Cardiovascular Goals and Objectives

Education Purpose: Residents should receive a fundamental understanding of the methods, indications, and contraindications for cardiovascular NM, MR and CT. The mentored interpretations of cardiac and vascular cases should be coupled with comparison and integration of the results with relevant clinical and other imaging studies.

Teaching Methods and Resources

A. Lectures: Twice monthly cardiovascular case based and didactic lectures will be given during each academic year with each topic covered once, to be repeated every two years. Topics will include:
- Knowing your tubes and lines
- Postoperative thorax
- Thoracic Aorta and Great Vessels
- Myocardial Disease
- Cardiac Valvular Disease
- Pericardial Disease
- Congenital Heart Disease in the Adult
- Congenital Heart Disease in childhood:
- Ischemic Heart Disease
- Non-ischemic Heart Disease

B. Self-directed study:
i. www.MRIsafety.com which list all devices and the safety of CMR
ii. www.med-ed.virginia.edu/courses/rad/cardiacmr/index.html which provides an introduction to cardiac MR with post test question
iii. SCMR.org which is the society of cardiac MRI
iv. Textbooks-
***Lee. Cardiovascular MR Imaging: Physical Principles to Practical Protocols***
-- Cardiac Imaging: the Requisites; Mosby, second edition, 2004
-- Bogart. Clinical Cardiac MR
-- Kwong. Cardiovascular Magnetic Resonance Imaging

ROTATION 1 (Radiology Year 1):

Resident responsibilities:

- Cardiac CT, MR, NM studies
- Consultations with referring clinicians
- Cardiology and Cardiovascular Interdisciplinary Conferences

MEDICAL KNOWLEDGE:

- Residents must demonstrate knowledge about established and evolving biomedical, clinical,
and cognitive sciences and the application of this knowledge to patient care.

At the end of the first rotation, the resident should be able to:

**Knowing your tubes and lines**
1. Describe and identify on chest radiography the normal appearance and complications associated with each of the following:
   - endotracheal tube
   - central venous catheter
   - peripherally inserted central venous catheter
   - pulmonary artery catheter
   - feeding tube
   - nasogastric tube
   - chest tube
   - intra-aortic balloon pump
   - pacemaker generator and leads (including triple lead devices)
   - automatic implantable cardiac defibrillator
   - left ventricular assist device
   - atrial septal defect closure device
   - pericardial drain
   - extracorporeal life support cannulae (ECMO)
   - intraesophageal manometer, temperature probe or pH probe
   - tracheal, bronchial or esophageal stent
2. Explain how an intra-aortic balloon pump works.
3. Describe the venous anatomy and expected course of veins from the axillary vein to the right atrium relative to anatomic landmarks.
4. Recognize the difference between a skinfold and pneumothorax on a portable chest radiograph.

**Postoperative thorax.**
1. Identify normal postoperative findings and complications of the following procedures on chest radiography, CT, and MRI:
   - wedge resection, lobectomy, pneumonectomy
   - coronary artery bypass graft surgery
   - cardiac valve replacement
   - aortic graft
   - aortic stent
   - transhiatal esophagectomy
   - lung transplantation
   - heart transplantation
   - lung volume reduction surgery.

**PRACTICE-BASED LEARNING AND IMPROVEMENT**

Residents must be able to investigate and evaluate their patient care practices, appraise and assimilate scientific evidence, and improve their patient care practices.

At all levels, residents will be expected to:
• Apply knowledge of study designs and statistical methods to the appraisal of clinical studies and other information on the diagnostic effectiveness of cardiovascular imaging and its role in clinical care of the patient
• Use information technology to manage information, access on-line medical information; and support their own education
• Facilitate the learning of students and other health care professionals
• Locate, appraise and assimilate evidence from scientific studies about cardiovascular and thoracic imaging
• Recognize limitations in personal knowledge and skills, being careful to not make decisions beyond the level of personal competence

SYSTEMS BASED PRACTICE

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

Residents are expected to:

• Understand how their professional practice affects other health care professionals, the health care organization and the larger society, and how these elements affect their own practice
• Assist referring clinicians in providing cost effective healthcare
• Practice cost effective health care and resource allocation that does not compromise quality of care
• Recognize when the submitted study does not answer the posed clinical question

PATIENT CARE

Residents must be able to provide age appropriate patient care that is compassionate, appropriate and effective for the diagnosis and treatment of health problems.

