



Curriculum in Neuroradiology (rev. 6/3/2019)

Faculty point person: Naveed Akhtar, MD Clinical Asst Professor of Radiology

Interventional Neuroradiology Fellowship: Temple University Hospital, Philadelphia, PA
Neuroradiology Fellowship: University of Maryland, Baltimore, MD

Other teaching faculty in Neuroradiology:

1. William Holloway, MD (SLH) – Fellowship program director
2. Coleman Martin, MD (Vascular Neurointerventional, SLH)
3. Jared Halpin, MD (SLH)
4. Natasha Acosta, MD (TMC)
5. Tim Zinkus, MD (CMH)
6. Grace Mitchell, MD (CMH)
7. Dave Nielsen (CMH)
8. Steven Welch, MD (CMH)

Core lecture series in Neuroradiology

Core lectures **Biweekly year round** **7:30am at SLH**

1. Neuroanatomy basics – Acosta (adults) & Halpin (peds)
2. Traumatology: Brain and Spine – Basic imaging techniques --- Holloway
3. Traumatology: Brain and Spine – Advanced imaging techniques --- Holloway
4. Infections: Head, Neck, and Spine
5. Tumors: Brain --- Halpin
6. Advanced Imaging Techniques, MR Spectroscopy, Diffusion, Perfusion, and functional imaging – Holloway (MRS)
7. MRI and CT Physics – Kasarie
8. Imaging of Temporal Bone --- Halpin (adult) and Zinkus (peds)
9. Imaging of Paranasal Sinuses --- Acosta
10. Imaging of Stroke --- Akhtar
11. Introduction to Neuro-imaging Techniques – Anatomy - Halpin
12. Orbits: Anatomy and Pathology – Holloway
13. Vertebroplasty/kyphoplasty --- Akhtar
14. Myelography – Akhtar
15. Pediatric Spine and head US including Doppler – Mitchell, Zinkus

This curriculum is supplemented by the following interdisciplinary lectures:

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|----------------------------|--|
| 1. Biweekly | Case conferences |
| 2. Weekly Wednesday 4-5 pm | Stroke Conferences – Neuroradiology |
| 3. Daily Afternoons | Journal club, M&M, Research presentation Neuroradiology Review Videos |

General overview

Radiology resident rotations in Neuroradiology Imaging will include at least 4 months during residency. Rotations will occur at Saint Luke's Hospital of Kansas City and Truman Medical Center. The specific goals include objectives required for every level of training with graded supervision by the attending faculty. All aspects of Neuroradiology imaging will be incorporated into the residency, including cross-sectional imaging (CT, MRI, Ultrasound), transcranial Doppler, myelography, neuroangiography, principles of neurointervention, disc aspiration, bone biopsies, and vertebroplasty/kyphoplasty.

Residents rotate through the Section of Neuroradiology during each of their four years of training. Over this time it is expected that residents will progressively develop their abilities to perform and interpret imaging studies of the central nervous system. Residents will be taught the practical clinical skills necessary to interpret plain radiographs, neurovascular ultrasound exams, CT scans, and MRI exams of:

- I. brain and skull;
- II. spinal cord and vertebral column and;
- III. head and neck.

They will be instructed in the performance and interpretation of invasive procedures including cerebral angiography, myelography / spinal canal puncture, image-guided biopsies of the spine and skull base, facet blocks and vertebroplasties. The goals and objectives listed are therefore outlined by level of training.

The residents will receive instruction in the science that underlies clinical neuroradiology, in particular neuroanatomy and neuropathology. They will learn the physical principles of CT and CTA; MRI and MRA; plain radiography, and catheter angiography. They will learn the relative value of each modality, enabling to them to choose the appropriate study and the appropriate protocol for each patient.

It is expected that residents will participate in the performance of examinations done by the section. They will obtain informed consents and at times will perform intravenous injections of contrast material. In order to perform these duties, the residents will learn the indications and contraindications for contrast administration.

They will learn to recognize and treat adverse reactions. Residents will protocol and monitor CT and MR exams after they have demonstrated a sufficient level of knowledge and experience to perform these tasks.

Residents will aid in the performance of invasive procedures including angiograms, myelograms, spinal taps, facet injections and vertebral biopsies. They will learn to explain these procedures to patients and their families, obtain pre-procedure consent and write pre- and post-procedure orders. They will learn techniques of arterial puncture, catheter choice and manipulation, and contrast dosage. They will learn to recognize and treat complications of these invasive procedures.

