenic systemic fibrosis (NSF)

NSF predominantly involves skin and subcutaneous tissues but also affects lungs, esophagus, heart and skeletal muscles with progressive fibrosis leading to pain disability and not infrequently death. There is no known cure. The typical patient is middle aged (pediatric and elderly cases are reported) with end stage renal disease, commonly on either hemo- or peritoneal dialysis, with no gender or racial predilection reported. Some years after initial reports, a clear relationship with prior exposure to GBCA was established.

**Typical course:**
- onset few days to 3 months after exposure
- swelling, induration and pain of distal parts of extremities
- loss of flexibility, may progress to contractures and cachexia
- internal organs including heart liver lungs and diaphragm may be involved, sometimes leading to death

**NSF Etiology:**
The strongest risk factors for NSF are renal disease and exposure to intravenous GBCA. High dose exposures, with double dose for MRA, have been noted in patients with NSF as have multiple exposures leading to high cumulative dose. Most patients have had severe chronic kidney disease (CKD5/ESRD) and were commonly on dialysis. Cases have been reported with an estimated glomerular filtration rate (eGFR) <15, and less commonly reported with eGFR between 15 - 30. The incidence of NSF with eGFR > 30 is probably less than 1 %. The incidence in the highest risk category (ESRD on dialysis approximates 4%)
Cofactors

Other cofactors including metabolic acidosis, acute liver failure, abnormal iron metabolism, high dose erythropoietin treatment, immunosuppression, vasculopathy, acute pro-inflammatory event, infection have been reported but none have been absolutely established as causative. The great majority (at least 90%) of cases of NSF have occurred after exposure to gadodiamide. Other agents have also been reported to precede NSF, with some cases having had exposure to both gadodiamide as well as other agents thereby confounding the data. (See Table of Gadolinium Based Contrast Agents [GBCA]) The precise pathogenesis remains unproven.

The presence of gadolinium in affected tissues such as skin, along with activated fibroblasts and a fibroblast/inflammatory process has been documented. One theory with some supportive evidence relates to transmetallation, whereby the gadolinium ion separates from the protective chelate, and stimulates the reaction leading to the fibrosis. This theory (although unproven) can explain some possible contributory factors such as risk from renal failure, dose relationship and the data showing some agents are seemingly more commonly associated with NSF because:

- GBCA are excreted by the kidney. With renal failure, the agents circulate longer in the body, allowing for more time for transmetellation.
- Larger dose also leads to more free gadolinium.
- Agents with less stability are more prone to transmetellation.
- Gadodiamide has greater potential for transmetellation than with other agents such as the macrocyclic agents.

NSF: Patient Management

There is no cure or effective treatment for NSF. Thus careful screening is mandatory to avoid inducing NSF.

Recommendations include: [32, 33, 36, 37]

- Patients referred for MRI with GBCA should be screened for risk factors, primarily renal disease (liver failure especially acute may also merit screening).
- This may be done by interview/history but may be most reliable with laboratory testing and calculation of eGFR for risk stratification, particularly for high risk groups or in a practice where higher risk agents such as gadodiamide or gadopentetate dimeglumine are in selected use. At the time of this writing, the ACR does not mandate laboratory testing.
- No cases of NSF have been reported with normal renal function (eGFR>60) with any agent. The risk is very low with eGFR 30-60.
- Management of patients with CKD 4 or 5 (eGFR<30) is difficult; both CIN and NSF are more likely in this group from iodinated contrast or GBCA, respectively.
With eGFR 15-30, use of GBCA of a type not commonly associated with NSF may be safer than use of iodinated contrast or use of GBCA more commonly associated with NSF.

In patients with ESRD on dialysis, consideration should be for CT with iodinated contrast; if GBCA enhanced MRI is clinically necessary, then the lowest possible dose and immediate dialysis are recommended, although dialysis has not been proven to eliminate risk of NSF, and 3 treatments are needed to effectively eliminate gadolinium.

Although informing patients of the indications, and the possible risks and potential benefits of imaging in their individual cases is a reasonable practice, written informed consent has not been mandated by any group.

New and noteworthy literature: [38]

**TABLE: Gadolinium based contrast agents (adapted From ESUR Guidelines) [37]**

<table>
<thead>
<tr>
<th>Agent</th>
<th>trade name</th>
<th>ligand</th>
<th>NSF incidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gadobenate dimeglumine</td>
<td>multihance</td>
<td>ionic linear</td>
<td>no unconfounded case</td>
</tr>
<tr>
<td>Gadobutrol</td>
<td>gadovist (US)/gadavist (EU)</td>
<td>nonionic linear</td>
<td></td>
</tr>
<tr>
<td>Gadodiamide</td>
<td>omniscan</td>
<td>nonionic linear</td>
<td>3-7% if at risk</td>
</tr>
<tr>
<td>Gadofosvest trisodium</td>
<td>vasovist*</td>
<td>ionic linear</td>
<td>limited experience</td>
</tr>
<tr>
<td>Gadopentetate dimeglumine</td>
<td>magnevist</td>
<td>ionic linear</td>
<td>0.1-1% if at risk</td>
</tr>
<tr>
<td>Gadoterate meglumine</td>
<td>dotarem*</td>
<td>ionic cyclic</td>
<td>no unconfounded case</td>
</tr>
<tr>
<td>Gadoteridol</td>
<td>prohance</td>
<td>nonionic cyclic</td>
<td>no unconfounded case</td>
</tr>
<tr>
<td>Gadoversetamide</td>
<td>optimark</td>
<td>nonionic linear</td>
<td>no unconfounded case</td>
</tr>
<tr>
<td>Gadoxetate disodium</td>
<td>Eovist/Primovist</td>
<td>ionic linear</td>
<td>no unconfounded case</td>
</tr>
</tbody>
</table>

*not approved by FDA for use in USA

Confounded case means this agent used and also another agent at different exam

The ACR Version 7 of the Manual on Contrast Media [32] was published in 2010, as a web-based product. Content changes now take place as a result of changes in technology, clinical treatment, or other evidence based decisions from the contrast committee. This manual is now frequently updated and residents should be familiar with its content.
Attention to new findings with respect to Adverse Reactions to Gadolinium-Based Contrast Media and Nephrogenic systemic fibrosis (NSF) should be appreciated.