Residents are expected to:

• Communicate effectively and demonstrate caring and respectful behaviors when interacting with patients and their families
• Gather essential and accurate medical and radiologic history pertinent to the procedure for which the patient is scheduled
• Make informed decisions about diagnostic and therapeutic interventions based on patient information, up-to-date scientific evidence and clinical judgment
• Work with health care professionals, including those from other disciplines to provide patient focused care
• Dictate examinations accurately after review by the attending radiologist

INTERPERSONAL COMMUNICATION SKILLS
Residents must be able to demonstrate interpersonal and communication skills that result in effective information exchange with technologists, referring physicians and other medical personnel. Residents are expected to

- Provide appropriate CT protocols for cardiovascular imaging
- Communicate findings effectively with the referring clinicians
- Communicate and document the communication of critical findings with the appropriate medical personnel in a timely fashion.
- Preliminary review studies and discuss findings with the radiologist, then dictate as directed
- Suggest the appropriate study to answer clinical questions after consultation with attending radiologist

PROFESSIONALISM

Residents must demonstrate a commitment to carrying out professional responsibilities, adherence to ethical principles, and sensitivity to a diverse patient and professional population. Residents are expected to

- Demonstrate respect, compassion and integrity
- A commitment to excellence and on-going professional development
- Demonstrate a commitment to ethical principles pertaining to provision or withholding of clinical care, confidentiality of patient information, and business practices
- Demonstrate sensitivity and responsiveness to patients' culture, age, gender and disabilities
- Recognize limitations in personal knowledge and skills, being careful to not make decisions beyond the level of personal competence

ROTATION 2 (Radiology Year 2):

Resident responsibilities:

- Cardiac CT, MR, NM studies
- Consultations with referring clinicians
- Cardiology and Cardiovascular Interdisciplinary Conferences

MEDICAL KNOWLEDGE:

At the end of the second rotation, in addition to the previous educational objectives, the resident should be able to:

**Thoracic Aorta and Great Vessels.**—
1. State the normal dimensions of the thoracic aorta.
2. Describe the classifications of aortic dissection (De-Bakey I, II, III; Stanford A, B) and implications for classification on medical versus surgical management.
3. Describe and recognize the findings of, and distinguish between each of the following on CT and MR:
- aortic aneurysm
- aortic dissection
- aortic intramural hematoma
- penetrating atherosclerotic ulcer
- ulcerated plaque
- ruptured aortic aneurysm
- sinus of Valsalva aneurysm
- subclavian or brachiocephalic artery aneurysm
- aortic coarctation
- aortic pseudocoarctation
- pulsation artifact at aortic root

4. Recognize a right aortic arch and a double aortic arch on a chest radiograph, chest CT, and chest MRI.
5. State the significance of a right aortic arch with mirror image branching versus with an aberrant subclavian artery.
6. Recognize a cervical aortic arch on a chest radiograph and CT.
7. Recognize an aberrant subclavian artery on chest CT.
8. Recognize normal variants of aortic arch branching, including common origin of brachiocephalic and left common carotid arteries (“bovine arch”), and separate origin of vertebral artery from arch on CT and MRI/MRA.
9. Define the terms aneurysm and pseudoaneurysm.
10. Describe the cardiac anomalies commonly associated with aortic coarctation.
11. Describe and identify the findings of Takayasu arteritis on chest CT and chest MRI.
12. Describe the advantages and disadvantages of CT, MRI/MRA, and transesophageal echocardiography in the evaluation of the thoracic aorta.