The residents will learn to dictate concise and appropriate radiographic reports and to serve as consultants to referring physicians.

Resident responsibilities:

1. Residents work directly with the attending neuroradiologist and are involved in the daily conduct of the service. At the beginning of every work day, the resident should be familiar with the patient schedule and anticipate needs for any procedures. The resident will check requisitions to evaluate the appropriateness of requested study or if other exams need to be performed. Clinical information should be obtained prior to protocoling MR and CT scans as well as prior to

- scheduling biopsies or other interventional procedures. Absent clinical indication or seemingly inappropriate requests will be clarified and discussed with the referring physician/service.
2. The resident assigned to the Neuroradiology rotation is expected to be available for consultation by the imaging technologists, clinicians and other health care professionals during regular office hours except during conference times, when attending faculty will cover.
 3. Examinations should be checked by the resident before the patient leaves the department if requested to do so by the supervising faculty.
 4. Questions should be referred to the supervising faculty to which the resident is assigned.
 5. Preliminary reports may be written for emergency room studies and patients who are going to clinic appointments on the same day of the examination when appropriate. This is communicated to attending radiologist and documented in the final report with name, date and time of such a communication.
 6. Review of cases with the supervising faculty will be conducted as many times in the day as necessary to keep an efficient work flow.
 7. All studies should be dictated by the end of every working day.
 8. The resident will check his/her reports prior to final verification by supervising faculty.

Staff responsibilities:

1. Supervising faculty should be available at all times for any questions or consultations needed by the resident.
2. Supervising faculty should review all cases with the resident before the end of the day.
3. Supervising faculty should provide the resident with constructive feedback in any problem areas encountered during the rotation as well as through rotation evaluations.
4. Supervising faculty should sign resident-generated reports in a timely manner and inform the resident of any major changes he/she made.

Resident evaluation: UMKC faculty use on line electronic evaluations, which are based on the 6 ACGME core competencies. Residents are also evaluated by 1-2 technologists. See the resident handbook for further details.

Neuroradiology Imaging – Rotation 1 – Goals and Objectives

I. Patient care:

- (a) Residents are required to complete an on line Patient Care, Radiation Safety module at least biannually.
- (b) The resident should have knowledge of indications for the examinations requested. When the reason for the examination is not clear, the resident should effectively communicate with the patient or referring physician until this is clarified.
- (c) The resident should be familiar with available medical records and how to access them for purposes of patient care.
- (d) All studies should be reviewed with supervising faculty attending.
- (e) Preliminary reports should be made available to all referring clinicians if needed prior to final review of cases. If there is a significant discrepancy between the preliminary reading and final reading, the resident should notify the referring clinician immediately.

II. Medical Knowledge:

- 1st Rotation reading assignments (AO refers to Osborn's Brain book; RP refers to RadPrimer)**
- 1. AO: Chapter 1 (Trauma overview)**
- 2. RadPrimer: Anatomy:**
 - a. Scalp, Skull, Meninges
 - b. Supratentorial Brain
 - c. Infratentorial Brain
 - d. Cranial Arteries
 - e. Veins and Venous Sinuses
 - f. CSF Spaces
 - g. Orbit
 - h. Nose and Sinuses

3. **RP: Cerebral Ischemia/Infarction**
4. **RP: Primary and Secondary Effects of CNS Trauma**
5. **RP: Orbit Overview, Sinonasal Overview**
6. **RP: Nomenclature of Degenerative Disc Disease**

□ **Prior to starting weekend call: RadPrimer**

1. **Aneurysms and Subarachnoid Hemorrhage**
2. **Non-traumatic Intracranial Hemorrhage**
3. **RP: Facial Trauma and Other Head and Neck Emergencies**
4. **Fracture Classification**
5. **Odontoid C2 Fracture**
6. **RadPrimer Beginner level questions complete by the end of rotation**

Knowledge-Based Objectives:

- (a) Learn the basic principles of neuroradiology with an emphasis on normal anatomy of the skull, brain, spine, contents of the spinal canal and head and neck as identified on plain radiographs, CT and MRI.
- (b) Develop skills in the interpretation of plain films of the skull, facial bones and spine in the setting of acute trauma. Learn to interpret CT scans of the brain, spine, and head and neck with a particular emphasis on studies performed on individuals presenting with acute or emergent clinical abnormalities.
 1. Brain --- Infarction, spontaneous intracranial hemorrhage, aneurysmal subarachnoid hemorrhage, traumatic brain injury, infection, hydrocephalus, types of brain edema, brain herniation.
 2. Head and Neck – fractures (orbital, facial and petrous), infection (sinusitis, orbital cellulitis, neck abscess) and airway obstruction.
 3. Spine – trauma (stable and unstable injuries), degenerative disease, infection, neoplasm (vertebral metastases), and cord compression.
- (c) Be able to understand the basic physics of computed tomography (CT). Be familiar with various standard CT imaging protocols and imaging techniques including:
 1. Use of various window and level settings;
 2. Use of soft tissue and bone algorithms;
 3. Options in selecting slice thickness, interslice gap, and helical / multi-row scanner imaging parameters.
- (d) Learn the basic physical principles of MRI and be able recognize and understand the clinical value of commonly utilized pulse sequences.
- (e) Recognize and understand common imaging artifacts.

Technical and Non-interpretive Objectives

- (a) Contrast administration – Learn to obtain informed consent, by explaining the risks and benefits of contrast enhanced CT/MR to the patient. Learn appropriate techniques for injection of contrast (including use of power injectors). Learn to recognize and treat contrast reactions.

Decision making/Value judgment skills

- (a) Learn the appropriate format for dictation of reports of neuroradiologic imaging studies.
- (b) Develop skills in providing consultations for house staff and referring physicians on routine and emergent imaging studies.
- (c) Can discuss complications and duration of procedure with patient and informed consent.
- (d) Round with staff on interventional neuroradiology service.

III. *Practice Based Learning and Improvement:*

- (a) Residents are required to complete an on line Fluoroscopic Procedures and Radiation Safety module at least biannually.
- (b) The resident should demonstrate evidence of independent reading and learning through the use of printed and electronic sources.
- (c) Follow-up of abnormal or interesting studies should be accomplished through communication with the referring physician and/or patient medical records.
- (d) Residents should assist with preparation and presentation of cases for interdisciplinary conferences when requested by the attending physician.
- (e) The resident should be competent in using the PACS and Powerscribe systems in the daily accomplishment of the work load and instruct others in its use.

IV. Interpersonal Communication Skills:

- (a) The resident should be able to communicate effectively results of studies to referring clinicians whenever needed. For emergent studies, reports to referring clinicians should be made in a timely manner.
- (b) The resident should be able to effectively convey the findings of examinations through accurate dictation of reports.
- (c) Residents should discuss fluoroscopic procedures and study results with the patient and family when requested to do so by supervising faculty.

V. Professionalism:

- (a) Residents are required to complete an on line professionalism module at least biannually.
- (b) Recognize limitations in personal knowledge and skills, being careful to not make decisions beyond the level of personal competence.
- (c) Residents should be able to explain the nature of the examination or findings in an examination to the patient and family when needed.
- (d) Residents should observe ethical principles when recommending further work-up for cases.
- (e) Promptness and availability at work are expected of every resident.
- (f) Residents should dress appropriately at work, wearing a name badge at all times.
- (g) Technologists and other health workers should be treated with respect as part of the health care team.
- (h) Patient confidentiality should be observed at all times.

VI. System Based practice:

- (a) Residents should be familiar with departmental procedures necessary in the performance of the examination.
- (b) Residents should learn appropriate language to be used in communicating to clinicians through reports or consultations so proper management decisions can be made.
- (c) Proper dictations should be made with indications, technique, findings and conclusions
- (d) Residents should dictate and correct their reports in a timely fashion to avoid delay in patient disposition.
- (e) Residents should assist in facilitating examinations whenever possible.
- (f) Resident should recognize the role that nuclear medicine plays in the management of patient's illness and make proper recommendations when needed.
- (g) Residents are encouraged to make suggestions to improve methods and systems utilized in radiology should be made whenever appropriate.

Reading list:

1. Diagnostic Neuroradiology. Anne G. Osborn, CV Mosby.
2. Handbook of Head and Neck Imaging. H. Ric Harnsberger, CV Mosby.
3. MRI, the Basics. Ray H. Hashemi and William G. Bradley, Williams and Wilkins.

