CARDIAC IMAGING ROTATION:
Cardiology Fellows
2007 – 2008

Overview of Imaging Curriculum Statement
Cardiovascular specialists are required to have skills in the indications for, performance of and interpretation of cardiac imaging procedures using radionuclides, CT, MR and PET techniques. The goal of the two required imaging rotations for cardiology fellows is to accomplish Level I training in these disciplines and to offer a platform for more advanced training if desired by a trainee. The schedule for the two required months is a composite of the imaging technologies designed to best integrate the educational experience for the trainee. This experience will be further supplemented by nuclear imaging during the VA rotations and through the didactic conferences and direct patient care experienced by each fellow during the three-year training cycle.

Nuclear Cardiology
I. Overview of Rotation
Nuclear cardiology imaging procedures are important elements in the evaluation and management of individuals with suspected or proven cardiovascular disease. The modern cardiologist requires expertise in the appropriate application of nuclear techniques and their interpretation. Furthermore, an understanding of the fundamentals of nuclear medicine technology will enhance the cardiologist's contribution to image acquisition, processing and patient safety.

All cardiology fellows will be required to complete a core experience in nuclear cardiology (2 imaging months, 1-2 months additional cumulative embedded in general program) devoted to gaining a general overview in the field. The core cardiology curriculum mandates that the first month rotation in the nuclear laboratory occur during the first year of fellowship.

Some cardiology fellows will be interested to satisfy the COCATS Guidelines for Level 2 Training in Nuclear Cardiology by completing a program consisting of the following components (adapted from the COCATS Guidelines):

1. A minimum of 700 hours of didactic, clinical study interpretation, and hands-on clinical case and radiation safety training in nuclear cardiology.
2. A clinical didactic program including a lecture curriculum and self-study which will take place during a one to two year cycle and include all aspects of standard nuclear cardiology imaging procedures.

3. Classroom and laboratory training of a minimum of 80 hours which will cover radiation physics, instrumentation, radiation protection, measurement of radioactivity, pertinent chemistry, mathematics and radiation biology and a review of NRC and state applicable regulations.

4. Participation in the clinical interpretation of a minimum of 300 clinical studies.

5. Correlation of nuclear cardiac studies with other imaging procedures (catheterization or CTA) for a minimum of 30 cases. The may be covered in a classroom setting.

6. Direct hands-on participation in a minimum of 25 myocardial perfusion scans and 10 resting gated cardiac blood pool scans (MUGA). This participation will include dose preparation and administration, study acquisition, processing and interpretation.

7. On going training in radiation safety during the clinical experience. This will include a) Ordering, receiving and unpacking radioactive materials safely and performing the related radiation surveys;

   b) Performing quality control procedures on instruments used to determine the activity of dosages and performing checks for proper operation of survey meters;

   c) Calculating, measuring and safely preparing patient or human research subject dosages;

   d) Using administrative controls to prevent a medical event involving the use of unsealed byproduct material;

   e) Using procedures to safely contain spilled radioactive material and using proper decontamination procedures;

   f) Administering dosages of radioactive material to patients or human research subjects; and

   g) Eluting generator systems appropriate for preparation of radioactive drugs for imaging and localization studies, measuring and testing the eluate for radionuclide purity, and processing the eluate with reagent kits to prepare labeled radioactive drugs.
II. Medical Knowledge

The cardiology fellow rotating through nuclear cardiology is expected to participate in all aspects of the operation of the nuclear medicine laboratory as permitted by a graduated learning process. The major learning objectives associated with the nuclear laboratory rotations are identified below.

For those fellows who wish to complete Level 2 training and be eligible to take the certifying examination of the American Board of Nuclear Cardiology, additional dedicated time is necessary to satisfy the COCATS requires described above.

First Month (88 hours):
1. Clinical
   a) Learn the indications and contraindications to standard and pharmacologic stress testing.
   b) Understand the proper application and various acquisition protocols for myocardial perfusion imaging.
   c) Correlate angiographic, ultrasound or other relevant clinical details to the information gained from nuclear cardiac techniques.

2. Technical
   a) Gain an understanding of basic principles of gamma camera function and image acquisition.
   b) Learn the standard operation of the imaging workstation
   c) Understand the basic characteristics of thallium and technetium tracers.