Myocardial Disease.—
1. Define the types of cardiomyopathy (dilated, hypertrophic, restrictive) and list the common causes of each.
2. Define right ventricular dysplasia, describe the role of MRI in its diagnosis, and identify MRI findings that support the diagnosis.
3. Name the most common benign primary cardiac tumors, including myxoma, lipoma, fibroma, and rhabdomyoma.
4. Name the most common malignant primary cardiac tumors, including angiosarcoma, rhabdomyosarcoma, and lymphoma.
5. Distinguish cardiac tumor from thrombus on CT and MRI.
6. Name the most common malignancies to metastasize to the heart, and describe the appearance on a chest radiograph, chest CT and chest MR.
7. Describe the advantages and disadvantages of echocardiography, CT, and MRI for evaluation of cardiomyopathy and cardiac tumors.
8. Recognize calcification of papillary muscles as distinct from myocardial calcifications and describe the significance of each.

ROTATION 3 (Radiology Year 3):

Resident responsibilities:
MEDICAL KNOWLEDGE:

At the end of the third rotation, in addition to the previous educational objectives, the resident should be able to:

**Cardiac Valvular Disease.**
1. Identify and describe the findings of each on a chest radiograph:
   - enlarged right atrium
   - enlarged left atrium
   - enlarged right ventricle
   - enlarged left ventricle
2. Describe and recognize the chest radiograph findings associated with each of the following valvular diseases:
   - mitral regurgitation
   - mitral stenosis
   - aortic regurgitation
   - aortic stenosis
   - tricuspid regurgitation
3. Recognize an enlarged ascending aorta and aortic valve calcification on a chest radiograph and suggest the diagnosis of aortic stenosis when these findings are present.
4. Recognize an enlarged left atrium, vascular redistribution, and mitral valve calcification on a chest radiograph and suggest the diagnosis of mitral stenosis when these findings are present.
5. State the most common etiologies of the following:
   - aortic stenosis
   - aortic regurgitation
   - mitral stenosis
   - mitral regurgitation
   - tricuspid regurgitation
   - pulmonary stenosis
6. Name the cardiac diseases associated with mitral annulus calcification
7. Identify endocarditis or complications of endocarditis on a chest radiograph, CT, and MRI.
8. Describe the advantages and disadvantages of echocardiography and MRI for evaluation of valvular heart disease.
9. Describe the pulse sequences and appropriate planes for evaluating cardiac valvular disease and making quantitative measurements including pressure gradients, regurgitant fractions, and valve areas.

**Pericardial Disease.**
1. Recognize pericardial calcification on a chest radiograph and CT and name the most common causes.
2. Describe and identify two chest radiographic signs of a pericardial effusion.
3. Name five causes of a pericardial effusion.

4. Describe and recognize the findings of each of the following on a chest radiograph, CT, and MR:
   - pericardial cyst
   - constrictive pericarditis
   - pericardial hematoma
   - pericardial metastases
   - partial and complete absence of the pericardium
   - pneumopericardium

5. Describe the role of MRI in diagnosing constrictive pericarditis and differentiating constrictive pericarditis from restrictive cardiomyopathy.

**ROTATION 4 (Radiology Year 4):**

Resident responsibilities:

- Cardiac CT, MR, NM studies
- Consultations with referring clinicians
- Cardiology and Cardiovascular Interdisciplinary Conferences

**MEDICAL KNOWLEDGE:**

At the end of the fourth rotation, in addition to the previous educational objectives, the resident should be able to:

**Congenital Heart Disease in the Adult.**—

1. Recognize increased vascularity and decreased vascularity on a chest radiograph and name the common causes of each.

2. Describe and recognize the following on a chest radiograph, CT, or MRI.

**Heart disease presenting during adulthood:**

- Left-to-right shunts and Eisenmenger physiology
- Atrial septal defect
- Ventricular septal defect
- Partial anomalous pulmonary venous connection
- Patent ductus arteriosus
- Coarctation of the aorta
- Tetralogy of Fallot and pulmonary atresia with ventricular septal defect
- Congenitally corrected transposition of the great arteries
- Persistent left superior vena cava
- Truncus arteriosus
- Ebstein anomaly
- Cardiac malposition, including abnormal situs
- Coronary artery anomalies