Reference Texts:

1. Magnetic Resonance Imaging of the Brain and Spine. Scott W. Atlas, Lippincott (Companion CD available).
2. Head and Neck Imaging. Peter M. Som and Hugh D. Curtin, CV Mosby.
3. Pediatric Neuroimaging. A. James Barkovich, Raven Press.

Journals:

1. American Journal of Neuroradiology
2. Radiology
3. American Journal of Roentgenology
4. Neuroimaging Clinics of North America

Neuroradiology Imaging – Rotation 2 – Goals and Objectives

I. Patient care:

- (a) Residents are required to complete an on line Patient Care, Radiation Safety module at least biannually.
- (b) The resident should have knowledge of indications for the examinations requested. When the reason for the examination is not clear, the resident should effectively communicate with the patient or referring physician until this is clarified.
- (c) The resident should be familiar with available medical records and how to access them for purposes of patient care.
- (d) All studies should be reviewed with supervising faculty attending.
- (e) Preliminary reports should be made available to all referring clinicians if needed prior to final review of cases. If there is a significant discrepancy between the preliminary reading and final reading, the resident should notify the referring clinician immediately.

II. Medical Knowledge:

2nd Rotation reading assignments (AO refers to Osborn's Brain book; RP refers to RadPrimer)

1. AO Book:

- a. **Chapter 7 (Vascular Malformations)**
- b. **Chapter 9 (Venous Anatomy and Occlusions)**
- c. **Chapter 15 (Demyelinating and Inflammatory Diseases)**

2. Radprimer Questions: Intermediate questions complete by end of rotation

3. Radprimer Anatomy:

- a. **Spinal Osseous Structures, Ligaments, and Muscles**
- b. **Spinal Cord, Meninges, Arteries, Veins**
- c. **Plexi and Peripheral Nerves**

4. RP: (Review) Nomenclature of Degenerative Disc Disease

5. RP: Infections

6. RP: Diseases of the Ventricles and Subarachnoid Spaces

7. RP: Introduction to Brain Neoplasms and Cysts

8. RP: Sinuses and Orbits (sections not covered in 1st year assignments)

9. RP: Suprahyoid and Infrahyoid Neck

10. RP: Spine Trauma (sections not covered in pre-call requirements)

11. RP: Spine Degenerative Disease and Arthritis

Knowledge-Based Objectives

- (a) Continue to expand knowledge of the anatomy of the brain and spine. Become familiar with the complex anatomy of the orbit, petrous bone, skull base and soft tissues of the neck (supra- and infra hyoid) as displayed on plain radiographs CT and MR. Have knowledge of established anatomic classification systems for each of these areas. Become proficient in the interpretation of plain radiographs and CT scans of the brain, head and neck, and spine
- (b) Develop a greater understanding of the basic pathology and pathophysiology of disease of the brain, spine, and head & neck including neoplastic and inflammatory lesions. Continue to develop skills in the interpretation of emergent studies begun in the first year.
- (c) Learn the imaging features CT and MR of hyperacute infarction. Become familiar with the use of new MR sequences (diffusion, perfusion, and MR spectroscopy) and with CTA and CT perfusion in the detection of these lesions.
- (d) Develop the ability to use imaging findings to differentiate different types of focal intracranial lesions based on anatomic location (e.g. intra- vs. extra-axial), contour, intensity and enhancement pattern.
- (e) Learn to identify and differentiate diffuse intracranial abnormalities (e.g. hydrocephalus and atrophy).
- (f) Learn the vascular anatomy of the neck and head as displayed on catheter, MR, and CT angiography.
- (g) Learn the indications, limitations, risks and benefits for each technique used for visualization of vascular anatomy.
- (h) Develop a more detailed understanding of causes of density changes on CT and intensity changes on MR in a variety of lesions (e.g. intracranial hemorrhage).
- (i) Become proficient at the assessment of the spine and contents of the spinal canal using a variety of imaging techniques including plain radiographs, CT, MR, myelography and CT-myelography.
- (j) The resident must understand spinal anatomy as displayed on multiplanar images including reformatted helical CT scans and MR scans.
- (k) Be able to diagnose and differentiate degenerative spinal diseases including disc herniations,