Second Month (88 hours)
1. Clinical
   a) Learn the principles of gated myocardial perfusion imaging and cardiac blood pool scanning.
   b) Understand the advantages and disadvantages of the different available myocardial tracers including sestamibi, tetrofosmin, teboroxime and thallium.
   c) Refine skills in interpretation of all imaging studies performed during the rotation.

2. Technical
a) Gain a full understanding of the principles of radiation safety including the ALARA (as low as reasonably achievable) and dose reduction (time, distance and shielding).
b) Understand how to monitor for radiation contamination as well as its prevention and the steps to follow when it occurs.

Third month (88 hours)
1. Clinical
   a) Become familiar with PET imaging of myocardial perfusion (Rb-82, N-13 ammonia) and viability (FDG)
   b) Appreciate the potential role of the following:
      i. Myocardial infarct imaging
      ii. Shunt studies
      iii. Metabolic imaging with fatty acids and norepinephrine analogs
   c) Understand the application of first pass radionuclide angiography.

2. Technical
   a) Appreciate quality control issues in nuclear imaging, including uniformity floods, energy peaking, center of rotation and attenuation artifacts.
   b) Understand quality control issues in nuclear medicine laboratories, including room surveys, wipe tests and administrative controls.

Integrated time in Nuclear Cardiology (100 hours)
Also counted for the nuclear cardiology training experience through is time spent in consultation regarding nuclear imaging examinations, conference time (attending and presenting), and work done at the White River Junction VAMC.

Elective time, for Level 2 training (50 hours/week)
1. Clinical
   a) Demonstrate the ability to independently manage a stress lab and imaging facility.

2. Technical
   a) Understand the components of radiopharmaceutical kit production.
   b) Participate in dose calibration and preparation
   c) Observe the multiple aspects of ordering, receiving and unpacking radionuclide materials safely.
Additional responsibilities for the cardiology fellow during the nuclear cardiology rotation include the direct supervision of stress tests, both treadmill and pharmacologic, as scheduled daily in the department. It is expected that the fellow will identify the purpose of the study in each patient and bring the clinical elements to the daily interpretive sessions. Attendance at the interpretive sessions is mandatory.

The supervising physicians from Cardiology and Nuclear Medicine, with the participation of the cardiology fellows, will develop and maintain a teaching file of supplementary educational material composed of case studies, relevant literature from peer-reviewed journals and other teaching aids. In addition, cardiology fellows will participate in the Nuclear Cardiology teaching core curriculum, consisting of periodic didactic lectures and case presentation conferences.

It is anticipated that fellows will have an opportunity to read or utilize study materials during working hours for some component of most days. The following list of educational resources is considered fundamental to gaining a full understanding of nuclear cardiology.

III. Bibliography

IV. Core competencies

Patient Care
- The fellow gathers essential and accurate information regarding patients scheduled for cardiac MR, CT, and nuclear imaging examinations.
- The fellow integrates diagnostic imaging results into a management strategy.
- The fellow demonstrates competency in performing the post-processing of imaging data and in interpretation of diagnostic images.

Medical Knowledge
- The fellow demonstrates knowledge of the physical principles and technical aspects of diagnostic imaging studies.
- The fellow exhibits sound reasoning and analysis of the cardiac imaging literature, including application to image interpretation and patient management.

Practice-Based Learning and Improvement
- The fellow engages in self-directed education via a variety of available resources above and beyond assigned materials.
- The fellow synthesizes assigned educational materials and discusses accrued knowledge with students and health care professionals in both formal presentation and informal venues, such as read-out sessions.

Interpersonal and Communication Skills
- The fellow supervises examinations via effective communication with performing technologists.
- The fellow effectively communicates with patients and referring physicians in pre-testing information sharing and post-testing results communication.

Professionalism
- The fellow demonstrates sensitivity and responsiveness to the cardiac imaging needs and concerns of the individual patient.
- The fellow understands the broader societal ramifications and ethical principles surrounding decision-making with respect to the utilization and application of cardiac imaging examinations.
Systems-Based Practice

- The fellow applies evidence-based imaging principles and methodology, such as appropriateness criteria, in the analysis of utilization of cardiac imaging technologies.
- The fellow approaches cardiac imaging modality selection in a manner consistent with the most cost-effective health care delivery without jeopardizing the quality of care.