The vast majority of immediate adverse reactions to gadolinium containing agents are minor. Severe anaphylactoid reactions are exceedingly rare. Risk factors include prior reaction to iodinated contrast media, persons with asthma and various other allergies. (Patients who have had adverse reaction to iodinated contrast media are more than twice as likely to have an adverse reaction to gadolinium.) Pre-medication with steroids could be used.

The clinician and the facility must be prepared to address any reaction due to the injection of Gadolinium-based contrast media as there have been reports of anaphylactoid type of reactions.

Iodinated contrast media, while safe in most patients, are associated with a substantial incidence of life threatening adverse events, particularly in high-risk patients. The resident must be familiar with the value, safety, and effectiveness of Gadolinium-enhanced spiral CT examinations for such patients. [32, 34-36]

**Imaging and use of Contrast Media during Pregnancy:**

Proper diagnosis and treatment of maternal illnesses during pregnancy may require radiographic imaging. The resident should be familiar with the potential effects of radiation dosages from routine diagnostic examination. Radiation induced teratogenesis, radiation induced malignancies and gene mutations are potential risks. Knowledge of the above potential risks is required to properly council the pregnant patient. The resident physician must be able to answer such questions to help the patient understand the potential risks and benefits of such radiographic procedures.

Iodinated diagnostic contrast media have been shown to cross the human placenta and enter the fetus in measurable quantities. There is no evidence suggesting that iodinated contrast agent is teratogenic or mutagenic in humans. However, it is wise to avoid contrast medium whenever possible, yet judicious use of contrast agents when the studies requiring them are thought to be essential is appropriate.

Depression of fetal thyroid function is the most important potential harmful effect of iodinated contrast media within the fetus. Neonatal thyroid function should be checked during the first week if iodinated contrast media was given during the pregnancy. No effect on the fetus has been seen after gadolinium contrast media administration.

The ACR Committee recommends the following guidelines regarding whether to perform a contrast exam:

1. That the information requested and the necessity for contrast material administration cannot be acquired via other means.
2. The information needed affects the care of the patient and/or fetus during the pregnancy.
3. The referring physician is of the opinion that it is not prudent to wait to obtain this information until after the patient is no longer pregnant.
4. The referring physician obtains consent, making sure that the patient understands the risk/benefits of the procedure. [32]

Gadolinium based contrast agents cross the placenta and enter into the fetus when given in clinical dose ranges. There is no compelling evidence to suggest any teratogenic effect of MR Imaging or gadolinium-based contrast agents. Neither for exposure to the MR scanning environment nor for the administration of MR contrast agents has safety been established for the pregnant patient.

ACR recommends the following:
1. The information requested from the MR study cannot be acquired using other non-ionizing radiation imaging modalities (e.g., ultrasonography)

2. The information needed affect the care of the patient and/or the fetus during the pregnancy.

3. The referring physician is of the opinion that it is not prudent to wait to obtain the information until after the patient is no longer pregnant.

Obtain consent to document that the patient understands the risks/benefits of the MR and the use of contrast medium. [32]

Lactation:
Administration of contrast media is at times indicated in patients who are breast feeding. The literature on excretion of iodinated and gadolinium-based contrast agents into breast milk and gastrointestinal absorption of these agents is very limited. Less than 1% of administered dose is excreted by the breast milk, and less than 1% of the ingested milk by the infant is absorbed by the gastro-intestinal tract. [32, 39]

The current ACR policy states that it is safe to breast feed the baby in such situations however the mother must be informed and given an option to avoid breast feeding the baby for 24 hours if there is any concern by the mother of any potential ill effects, with active expression and discarding of breast milk from both breasts during that period. In anticipation of this, the mother may wish to use a breast pump prior to the contrast study to bank breast milk for feeding the infant during the 24-hour period following the examination. [32]

Ultrasound Contrast Agents:
Ultrasound contrast agents are gas-filled micro-bubbles. Their effect is mainly produced by increased back-scattering intensity as compared to that from blood, other fluids, and
most tissues. The resident must be familiar with the basic mechanism and physical principles of the acoustic properties of microbubble based ultrasound contrast media.

Generally ultrasound contrast media are considered safe. The majority of reactions are minor. It is however recommended to use the lowest level of acoustic output and shortest scanning time to allow a diagnostic examination. [40]

**Pharmacologic Interaction between Contrast Media and Other Drugs:**
“Interaction” is the term used to describe a drug’s capacity to influence the pharmacologic action of another drug. Referring physicians and patients are required to notify the radiologists of the various medications the patient is currently taking as a variety of such medications can directly or indirectly affect the health of the patient. It is important for the resident trainee to be aware of both acute and subacute interaction of drug therapies in patients who are receiving radiographic contrast media.

Most interactions can be categorized as follows:
- Pharmacodynamic interactions
- Pharmacokinetic interactions
- Emergency medication interactions
- Interactions leading to increased sensitization
- Interaction leading to hemostatic changes

1. **Pharmacodynamic Interaction:**
X-ray attenuation can be affected only indirectly; i.e.- by modifying the distribution of contrast agent. Theoretically one such example could be an agent which increases blood brain barrier permeability, thus increasing the detectability of central nervous system lesions.