- spinal stenosis, endplate changes, and facet joint disease.
- (l) Be able to characterize traumatic lesions and identify signs of instability.
 - (m) Be able to identify spinal cord compression and the cause for the compression (e.g. neoplastic involvement of the vertebral body, infection, and trauma).
 - (n) Learn the imaging features that allow for spatial classification of spinal lesions (extra-dural, intra-dural extra-medullary, and intra-medullary).
 - (o) Learn the differential diagnosis for each intra-spinal space.
 - (p) Become proficient at the identification of common lesions of the orbit, petrous bones, skull base and soft tissues of the neck.
 - (q) Be able to identify and characterize common inflammatory processes in the paranasal sinuses and mastoid bones.
 - (r) Be able to identify and classify traumatic lesions of the facial bones, petrous bones and orbits using established classification nomenclature.
 - (s) Be able to identify common inflammatory and neoplastic mass lesions. Have knowledge of criteria for identification and differentiation of causes of cervical adenopathy.

Technical and Non-interpretive Objectives

- (a) Learn to obtain informed consent for invasive procedures for including myelography, angiography and image guided biopsies. The resident must understand and be able to explain the risks, benefits and complications of these procedures to patients and their families.
- (b) Learn to perform fluoroscopically guided punctures of the lumbar spinal canal for the purpose of myelography, spinal fluid collection, and intrathecal injection of medications.
- (c) Assist senior residents, fellows, and attendings in the performance of angiograms, myelograms, and biopsies.

Decision Making and Value Judgment Skills

- (a) Protocol and monitor CT studies. Be able to modify imaging protocols based on identification of unexpected or novel findings.
- (b) Act as a consultant for house staff and attending physicians in the Emergency department.
- (c) Provide emergent provisional interpretations of plain radiographs, CT scans and MR scans as needed.
- (d) Direct the choice of imaging modality and protocol emergent studies.
- (e) Be able to identify those cases that require the additional expertise in assessment of imaging studies.

III. Practice Based Learning and Improvement:

- (a) Residents are required to complete an on line Fluoroscopic Procedures and Radiation Safety module at least biannually.
- (b) The resident should demonstrate evidence of independent reading and learning through the use of printed and electronic sources.
- (c) Follow-up of abnormal or interesting studies should be accomplished through communication with the referring physician and/or patient medical records.
- (d) Residents should assist with preparation and presentation of cases for pediatric interdisciplinary conferences when requested by the attending physician.
- (e) The resident should be competent in using the PACS and Powerscribe systems in the daily accomplishment of the work load and instruct others in its use.

IV. Interpersonal Communication Skills:

- (a) Residents should be able to communicate effectively results of studies to referring clinicians whenever needed. For emergent studies, reports to referring clinicians should be made in a timely manner.
- (b) The resident should be able to effectively convey the findings of examinations through accurate dictation of reports.
- (c) Residents should discuss fluoroscopic procedures and study results with children and their families when requested to do so by supervising faculty.

V. Professionalism:

- (a) Residents are required to complete an on-line professionalism module or other professionalism at least biannually.
- (b) Recognize limitations in personal skill and knowledge, always making sure dictations and consultations are checked by the radiologist in charge.
- (c) Recognize limitations in personal knowledge and skills, being careful to not make decisions beyond the level of personal competence.
- (d) Residents should be able to explain the nature of the examination or findings in an examination to patients and their families when needed.
- (e) Residents should observe ethical principles when recommending further work-up for cases.
- (f) Promptness and availability at work are expected of every resident.
- (g) Residents should dress appropriately at work, wearing a name badge at all times.
- (h) Technologists and other health workers should be treated with respect as part of the health care team.

- (i) Patient confidentiality should be observed at all times.

VI. System Based practice:

- (a) Residents should be familiar with departmental procedures necessary in the performance of the examination.
- (b) Residents should learn appropriate language to be used in communicating to clinicians through reports or consultations so proper management decisions can be made.
- (c) Proper dictations should be made with indications, technique, findings and conclusions
- (d) Residents should dictate and correct their reports in a timely fashion to avoid delay in patient disposition.
- (e) Residents should assist in facilitating examinations whenever possible.
- (f) Resident should recognize the role that nuclear medicine plays in the management of patient's illness and make proper recommendations when needed.
- (g) Residents are encouraged to make suggestions to improve methods and systems utilized in radiology should be made whenever appropriate.