IV. Administrative Issues

The Nuclear Medicine Laboratory is under the jurisdiction of the Chairman of the Department of Radiology (Peter Spiegel, M.D.) and the Director of Nuclear Medicine (Alan Siegel, M.D.). Cardiology fellows must recognize that they are guests in the laboratory and professional conduct is expected at all times. The fellow is responsible for supervision of the exercise or pharmacologic testing and any medical issues surrounding their successful completion. Specifically, the fellow will assess the appropriateness of the dynamic studies and interact with the ordering physician if concerns regarding contraindications are identified. Furthermore, the fellow will assess and diligently manage any untoward events during the performance of the stress testing or subsequent imaging procedures. The fellow should notify the appropriate staff physicians of any unexpected events.

At the discretion of the Director of Nuclear Medicine, the fellow will participate in various aspects of laboratory operation. This may require an earlier start time to coordinate with the schedule of the nuclear medicine technical staff. The fellow should seek guidance from the Director of Nuclear Medicine or his designee on these issues.

Alan Siegel, MD
Julianna Czum, MD
Edward Catherwood, MD
July 24, 2007
Cardiac CT, MR and PET

I. BACKGROUND

II. STRUCTURE OF ROTATION
   A. Duration
   B. Educational objectives
   C. Evaluation

III. REFERENCES

IV. APPENDICES

   Appendix 1: Cardiology Fellows Cardiac Imaging Rotation Assignment Schedule
   Appendix 2: CT and MR Case Volumes Needed to Support Training Levels
   Appendix 3: Core Competencies
   Appendix 4: Educational Resources
I. BACKGROUND:

Recent advances in cardiac MR and especially cardiac CT require that cardiac imagers-in-training – both cardiology fellows and radiology residents – experience these modalities at a level commensurate with their respective specialty accrediting board recommendations as well as the individual’s target level of achievement. To this end, non-invasive cardiac imaging rotations will accomplish the minimum required level (COCATS Level 1 or ACR equivalent) of training for all cardiology fellows and senior radiology residents, as well as more advanced training (COCATS Level 2 or ACR equivalent) for interested trainees.

As the rotation structure and educational objectives for cardiology fellows and radiology residents are not equivalent, they are handled separately, this document applying only to the fellows.

II. STRUCTURE OF ROTATION:

A. Duration:
   1. Two 4-week imaging blocks annually, for Year One and Year Two fellows
      [See Appendix 1]
   2. Year Three Elective: by arrangement

B. Educational objectives (CT and MR components; Nuclear Cardiology excluded)

   1. Year One rotation
      Indications and contraindications
      Physical principles
         General CT physics and instrumentation
         Unique aspects of gated CT
         General MR physics and instrumentation
         Cardiac-specific MR sequences
      Patient procedure:
         Patient safety issues
         Cardiac CT prep
         Cardiac stress MR
      Imaging protocols
         Parameters
         Acquisition modes
         Pulse sequences
      Post-processing
         Coronary calcium scoring
         Vessel analysis
         Cardiac functional analysis
         Flow analysis
      Interpretation
         Artifacts
         Cardiac findings
         Extracardiac findings, including vascular pathology
      Clinical and imaging correlation
2. Year Two rotation
   Increased level of case supervision, independent post-processing and primary interpretation

3. Year Three elective
   Advanced (Level 2) training in CT or MR
   CT and MR case volumes: increases needed to support elective rotation/Level 2 training [See Appendix 2]

C. Evaluation
   Core competencies-based [See Appendix 3]
   Case log: documentation for minimum Level 1 case volume
   Reading/other educational materials covered
   Participation and performance in conferences
   Other achievements

D. Additional responsibilities:
   Assigned and self-directed reading
   Case presentations (one-per-fellow-per-block at dedicated conference)
   Teaching file submissions
   Imaging conferences: attendance and participation
   Didactic lectures
   Research and publication (during elective/advanced training)

E. Resources [See Appendix 4]

III. REFERENCES


### CARDIAC IMAGING ROTATION ASSIGNMENT SCHEDULE

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Appendix 2: CT and MR Case Volumes Needed to Support Training Levels

**COCATS**
Level 1. General: working knowledge of methods, diagnostic utility, etc.
Level 2. Specialized: 2+ months; independent performance/interpretation
   (Level 3. Advanced: Operation of imaging lab – patient care, teaching, research)

A. *Volumes needed to achieve training levels per COCATS:*

1. **MR:**
   a. **Level 1** (1 month): Minimum 50 cases: “live” cases preferred, but can be from teaching file and/or other sources.
   b. **Level 2** (3-6 months): Minimum 150 cases: minimum 50 “live” cases (as interpreter) + 100 other cases (up to 50 of these from teaching file and/or other sources).