Radiographic contrast media have osmotic effects that could lead to renal insufficiency. This can increase the risk of lactic acidosis in diabetics receiving biguanide treatment (e.g. metformin and its derivatives). [41-44]

2. **Pharmacokinetic Interaction:**
Interactions, which affect basic pharmacokinetic parameters, such as distribution, metabolism or elimination, are included in this group. For example with lithium therapies, reduced sodium resorption in the proximal tubules due to osmosis will lead to increased plasma lithium levels.

3. **Interactions with Emergency Medication:**
If a patient is taking cardioactive beta-receptor blockers this can significantly reduce the effectiveness of the catecholamines that are necessary in an acute emergency situation.
4. Increased Sensitization:
In addition to interferons and interleukins, beta-receptor blockers also lead to increased tendency to allergic reactions. Furthermore, there is a long interaction time, sometimes occurring several days to weeks after the last medication treatment.

5. Conditions Affecting Hemostasis:
Both ionic, and to a lesser extent, nonionic contrast media interact with the coagulation mechanism, platelet activation and degranulation and with thrombolytic drugs. Ionic iodinated contrast media can directly inhibit thrombin productions and both platelet activation and aggregation, increase bleeding time and inhibit fibrinolysis and do so more effectively than non ionic contrast media. Both ionic and non ionic contrast can prolong clotting time and may exaggerate effects of anticoagulant and antiplatelet drugs. Also, clotting tests should be avoided within 6 hours or more after contrast administration as both ionic and nonionic contrast media can falsely elevate clotting tests. [41, 42]

The reader is referred to the current Physician’s Desk Reference, ACR Manual on Contrast Media, and or the manufacturer’s package insert for a full discussion of specific drug interactions, and the relationship to radiographic contrast media.

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5. APPENDIX A: Curriculum Syllabus by Topic

In depth knowledge of all of the following listed items, particularly the more unusual or rare entities is not expected, but by the end of residency training, the resident should recognize and have mastered a majority of the categories on this list incorporating them into his or her fund of knowledge.


1. Adrenal glands
   • Malignant tumors (primary and secondary)
   • Benign tumors
   • Endocrine tumors
   • Functional diseases
   • Granulomatous diseases
   • Hemorrhage
   • Trauma/iatrogenic
   • Congenital anomalies

2. Kidneys
   • Malignant tumors (primary and secondary)
   • Benign tumors
   • Endocrine tumors
   • Cysts
   • Granulomatous diseases
   • Infection/inflammation
   • Hemorrhage
   • Infarction and ischemia
   • Trauma/iatrogenic
   • Congenital anomalies
   • Medical renal disease
   • Inherited diseases involving the kidneys including transplantation

3. Ureter
   • Malignant tumors
   • Benign tumors
   • Infection/inflammation
   • Hemorrhage
• Trauma/iatrogenic
• Congenital anomalies
• Stricture

4. Bladder and neobladders
• Malignant tumors
• Benign tumors
• Infection/inflammation
• Hemorrhage
• Trauma/iatrogenic
• Congenital anomalies

5. Prostate gland and seminal vesicles
• Malignant tumors
• Benign tumors and hyperplasia
• Infection/inflammation
• Trauma/iatrogenic
• Congenital anomalies

6. Urethra and penis
• Malignant tumors
• Benign tumors
• Infection/inflammation
• Trauma/iatrogenic
• Congenital anomalies
• Stricture

7. Scrotum and contents
• Malignant tumors
• Benign tumors
• Infection/inflammation
• Trauma/iatrogenic
• Hemorrhage
• Congenital anomalies
• Vascular abnormalities
• Torsion
• Microlithiasis

8. Retroperitoneum
• Malignant tumors (primary and secondary)
• Benign tumors
• Hemorrhage
• Trauma/iatrogenic
• Congenital anomalies
• Aortic aneurysm
• Retroperitoneal fibrosis
• Pelvic lipomatosis
• Venous anomalies

9. Vascular diseases affecting the genitourinary tract
• Aneurysms
• Stenoses
• Malformations
• Fistulae
• Occlusions
• Congenital anomalies

10. Uterus and cervix
• Malignant tumors
• Benign tumors
• Adenomyosis
• Infection/inflammation
• Hemorrhage
• Trauma/iatrogenic
• Congenital anomalies

11. Ovaries
• Malignant tumors
• Benign tumors
• Cysts
• Cystic diseases
• Torsion
• Hemorrhage
• Infection/inflammation
• Trauma/iatrogenic

12. Intravascular contrast media
• Adverse reactions (idiosyncratic and non-idiiosyncratic)
• Prevention and treatment of adverse reactions
• Extravasation

13. Urolithiasis (including kidney, ureter, bladder)

14. Techniques
• Excretory urography
• Cystography
• Urethrography (including antegrade and retrograde)
• Computed tomography (including CT urography, CT angiography)
• Magnetic Resonance imaging (including MR urography, MR angiography)
• Ultrasound (including Doppler and Color Flow)
• Hysterosalpingography
6. APPENDIX B: Pediatric Uroradiology

Basic Concepts: Training in pediatric radiology is achieved within a dedicated general pediatric rotation or within the general residency program. These two settings can complement each other. Case material and skill sets learned during the time devoted to pediatric radiology will help the resident faced with later presentations of congenital anomalies. Cases seen outside of the formal pediatric curriculum reinforce the cases seen while on the pediatric radiology rotation. Because the resident spends a limited time period within a pediatric radiology setting, pediatric GU material can be integrated into a standard GU curriculum. When interpreting images, it is also helpful to understand the normal developmental anatomy and the changes with age. For example, knowing the changes in the size and shape of the uterus prepubertal and postpubertal.