Reading list:

1. Diagnostic Neuroradiology. Anne G. Osborn, CV Mosby.
2. Handbook of Head and Neck Imaging. H. Ric Harnsberger, CV Mosby.
3. MRI, the Basics. Ray H. Hashemi and William G. Bradley, Williams and Wilkins.

Reference Texts:

1. MR Imaging of the Brain & Spine. SW Atlas, Lippincott (Companion CD available)
2. Head and Neck Imaging. Peter M. Som and Hugh D. Curtin, CV Mosby.
3. Pediatric Neuroimaging. A. James Barkovich, Raven Press.

Neuroradiology – Rotation 3, 4, and Elective – Goals and Objectives

I. Patient care:

- (a) Residents are required to complete an on line Patient Care, Radiation Safety module at least biannually.
- (b) The resident should have knowledge of indications for the examinations requested. When the reason for the examination is not clear, the resident should effectively communicate with the patient or referring physician until this is clarified.
- (c) The resident should be familiar with available medical records and how to access them for purposes of patient care.
- (d) All studies should be reviewed with supervising faculty attending.
- (e) Preliminary reports should be made available to all referring clinicians if needed prior to final review of cases. If there is a significant discrepancy between the preliminary reading and final reading, the resident should notify the referring clinician immediately.

II. Medical Knowledge:

- 3rd Rotation reading assignments (AO refers to Osborn's Brain book; RP refers to RadPrimer)**

1. AO Book:

- a. **Chapter 17 (Astrocytomas)**
- b. **Chapter 22 (Tumors of the Meninges)**
- c. **Chapter 23 (Cranial Nerves and Nerve Sheath Tumors)**
- d. **Chapter 34 (Hydrocephalus and CSF Disorders)**

2. RP: Cranial Nerves, Temporal Bone, and Skull base

3. RP: Pediatric Head and Neck

4. RP: Spine Infection and Inflammatory Disorders

5. RP: Spine Congenital/Genetic Disorders

6. RP: Spinal Neoplasms, Benign

7. RP: Spinal Neoplasms, Malignant

- **4th Rotation reading assignments (AO refers to Osborn's Brain book; RP refers to RadPrimer)**
 1. **AO Book:**
 - a. **Chapter 12 (Congenital Infections, Acquired Pyogenic, and Viral Infections)**
 2. **Chapter 14 (HIV/AIDS)**
 3. **Chapter 20 (Pineal and Germ Cell Tumors)**
 4. **Chapter 26 (Sellar Neoplasms and Tumor-like Lesions)**
 5. **Chapter 27 (Metastases and Paraneoplastic Syndromes)**
 6. **Chapter 29 (Approach to Toxic, Metabolic, and Systemic Disease)**
 7. **Chapter 36 (Posterior Fossas Malformations)**
 8. **Chapter 39 (Familial Tumor and Neurocutaneous Syndromes)**
 9. **Brain Imaging: Case Review Series—Opening Round and Fair Game sections**

Knowledge-Based Objectives

- (a) Continue to expand knowledge of the anatomy and functional connections of the brain and spine begun during the first 2 years on the service.
- (b) Develop more detailed understanding of the basic pathology and pathophysiology of diseases of the brain, spine, and head & neck including neoplastic, vascular, and inflammatory lesions.
- (c) Expand and apply knowledge base in emergent neuroradiologic studies, including the triage and protocols for patients with acute ischemic stroke, hemorrhage, and trauma.
- (d) Study extracranial and intracranial vascular anatomy and its pathophysiology using CTA, MRA, catheter angiography, and ultrasound. Be familiar with strengths and weaknesses of these techniques for common imaging indications, and pitfalls in image interpretation.
- (e) Learn patterns of pediatric and developmental neuropathology, including neuronal migration disorders, metabolic disease, and disorders of myelination.
- (f) Refine indications for direct coronal imaging, and orthogonal and 3D reconstructions.
- (g) Learn to prepare and present cases in clinical conferences for tumor board, teaching, and management.

Technical and Non-Interpretive Objectives

- (a) Take increasing responsibility for obtaining informed consent for invasive procedures for including myelography, angiography and image guided biopsies. The resident must understand and be able to explain the risks, benefits and complications of these procedures to patients and their families.
- (b) Expand clinical consultation and technical experience for fluoroscopically guided punctures of the lumbar spinal canal for the purpose of myelography, spinal fluid collection, and intrathecal injection of medications.
- (c) Assist fellows, and attendings in the performance of angiograms, myelograms, and biopsies, taking on an increasing role as appropriate.