2. **CT:**
   a. **Level 1** (1 month): Minimum 50 cases: “live” cases preferred, but can be from teaching file and/or other sources.
   b. **Level 2** (2 months): Minimum 150 contrast cases (at least 50 non-contrast included or separate from contrast studies): minimum 35 “live” cases (fellow present) + the rest can be other cases (up to 50 of these from teaching file and/or other sources).

B. *Calculation of volumes needed to support training compared to current volumes:*

1. **MR:**
   a. **Level 1**: N/A. Can be achieved during one rotation, with a combination of “live” cases and other sources.
   b. **Level 2**: If there are: 6-7 MRs/week x 4-week rotation = 24-28 cases/rotation, can achieve approximately 50 cases in 2 rotations. Will need 1+ case/day. Current volumes from 1/1/07 to 5/31/07 = 75, i.e. 15/month. Thus, need approximately 100 % increase (2x) in volume.

2. **CT:**
   a. **Level 1**: N/A. Can be achieved during one rotation, with a combination of “live” cases and other sources.
   b. **Level 2**: If there are: 4-5 CTs/week x 4-week rotation = 16-20 cases/rotation, can achieve approximately 35 cases in 2 rotations. Will need 2+ cases/day (Tuesdays and Thursdays; 8 days in 4 weeks). Current volumes from 1/1/07 to 5/31/07 = 39, i.e. approximately 8/month. Thus, need approximately 100+ % increase (>2x) in volume.
Appendix 3

CORE COMPETENCIES

Patient Care
- The fellow gathers essential and accurate information regarding patients scheduled for cardiac MR, CT, and nuclear imaging examinations.
- The fellow integrates diagnostic imaging results into a management strategy.
- The fellow demonstrates competency in performing the post-processing of imaging data and in interpretation of diagnostic images.

Medical Knowledge
- The fellow demonstrates knowledge of the physical principles and technical aspects of diagnostic imaging studies.
- The fellow exhibits sound reasoning and analysis of the cardiac imaging literature, including application to image interpretation and patient management.

Practice-Based Learning and Improvement
- The fellow engages in self-directed education via a variety of available resources above and beyond assigned materials.
- The fellow synthesizes assigned educational materials and discusses accrued knowledge with students and health care professionals in both formal presentation and informal venues, such as read-out sessions.

Interpersonal and Communication Skills
- The fellow supervises examinations via effective communication with performing technologists.
- The fellow effectively communicates with patients and referring physicians in pre-testing information sharing and post-testing results communication.

Professionalism
- The fellow demonstrates sensitivity and responsiveness to the cardiac imaging needs and concerns of the individual patient.
- The fellow understands the broader societal ramifications and ethical principles surrounding decision-making with respect to the utilization and application of cardiac imaging examinations.

Systems-Based Practice
- The fellow applies evidence-based imaging principles and methodology, such as appropriateness criteria, in the analysis of utilization of cardiac imaging technologies.
- The fellow approaches cardiac imaging modality selection in a manner consistent with the most cost-effective health care delivery without jeopardizing the quality of care.
Appendix 4

**EDUCATIONAL RESOURCES (list incomplete)**

**Texts:**

*MR:*


*CT:*


**Journal volumes/monographs**


**Journal articles:**

*MR:*


5. Sangeeta Mandapaka, Ralph D'Agostino, Jr and W. Gregory Hundley Does Late Gadolinium Enhancement Predict Cardiac Events in Patients with Ischemic Cardiomyopathy? Circulation 2006;113;2676-2678.


CT:


On-line resources
www.ctisus.com
www.cardiosource.com

Self-assessment
1. CCT-SAP and CMR-SAP. American College of Cardiology.