Reducing Radiation Exposure for pediatric patients:
Residents should be taught ways in which clinically important information can be obtained while limiting radiation exposure to children. These strategies include substituting a test which has no ionizing radiation for one which does (e.g. substituting US for IVP), shifting to a radiation based modality which has less radiation (e.g. substituting IVP for Renal Scintigraphy), changing CT parameters in order to reduce the radiation dose without compromising diagnostic accuracy, using techniques to limit fluoroscopic radiation exposure and considering the use of MRU (while weighing the risks of sedation and or anesthesia).

Age appropriateness:
In dealing with pediatric patients, knowledge of age appropriate interaction, immobilization, and imaging is imperative. Showing sensitivity to the patient’s age shows respect to the patients and the patients’ parents. Judicious use of sedation or anesthesia can be based on the patient’s age or ability to cooperate, and also helps to obtain the best studies possible.
Fluoroscopy experience should include use of immobilization devices, child appropriate distraction and soothing techniques, and age appropriate catheters when performing voiding cystourethrography (VCUG). The resident should learn the indications for VCUG, the system used to grade reflux, and the implications of positive and negative studies. The possible post procedural complications should be explained. The resident should receive a level of training such that he/she could not only perform the VCUG but counsel the parents appropriately before and after the examination.

Specific Clinical Settings:
Congenital anomalies:
A topic specific to pediatric patients is the evaluation of anomalies and evaluation for associated anomalies. Trainees should be aware that renal US is performed when congenital anomalies such as cardiac, GI, skeletal, and Mullerian duct are known to be associated with renal anomalies. Trainees should be aware of common syndromes with associated renal anomalies and what renal anomalies to expect.
The extended use of pediatric ultrasound mandates that the resident be taught age appropriate indications and techniques. Training should also include the use of appropriate transducers for the task. Neonates also undergo US when prenatal imaging has detected an anomaly or hydronephrosis.

Hydronephrosis:
Many infants present with a diagnosis of prenatal hydronephrosis. Trainees should have a differential for prenatal hydronephrosis, and know the appropriate post natal tests and timing of these evaluations.

UTI and GU Reflux
Urinary tract infections (UTI) are a common pediatric problem. The etiology and evaluation is distinct from such infections in adults. The resident needs to be taught: definition of a UTI, the differences between cystitis and pyelonephritis, proper ways of obtaining urine culture, and how and when the multiple tests which are available to evaluate the genitourinary tract should be performed.
Trainees should be familiar with the signs and symptoms of reflux and the indications for a VCUG. Trainees should be able to counsel patients and families about this commonly performed procedure and possible complications, and implications of the procedure, such as the willingness to take prophylactic antibiotics. Knowledge of technical aspects of the procedure is also imperative: age appropriate immobilization, catheter selection, comfort techniques for patients and parents. Trainees should be familiar with the grading system of reflux and how to communicate the results to the referring clinicians, especially if reflux is present and the patient is not currently taking antibiotics.

Renal cystic disease:
Often considered an adult problem, renal cystic diseases often manifest in childhood. The genetics, presentation, and course of the many cystic diseases should be covered. The resident should understand the difference between simple cysts, multicystic dysplastic kidney and autosomal recessive and dominant polycystic kidney disease, and the appropriate imaging techniques for imaging evaluation.

Tumors:
Understanding the tumors of the genitourinary tract that occur in children requires knowledge of the presentation and imaging of benign tumors. The morphology and staging of malignant tumors should be part of the curriculum, either through didactic lectures or case material. The tumors of the lower urinary tract, particularly rhabdomyosarcoma, should be covered. Adrenal tumors (neuroblastoma, carcinoma, and pheochromocytoma) that present in childhood should be covered. Trainees should also be aware of many conditions or syndromes that require surveillance for associated renal tumors, such as nephroblastomatosis, hemihypertrophy, WAGR (Wilms’ tumor, aniridia, genitourinary anomalies, and mental retardation), and aniridia.

Adrenal Gland:
Trainees should be familiar with pediatric adrenal tumors, such as neuroblastoma, carcinoma, and pheochromocytoma. Of specific importance, the differentiating factors
between an adrenal neuroblastoma and Wilms tumor should be covered, as well as differentiating between a cystic adrenal hemorrhage in a neonate or a cystic neuroblastoma.

**Bladder and lower urinary tract:**
The bladder is routinely imaged during renal US. Bladder imaging may be important in understanding the findings in the kidney (e.g. detection of a ureterocele in a child with hydronephrosis). Bladder US may help to detect the cause for the child's symptoms when the kidneys are normal. It is important to recognize mimickers that are specific to bladder such as how an incised ureterocele and inflammatory change can simulate a bladder rhabdomyosarcoma.

**Gonads:**
It is important for the trainee to understand the changes in the testes and ovaries with age and especially pubertal changes. Ultrasound is the main imaging modality for the gonads, with MRI and CT as adjuncts in patients with masses. Causes for acute scrotal pain in the male and pelvic pain in the female should be taught, and include origins both within (including gonadal torsion) and unrelated to the gonads. Undescended testis is a common clinical problem, and the trainee should have knowledge of the imaging evaluation and the implications of an undescended testis.
The trainee should know how to evaluate the painful scrotum with both gray scale US and Doppler US, and have knowledge of the differential diagnosis, including torsion of the testis or appendix testis, epididymitis, and orchitis. Some problems are seen in all age groups (e.g. epididymitis, orchitis). Ovarian cysts are common and can be seen in a spectrum of ages, including newborns. When on the right, they may simulate the pain caused by an inflamed or ruptured appendix. Evaluation of the pelvis in a female child may include learning to diagnose or exclude ovarian cysts or ovarian torsion.

*Specific Imaging Techniques:*
**Radiography:** Plain films are of limited use in evaluating the GU tract in children. Suspected renal masses are better sought with US. Calcifications within the GU tract or adrenal may be seen with plain films but are better appreciated with US or non-contrast CT.