Decision-Making and Value Judgment Skills

- (a) Protocol and monitor CT and MRI studies. Learn to set up and refine imaging protocols in CT and MRI based on specific clinical indications. Be able to modify imaging protocols based on identification of unexpected or novel findings at the time of scanning.
- (b) Act as a consultant for house staff and attending physicians in the Emergency department.
- (c) Provide emergent provisional interpretations of plain radiographs, CT scans and MR scans as needed.
- (d) Direct the choice of imaging modality and protocol emergent studies.
- (e) Be able to identify those cases that require the additional expertise in assessment of imaging studies.

III. Practice Based Learning and Improvement:

- (a) Residents are required to complete an on line Fluoroscopic Procedures and Radiation Safety module at least biannually.
- (b) The resident should demonstrate evidence of independent reading and learning through the use of printed and electronic sources.
- (c) Follow-up of abnormal or interesting studies should be accomplished through communication with the referring physician and/or patient medical records.
- (d) Residents should assist with preparation and presentation of cases for pediatric interdisciplinary conferences when requested by the attending physician.
- (e) The resident should be competent in using the PACS and Powerscribe systems in the daily accomplishment of the work load and instruct others in its use.

IV. Interpersonal Communication Skills:

- (a) Residents should be able to communicate effectively results of studies to referring clinicians whenever needed. For emergent studies, reports to referring clinicians should be made in a timely manner.
- (b) The resident should be able to effectively convey the findings of examinations through accurate dictation of reports.
- (c) Residents should discuss fluoroscopic procedures and study results with children and their families when requested to do so by supervising faculty.

V. Professionalism:

- (a) Residents are required to complete an on line professionalism module at least biannually.
- (b) At the end of the rotation, the resident should be able to make preliminary decisions on all matters of film interpretation and consultation, recognizing and obtaining assistance with situations that require the expertise of the radiologist.
- (c) Recognize limitations in personal knowledge and skills, being careful to not make
- (d) decisions beyond the level of personal competence.
- (e) Residents should be able to explain the nature of the examination or findings in an examination to patients and their families when needed.
- (f) Residents should observe ethical principles when recommending further work-up for cases.
- (g) Promptness and availability at work are expected of every resident.
- (h) Residents should dress appropriately at work, wearing a name badge at all times.
- (i) Pediatric radiology technologists and other health workers should be treated with respect as part of the health care team.
- (j) Patient confidentiality should be observed at all times.

VI. System Based practice:

- (a) Residents should be familiar with departmental procedures necessary in the performance
- (b) of the examination.
- (c) Residents should learn appropriate language to be used in communicating to clinicians through reports or consultations so proper management decisions can be made.
- (d) Proper dictations should be made with indications, technique, findings and conclusions
- (e) Residents should dictate and correct their reports in a timely fashion to avoid delay in patient disposition.
- (f) Residents should assist in facilitating examinations whenever possible.
- (g) Resident should recognize the role that nuclear medicine plays in the management of patient's illness and make proper recommendations when needed.
- (h) Residents are encouraged to make suggestions to improve methods and systems utilized in radiology should be made whenever appropriate.

Reading list:

1. Diagnostic Neuroradiology. Anne G. Osborn, CV Mosby.
2. Handbook of Head and Neck Imaging. H. Ric Harnsberger, CV Mosby.
3. MRI, the Basics. Ray H. Hashemi and William G. Bradley, Williams and Wilkins.

Reference Texts:

1. Magnetic Resonance Imaging of the Brain and Spine. Scott W. Atlas, Lippincott (Companion CD available).
2. Head and Neck Imaging. Peter M. Som and Hugh D. Curtin, CV Mosby.
3. Pediatric Neuroimaging. A. James Barkovich, Raven Press.