**Heart disease originally treated in childhood:**
Coarctation of the aorta
Tetralogy of Fallot and pulmonary atresia with ventricular septal defect
Complete transposition of the great arteries
Congenitally corrected transposition of the great arteries
Truncus arteriosus
Commonly performed surgical corrections for congenital heart disease

3. Define the role of angiography, echocardiography, chest CT, and chest MRI in the evaluation of an adult patient with congenital heart disease, including the advantages and limitations of each modality depending on patient presentation.

**Ischemic Heart Disease.**—
1. Describe the anatomy of the coronary arteries and identify the following on a coronary arteriogram, MRI, and CT:
   - right coronary artery
   - left main coronary artery
   - left anterior descending coronary artery
   - left circumflex coronary artery
   - obtuse marginal
   - diagonals
   - acute marginals
   - septal perforators

2. Describe the clinical significance of coronary arterial calcification on a chest radiograph.
3. Recognize coronary arterial calcification on CT and describe the current role of coronary artery calcium scoring with helical or electron beam CT.
4. Name the coronary artery that is usually diseased when there is papillary muscle dysfunction.
5. Describe the common acute complications of myocardial infarction, including left ventricular failure, myocardial rupture, and papillary muscle rupture, and recognize radiologic findings indicating each.
6. Describe the common late complications of myocardial infarction, including ischemic cardiomyopathy, left ventricular aneurysm, left ventricular pseudoaneurysm, coronary-cameral fistula, dyskinesis, and akinesis, and recognize radiologic findings indicating each.
7. Identify signs of left heart failure on a chest radiograph and CT.
8. Define ejection fraction, including the normal value for left ventricular ejection fraction.
9. Identify myocardial calcification on CT and describe the etiology and significance of this finding.
10. Describe the difference between a left ventricular aneurysm and pseudoaneurysm.
11. Define and identify myocardial bridging on CT.
12. Define the role of angiography, echocardiography, stress perfusion scintigraphy, chest CT, and chest MRI in the evaluation of a patient with suspected ischemic heart disease as well as stunned myocardium and hibernating myocardium versus areas of infarction, including the advantages and limitations of each modality.
13. Differentiate viable from nonviable myocardium on MRI.
14. Identify myocardial perfusion defects on MRI.
15. Calculate right and left ventricular volumes, including ejection fraction, stroke volume, end-diastolic volume, and end-systolic volume using MRI and CT.

**Resident Evaluation:**

A. System-based Practice Competency
   i. Resident has a good understanding of the cardiovascular imaging workflow and assists in improving efficiency
   ii. Resident enters and retrieves CT and MRI data and attempts interpretation of studies. Resident ideally logs all cases into a personal procedure log.

B. Practice-based Learning and Improvement Competency
   i. Resident is responsive to constructive suggestion and demonstrates improvement in deficiencies
   ii. Resident is committed to cardiovascular scholastic learning and the use of evidence based cardiovascular imaging

C. Interpersonal and Communication Skills
   i. Resident effectively communicates and interacts with MRI and CT technologists
   ii. Resident effectively communicates with other clinicians and staff

D. Medical Knowledge
   i. Understand cardiovascular imaging sequences
   ii. Identify which sequences are used for a particular diagnosis and which diagnosis can be best made by CT or MR
   iii. Identify indications and contraindications of gadolinium or CT contrast for the particular diagnosis

C. Patient care
   i. Resident will appropriately triage patients for CT or MR. This will require knowledge about indication and contraindications for studies
   ii. Resident will be able to correlated cardiovascular imaging results with other imaging modalities

D. Professionalism
   i. Resident arrives on service on time and is an active participant
ii. Resident is available and accessible for patient care at all times

iii. Resident fulfills any additional obligations of the rotation including didactic conferences and case presentations