**Ultrasound:** The proper selection of transducers is the key to achieving a successful scan, and the transducer should be chosen in relation to the child's size. Also, knowledge of how to obtain quality images in children is important, such as prone scanning for better evaluation of the kidneys and patient immobilization and cooperation. When hydronephrosis is present, the bladder should be purposefully evaluated. If it is full, renal imaging should be performed after voiding because a distended urinary bladder may cause minor hydronephrosis or increase the grade of hydronephrosis.
While not widely performed, the resident should be taught about the evolving technique of sonographic cystography using ultrasound contrast agents. Doppler US is used to in a wide number of settings in the pediatric population. In the neonate, renal vein thrombosis
may be diagnosed or excluded. In older children, spectral and color Doppler US are used in a variety of settings.

**Computed Tomography:** With the newer and faster multidetector CT scanners, pediatric sedation is less of an issue or concern than in the past. Evolving techniques to decrease the radiation exposure for each GU indication should be taught.

**Magnetic Resonance Imaging:** The use of this technology in pediatric radiology is widespread and growing. Indications for GU specific exams include MR urography, evaluation of infections or congenital anomalies, and staging of tumors. Although MRI has the advantage of imaging without radiation exposure, this modality usually requires long scanning times that require knowledge of age appropriate sedation/anesthesia. Faster scanning techniques are changing this paradigm. Trainees should be familiar with valuable imaging sequences and planes for each indication, and also about pediatric specific coils and appropriate use of contrast material.

**Nuclear Scintigraphy:** The resident should understand the different chelates or "labels" that can be attached to the basic technetium isotope and the use of each: i.e. - which isotopes are preferred for cortical imaging and which provide functional or morphological information. The resident should understand the indications for renal scintigraphy, the techniques of performing and interpreting these examinations, and the pitfalls of these scans. Nuclear scintigraphy is a common procedure. For this reason the resident should become familiar with how these studies are performed and in the proper indications for each examination.

7. **APPENDIX C: Knowledge of Technologies and Skills for Competency**

Radiology is an ever-changing science. Since the last version of this document, there have been many advances that are now part of, or are emerging to be part of our imaging armamentarium.

- **New Imaging Modalities or emerging tools enhancing existing modalities**
  - **Ultrasound**
    - 3D Ultrasonography
    - Ultrasound Elastography
    - Microbubble contrast enhanced ultrasound
    - Focal therapy using high intensity focused ultrasound (HIFU)
    - Ultrasound guided biopsy using deformable fusion techniques
    - Focal therapy using targeted microbubble administration of chemotherapy agents
  - **CT**
    - Dual energy CT scanning
Low dose CT scanning
MRI
- MR elastography
- MR spectroscopy
- Diffusion weighted MRI
- Quantitative contrast enhanced MRI for imaging prostate cancer and renal cancer
- MRI PET fusion
- MR guided intervention and MRI guided focal therapy

PET
- New cyclotron-produced imaging tracers specific for imaging genitourinary neoplasms
- Use of this imaging information to monitor success of therapy regimens and to trigger rapid therapy regimen adjustments when needed

- Novel imaging tracers
  - Ultrasmall superparamagnetic iron oxide enhanced MRI
  - 11C-choline, 18F-fluorocholine, 11C-acetate, 11C-methionine, 18Ffluoro-5-alpha-dihydrotestosterone for PET imaging of prostate cancer
  - Microbubble contrast enhanced ultrasound of the prostate and renal masses

- Emerging interventional techniques
  - MR guided intervention and biopsies
  - Non rigid fusion techniques using MRI fused to ultrasound for biopsy
  - Use of ultrasound and MRI for focal therapy

- Imaging in drug trials
  - Familiarity with existing and developing new criteria

All relevant technologies should be incorporated into core training of residents as they become validated in the literature. Early and active involvement of residents in research activities utilizing these new technologies should be encouraged.

8. APPENDIX E: Suggested Core Lecture Topics

The following is a summary of core lecture topics gleaned from the core lecture topics that follow this one:

1) Combined Summary of Suggested Lecture Topics

Fundamentals of GU Imaging

On call/ preparatory lecture topics
1. Acute GU Pathology: Stones, Infection, Abscess, Hemorrhage/Trauma
3. Scrotal Pain/Trauma Imaging
4. Introduction to fluoroscopic GU imaging
5. Intravenous Contrast Agents, Risk, Benefits and Reactions
6. Multimodality approach to Acute Gynecologic Conditions including post partum complications
7. Imaging of Renal Transplants
8. Imaging the Pregnant Patient with abdominal pain: weighing the risks and benefits
9. First Trimester Emergencies

**Kidneys and Retroperitoneum**

1. Solid Renal Neoplasms, preoperative evaluation and biopsy
2. Cystic Disease of the Kidney
3. Neoplasms and Pseudolesions of the collecting system
4. Infectious, Inflammatory and Vascular Diseases of the Kidney
5. Renal Masses and Pseudotumors in the Pediatric Patient
6. Retroperitoneal Diseases
7. Multimodality approach to Renal Artery Stenosis
8. Approach to Adrenal Masses
9. PET/Molecular imaging in GU and GYN oncology

**Upper GU tract and Bladder**

1. Hematuria, Indications for imaging and imaging options: Cystoscopy, IVP, CTU or MRU?
2. GU Variants, Anomalies and Reflux disease
3. Diseases of the Bladder-inflammatory and malignant
4. GU Trauma

**Male Pelvis**

1. Diseases of the Male urethra
2. Male Impotence and Infertility
3. Prostate Cancer and the role of Transrectal US and Prostate MRI

**Female Pelvis**

1. Female Pelvis: Uterine Anomalies
2. Female Pelvis: Multimodality approach to benign disease of the uterus/vagina with emphasis on fibroid diagnosis and management
3. Female Pelvis: Multimodality approach to malignancy of the uterus, cervix and vagina
4. Female Pelvis: Multimodality approach to adnexal masses
5. Female Pelvis: Pelvic Floor, urethra and perineum
Obstetrical Sonography