Neuroangiography – PGY 2-5 – Goals and Objectives

I. Patient Care

Residents must be able to provide patient care that is compassionate, appropriate, and effective for the treatment of health problems and the promotion of health. *Residents are expected to:*

- (a) Identify the indications and contraindications for most neuro angiographic procedures.
- (b) Complete reading neuroangiography book handout within twenty-four hours of the first day of the clinical rotation.
- (c) Provide emergency treatment for adverse reactions to intravenous contrast material,
- (d) Become facile with PACs and utilize available information technology to manage patient information.
- (e) Perform routine neuro angiograms with minimal assistance in most patients.
- (f) Perform myelograms with minimal assistance.
- (g) Perform lumbar punctures with only supervision.
- (h) Work with the health care team in a professional manner to provide patient-centered care.
- (i) Notify referring clinician for urgent, emergent, or unexpected findings, and document in dictation.

II. Medical Knowledge

Residents must demonstrate knowledge of established and evolving biomedical, clinical, epidemiological, and social-behavioral sciences, as well as the application of this knowledge to patient care. *Residents are expected to:*

- (a) Correctly recognize routine and variant vascular anatomy.
- (b) Accurately interpret all but the most complex angiographic procedures and myelograms.
- (c) Recognize limitations of personal competency and ask for guidance when appropriate.
- (d) To learn about all the indications and risks of a procedure and obtain informed consent.
- (e) Should be able to detect and handle complications from an angiogram or myelogram.

III. 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 based on constant self-evaluation and lifelong learning. *Residents are expected to develop skills and habits to be able to:*

- (a) Assess angiographic images for quality and suggest methods of improvement.
- (b) Demonstrate independent self-study using various resources including texts, journals, teaching files, and other resources on the internet.
- (c) Facilitate the learning of students and other health care professionals.
- (d) Incorporate formative feedback into daily practice, positively responding to constructive criticism.
- (e) Follow-up interesting or difficult cases without prompting and share this information with appropriate faculty and fellow residents.

V. Interpersonal Communication Skills:

Residents must demonstrate interpersonal and communication skills that result in the effective exchange of information and teaming with patients, their families, and professional associates.

Residents are expected to:

- (a) Know the importance of accurate, timely, and professional communication.
- (b) Produce concise and accurate reports on most examinations.
- (c) Communicate effectively with physicians, other health professionals.
- (d) Obtain informed consent with the utmost professionalism.
- (e) Work effectively as a member of the patient care team.

V. Professionalism

Residents must demonstrate a commitment to carrying out professional responsibilities and an adherence to ethical principles. *Residents are expected to demonstrate:*

- (a) Understanding of the need for respect for patient privacy and autonomy.
- (b) Understanding of their responsibility for the patient and the service, including arriving in the reading room promptly each day, promptly returning to the reading room after conferences, completing the work in a timely fashion, and not leaving at the end of the day until all work is complete. If the resident will be away from a service (for time off, meeting, board review, etc.),

- this *must* be arranged in advance with the appropriate faculty and/or fellow.
- (c) Sensitivity and responsiveness to a diverse patient population, including but not limited to diversity in gender, age, culture, race, religion, disabilities, and sexual orientation.
 - (d) Respect, compassion, integrity, and responsiveness to patient care needs that supersede self-interest.

VI. Systems-Based Practice

Residents must demonstrate an awareness of, and responsiveness to, the larger context and system of health care, as well as the ability to call effectively on other resources in the system to provide optimal health care. *Residents are expected to:*

- (a) Understand how their image interpretation affects patient care.
- (b) Provide accurate and timely interpretations to decrease length of hospital and emergency department stay.
- (c) Appropriately notify the referring clinician if there are urgent or unexpected findings and document such without being prompted.
- (d) Practice using cost effective use of time and support personnel.
- (e) Advocate for quality patient care in a professional manner, particularly concerning imaging utilization issues.

Reading list:

1. Diagnostic Neuroradiology. Anne G. Osborn, CV Mosby.
2. Handbook of Head and Neck Imaging. H. Ric Harnsberger, CV Mosby.
3. MRI, the Basics. Ray H. Hashemi and William G. Bradley, Williams and Wilkins.

Reference Texts:

1. Magnetic Resonance Imaging of the Brain and Spine. Scott W. Atlas, Lippincott (Companion CD available).
2. Head and Neck Imaging. Peter M. Som and Hugh D. Curtin, CV Mosby.
3. Pediatric Neuroimaging. A. James Barkovich, Raven Press.

Journals:

1. American Journal of Neuroradiology
2. Radiology
3. American Journal of Roentgenology
4. Neuroimaging Clinics of North America