1. First trimester: Normal, Abnormal and Ectopic pregnancy
2. Second Trimester Screening for Aneuploidy
3. OB US: CNS and spine anomalies
4. OB US: Head/face, Neck, Skeletal anomalies
5. OB US: Placenta, Cervix, Poly/Oligohydraminos and Hydrops
6. OB US: Thoracic and Cardiac
7. OB US: Abdominal and GU anomalies
8. Twin Gestation, high risk obstetrics

Interventional and Operative

2. Renal Stone Disease: Intervention and Complications
3. Evaluation of the Renal transplant
4. Urinary Diversions and Imaging of the Post operative GU tract

The following are sample core lecture topics of programs from the membership of the committee that formulated this training document:

2) Resident Didactic Lectures – Brigham and Women’s Hospital

We have a yearly 3 week GI/GU block that runs a 2 year cycle. The GU lectures are listed below:

- CT Urography
- MR Techniques in the Pelvis
- CT/MR Female Pelvis
- CT/MR Male Pelvis
- Cystic Renal Masses
- Solid Renal Masses
- Adrenal Masses
- Prostate MR

The residents also attend the Fellows Seminar Series when rotating through the Section. There is some overlap, but I thought I would include them:

- Practical Approach to Adrenal Gland Imaging
- MRI of Gynecological Malignancies
- Non Prostate Male Pelvis MR
MR Female GYN pelvis
How To Manage the Renal Incidentaloma
MR Prostate
Renal Mass Biopsy
MRI of Benign Gynecology
CT Urography

3) BROWN UNIVERSITY GU RESIDENCY CURRICULUM

GI/GU modalities: IVP, Urethrography, Contrast media, CT, MRI, Ultrasound
Hematuria: Kidneys/Ureters: Anatomy, Cysts Masses, Obstruction, Stone Disease, Infection
Renal Transplant Evaluation (Including Doppler)
Adrenal Glands: Focal Lesion (Cyst/Solid) and Hemorrhage
Retroperitoneum: Adenopathy, Mass
Urinary Bladder: Mass, Calculi, Obstruction, Infection, Diverticula, Ureterocele,
   Color Flow Imaging Of Ureteral Jets, Volume Measurements
Prostate: Anatomy, Echogenicity, Cystic/Solid Mass, Carcinoma, Abscess, Biopsy
Scrotum: Anatomy, Mass, Torsion, Infection, Varicocele, Hydrocele, Spermatocele, Trauma,
   Testicular Calcifications (Microlithiasis, Granuloma)

PEDIATRICS:
Kidneys, Congenital
Kidneys, Tumor
UTI
Lower GU Anomalies
Male Testicle
Female Genital Track

INTERVENTIONAL:
Renal Artery Disease: Diagnosis/Intervention, Venous Sampling, AVM
Collecting System: Nephrostomy, Ureteral Access, Stone
Varicocele
Impotence
Uterus: UAE, Post-Partum Bleeding

WOMEN’S IMAGING:
Adnexa
Uterus and Endometrium
Neoplasm of the Cervix, Uterus, Adnexa, Vagina
Sonohysterography
MRI in Pregnancy
Fetal CNS
Fetal Abdomen
Fetal Thorax
Fetal Masses
OB Emergencies
First Trimester/Ectopic
Fetal Chromosomal Abnormalities
MRI of the Female Pelvic Floor

4) CINCINATTI GU RESIDENCY CURRICULUM

General
   Staging pelvic malignancies
   Urinary bladder disease
   Uterine disease
   Ovarian imaging and pathology
   Testicular imaging
   Prostate imaging

Renal
   Renal mass lesions
   Renal calcifications and stone disease
   Renal ultrasound
   Renal inflammatory disease

Adrenal Glands
   Adrenal masses
   Functional adrenal disease

Retroperitoneum
   Retroperitoneal anatomy
   Pathways and spread of retroperitoneal disease
   Retroperitoneal vascular disease and hemorrhage

5) MGH minicourse

GU Topics Summarize

1. Thyroid/Parathyroid US/Testicular US
2. Evaluating pelvic floor dysfunction in women with dynamic pelvic MRI
3. Uterine Imaging
4. Interventional Oncology: Opportunities for Innovation
5. Multidetector CT
6. Adnexal Imaging
7. Renal Masses
8. Adrenal Imaging  
9. Interventional Oncology- Ablation  
10. Infection  
11. Minimally Invasive treatment of Renal Cancer  
12. Biopsy and Drainage: How We Do It

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<tr>
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<th>Day</th>
<th>Topic</th>
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<tr>
<td>25-Apr</td>
<td>Monday</td>
<td>Thyroid/Parathyroid US/Testicular US</td>
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<td>Evaluating pelvic floor dysfunction in women with dynamic pelvic MRI</td>
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<td>28-Apr</td>
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<td>Imaging IBD</td>
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<td>Uterine Imaging</td>
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<td>2-May</td>
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<td>Cases for all</td>
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<td>4-May</td>
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<td>Interventional Oncology: Opportunities for Innovation</td>
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<td>5-May</td>
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<td>Multidetector CT</td>
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<td>9-May</td>
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<td>11-May</td>
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<td>PostOperative GI Tract: Radiologic Perspective</td>
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<td>Colon Cancer and CT Colonography</td>
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<td>13-May</td>
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<td>16-May</td>
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<td>MRI of the Liver</td>
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<td>19-May</td>
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<td>Outcomes</td>
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<td>20-May</td>
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<td>Interventional Oncology- Ablation</td>
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<td>23-May</td>
<td>Monday</td>
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<td>24-May</td>
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<td>25-May</td>
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<td>Thyroid Nodules To Biopsy or Not to Biopsy &amp; Postoperative Surveillance of Differentiated Thyroid Carcinoma</td>
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<td>31-May</td>
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<td>1-Jun</td>
<td>Wednesday</td>
<td>MR Enterography</td>
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<td>2-Jun</td>
<td>Thursday</td>
<td>Infection</td>
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<td>3-Jun</td>
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6-Jun  Monday  Best of the Rest
7-Jun  Tuesday  -
8-Jun  Wednesday  Minimally Invasive treatment of Renal Cancer
9-Jun  Thursday  Biopsy and Drainage: How We Do It
10-Jun  Friday  TBD

6) NYU Curriculum  CORE GU LECTURES

Summer series (repeated every year)
1. Contrast Reactions
2. Intro to IVP
3. Acute GU pathology: Stones, infection, Abscess, Heme
4. Testicular/Penile US
5. GYN emergencies
6. Transplant Part 2: Renal/Panc

Year 1
1. Cystic diseases of Kidneys
2. Renal Parenchymal Lesions: RCC and beyond
3. Renal US
4. Neoplasm and pseudoneoplasms of the collecting system
5. Adrenal Diseases
6. Inflammatory and Vascular Disease of the Kidney
7. Female Pelvis: A multimodality Approach to Benign Diseases
8. Ob US: First trimester screen and acute pathology
9. Ob US: 2nd trimester screen
10. Diseases of bladder, prostate and male urethra
11. How to approach imaging in pregnancy

Year 2:
1. Diseases of the Retroperitoneum
2. Obsetrical US: Chest/GU/GI anomalies
3. Female Pelvis: Uterine, Cervical and Vaginal malignancy
4. Ob US: Head/face, neck, spine, skeletal anomalies
5. Female Pelvis: Adnexal masses
6. Twin Gestation
7. Female Pelvis: Pelvic floor, perineal masses
8. Ob US: IUGR, placenta, cervix=CS
7) GU LECTURES: University of Maryland

We repeat these every 2 years but I have to reconfigure it for the new syllabus.

Cross sectional anatomy and ultrasound protocols
Anatomy of peritoneal and retroperitoneal spaces
US physics and Doppler
CT physics
CT protocols
MRI physics
MRI protocols
Contrast media
CTA/MRA
Retroperitoneal masses
Ureters and bladder
Renal neoplasms
Renal cystic disease
Renal syndromes
Renal congenital inflammatory
Renal transplantation
Scrotal imaging
Non neoplastic adnexa
Ovarian neoplasms
Non gravid uterus
Endometrium
First trimester
Ectopic pregnancy
Second trimester normal
Second trimester abnormal
Prostate MRI (seminal vesicle)
Adrenal imaging
Medicolegal issues

8) Walter Reed National Military Medical Center:
follows the most current version of the SUR GUIDELINES FOR
RESIDENT CURRICULUM AND TRAINING IN GENITOURINARY
RADIOLOGY, accessed at http://www.uroradiology.org/resources/curriculum.html
9. APPENDIX E: Core Reference Materials

**GENERAL REFERENCE TEXTS:**


American College of Radiology’s Appropriateness Criteria™

ACR Manual on Contrast Media

American College of Radiology’s Guidelines and Standards

American College of Radiology’s MR Safety

Association of Program Directors in Radiology
http://www.apdr.org

RSNA Educational Portal.
http://www.rsna.org/education/index.html

PubMed - National Library of Medicine provides access to citations from biomedical literature

MetaTextbook of Pediatric Radiology, Genitourinary System
http://www.vh.org/pediatric/provider/radiology/MetatextbookPedRad/Genito.html

CancerNet - Cancer Information from the National Cancer Institute http://cancernet.nci.nih.gov/

"Abdominal Imaging" - abstracts from the journal
http://link.springer.de/link/service/journals/00261/index.htm
"Journal of Computer Assisted Tomography" - online edition (limited)
http://www.rad.bgsu.edu/jcat/

Digital Urology Journal
http://www.duj.com/index.html

Investigative Radiology – abstracts from the journal

Academic Radiology – abstracts from the journal
http://www.academicradiology.org/

British Journal of Radiology – Full articles available
http://bjr.birjournals.org/

Interactive Uroradiology
http://www.uroradiology.net

Journal of Women’s Imaging – abstracts from the journal

YAHOO's Urology - search for urology resources
http://dir.yahoo.com/Health/medicine/urology/index.html

YAHOO's Obstetrics & Gynecology - search for obstetrics and gynecology
http://dir.yahoo.com/Health/medicine/obstetrics_and_gynecology/index.html

YAHOO's Nephrology - search for nephrology resources
http://dir.yahoo.com/Health/medicine/nephrology/index.html

MedPix™ Genitourinary Cases Medical Image Database from Uniformed Services University
http://rad.usuhs.mil/medpix/parent.php3?mode=tf2&action=pre&acr_pre=8

Online Teaching Cases
Department of Radiology, Brigham and Women's Hospital, Harvard Medical School
http://rad.usuhs.mil/medpix/parent.php3?mode=tf2&action=pre&acr_pre=8

RSNA Educational Portal
http://www.rsna.org/education/index.html

e-Medicine GU Radiology
http://www.emedicine.com/radio/GENITOURINARY.htm

e-medicine OB/GYN Radiology
http://www.emedicine.com/radio/OBSTETRICSGYNECOLOGY.htm

Chorus for GU
http://chorus.rad.mcw.edu/index/5.html

CTisus.com
http://www.ctisus.com/

[Note to Residents: When using the following references, it is suggested to give priority to review articles in BOLD font. The most recent ones will have additional references to detailed scientific articles in the]
literature. An additional listing of more recent scientific articles in normal font is not meant to be all inclusive.]

GENERAL (TECHNIQUES & MATERIALS)


CONTRAST AGENTS


Bruce RJ, Djamali A, Shinki K, Michel SJ, Fine JP, Pozniak MA. Background fluctuation of kidney function versus contrast-induced nephrotoxicity. AJR 2009; 192:711-718


Rao QA, Newhouse JH. Risk of nephropathy after administration of contrast material: a critical literature analysis. Radiology 2006; 239:392-397


Trika J, Schmidt C, Seitz CS, Bröcker E-B, Gross GE, Trautmann A. Anaphylaxis to iodinated contrast material: nonallergic hypersensitivity or IgE-mediated allergy? AJR 2008; 190:666-670

Beaty AD, Lieberman PL, Slavin RG. Seafood allergy and radiocontrast media: Are physicians propagating a myth? AJM online. 2008; 121(2):158.e1-158.e4


Elicker BM, Cypel YS, Weinreb JC. IV contrast administration for CT: a survey of practices for the screening and prevention of contrast nephropathy. AJR 2006; 186:1651-1658.


Thomsen HS. Guidelines for contrast media from the European Society of Urogenital Radiology. AJR 2003; 181:1463-1471.


Lieberman PL, Seigle RL. Reactions to Radiocontrast Material: anaphylactoid events in radiology. Allergy and Immunology. 1999; 469-496.


Younathan CM, Kande JV, Cook MD, Shaw GS, Peterson JC. Dialysis is not indicated immediately after administration of nonionic contrast agents in patients with end-stage renal disease treated by maintenance dialysis. AJR 1994; 163:969-971.


CT RADIATION DOSE & DOSE REDUCTION

(See also Renal Colic)


Eikfjord EN, Thorsen F, Rørvik J. Comparison of effective radiation doses in patients undergoing
unenhanced MDCT and excretory urography for acute flank pain. AJR 2007; 188:934-939


CT AND MR UROGRAPHY TECHNIQUE


COMMON CONDITIONS

Hematuria


Silverman SG. Leyendecker JR. Amis ES Jr. What is the current role of CT urography and MR urography in the evaluation of the urinary tract?.Radiology 2009; 250:309-323

**Colic (Renal)**


Eikefjord EN, Thorsen F, Rørvik J. Comparison of effective radiation doses in patients undergoing unenhanced MDCT and excretory urography for acute flank pain. AJR 2007; 188:934-939


Tack D, Sourtzis S, Delpierre I, de Maertelaer V, Gevenois PA. Low-dose unenhanced multidetector CT of patients with suspected renal colic. AJR 2003; 180:305-311


**Renal Stone Surveillance**


**Urinary Tract Infection & Inflammation**


ADRENAI


Dunick NR, Korobkin M. Imaging of adrenal incidentalomas: current status. AJR 2002 ;179:559-68.


**RETROPERITONEUM**


Freire M, Remer EC. Clinical and radiological features of cystic renal masses. AJR 2009; 192:1367-1372

**URINARY TRACT**

**KIDNEY**

**Pelvocalyceal System**


Kidney Masses


**Renovascular Disease**


**Transplant (Renal)**


Sahani DV, Rastogi N, Greenfield AC, et al. Multi–Detector Row CT in Evaluation of 94 Living Renal Donors by Readers with Varied Experience Multi–detector row CT used as the sole imaging technique in the preoperative evaluation of living renal donors provides high accuracy even when images are read by multiple readers with varied levels of expertise. Radiology 2005, 235: 905-910.


**KIDNEY & UPPER URINARY TRACT TRAUMA**


BLADDER & NEOBLADDER


Sadow CA, Silverman SG, O'Leary MP, Signorovitch JE. Bladder cancer detection with CT urography in an Academic Medical Center. Radiology 2008; 249:195-202

Tsampoulas C, Tsili AC, Giannakis D, Alamanos Y, Sofikitis N, Efremidis SC. 16-MDCT cystoscopy in the evaluation of neoplasms of the urinary bladder. AJR, 2008 190:729-735,


Kundra V, Silverman PM. Imaging in oncology from the University of Texas M. D. Anderson Cancer Center. Imaging in the diagnosis, staging, and follow-up of cancer of the urinary bladder. AJR 2003; 180:1045-1054.


URETERS


URETHRA


FEMALE PELVIS

CERVIX


OVARY


**Uterus & Fallopian Tubes**


Hann LE, Gretz EM, Bach AM, Francis SM. Sonohysterography for evaluation of the endometrium in women treated with tamoxifen. AJR 2001; 177: 337-342.


**Obstetrical Imaging**


**Pelvic Floor Imaging**


Miscellaneous Gynecologic


Male Pelvis

Penis


Prostate, Seminal Vesicles, and Ejaculatory Ducts


Banson ML. Normal MR anatomy and techniques for imaging of the male pelvis. MRI Clin North Am 1996; 4:481-496


Secaf E. Nuruddin RN. Hricak H. et al. MR imaging of the seminal vesicles. AJR


Scrotal Imaging


Mazzu D, Jeffrey RB Jr, Ralls PW. Lymphoma and leukemia involving the testicles: findings on gray-scale and color Doppler sonography. AJR 1995; 164: 645-647.


Intervention (Genitourinary)


Verma SK, Gonsalves CF, Baltarowich OH, Mitchell DG, Lev-Toaff AS, Bergin D. Spectrum of imaging findings on MRI and CT after uterine artery embolization. 2008 Abdom Imaging ??


Kawamoto S, Solomon SB, Bluemke DA, Fishman EK. Computed tomography and magnetic resonance imaging appearance of renal neoplasms after radiofrequency ablation and cryoablation. Semin Ultrasound CT MR 2009; 30:67-677


Pediatric Uroradiology


Miscellaneous


