What's New in 10 Years? A Revised Cardiothoracic Curriculum for Diagnostic Radiology Residency with Goals and Objectives Related to General Competencies

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This is a cardiothoracic curriculum document for radiology residents meant to serve not only as a study guide for radiology residents but also as a teaching and curriculum reference for radiology educators and radiology residency program directors. This document represents a revision of a cardiothoracic radiology resident curriculum that was published 10 years ago in *Academic Radiology*. The sections that have been significantly revised, expanded, or added are (1) lung cancer screening, (2) lung cancer genomic profiling, (3) lung adenocarcinoma revised nomenclature, (4) lung biopsy technique, (5) nonvascular thoracic magnetic resonance, (6) updates to the idiopathic interstitial pneumonias, (7) cardiac computed tomography updates, (8) cardiac magnetic resonance updates, and (9) new and emerging techniques in cardiothoracic imaging. This curriculum was written and endorsed by the Education Committee of the Society of Thoracic Radiology. This curriculum operates in conjunction with the Accreditation Council for Graduate Medical Education (ACGME) milestones project that serves as a framework for semiannual evaluation of resident physicians as they progress through their training in an ACGME-accredited residency or fellowship programs. This cardiothoracic curriculum document is meant to serve not only as a more detailed guide for radiology trainees, educators, and program directors but also complementary to and guided by the ACGME milestones.

Key Words: curriculum; cardiothoracic; radiology residency; Accreditation Council for Graduate Medical Education (ACGME); American Board of Radiology (ABR); study guide; examination.

INTRODUCTION

This document is a revision of a previously published cardiothoracic curriculum for diagnostic radiology residency (1) and reflects interval changes in the clinical practice of cardiothoracic radiology, including updates in the Accreditation Council for Graduate Medical Education (ACGME) requirements for diagnostic radiology training programs.

Radiology residency programs must define the specific knowledge, skills, behaviors, and attitudes required of residents and must provide adequate educational experience to achieve competency in six areas defined by the ACGME: (1) patient care (PC), (2) medical knowledge (MK), (3) professionalism (P), (4) interpersonal/communication skills (ICS), (5) practice-based learning and improvement (PBLI), and (6) systems-based practice (SBP). These six areas, as they specifically relate to radiology, have been previously published (2).

The 10 subspecialty areas of radiology residency, as defined by the ACGME, are neuroradiology, musculoskeletal radiology,

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vascular and interventional radiology, *cardiac radiology* (new since 2005), chest radiology, breast imaging, abdominal radiology, pediatric radiology, ultrasound (including obstetrical ultrasound and vascular), and nuclear medicine.

The Society of Thoracic Radiology (STR) Education Committee has responded to the changing practice of cardiothoracic imaging and the revised ACGME guidelines by revising the previously published Cardiothoracic Curriculum document. There have also been important changes to the structure of radiology residencies across the United States since the last curriculum document was published (1). The STR Education Committee decided to keep the structure of the curriculum document divided into years 1 and 2, then years 3 and 4 combined, recognizing that the new residency format with general and subspecialty years may not allow a trainee to achieve all the educational goals and objectives in years 3 and 4 if the trainee has not selected cardiothoracic imaging as a subspecialty. Ideally, the third and fourth rotations must occur in year 3 or very early in year 4 so that both occur before the new core American Board of Radiology (ABR) examination that typically occurs early in year 4.

This curriculum document is focused on adult cardiothoracic imaging, as pediatric radiology is considered a separate subspecialty by the ACGME. There is overlap, however, between cardiothoracic imaging and other ACGME subspecialties and, where appropriate, components of other ACGME subspecialties, such as ultrasound or vascular and interventional radiology, are also included. Educational objectives for physics are not included in this document, as most radiology residencies include a physics course with its own course objectives.

In this document, learning goals and objectives that relate to clinical knowledge, technical, communication, and decision-making skills are outlined for each year of training.

Six general competencies have been defined by the ACGME (2,3). Throughout this document, the following abbreviations for the six specific competencies are used: PC, MK, P, ICS, PBLI, and SBP.

The ACGME has recently completed a milestone project to describe competency-based developmental outcomes with several purposes. For the radiology residency training programs (as well as fellowship programs), the ACGME milestones serve as a framework for Clinical Competency Committees and guide curriculum development as well as aid identification of struggling resident trainees. For the resident trainees, the milestones clearly outline expectations for performance and facilitate self-directed learning and assessment. For accreditation purposes, the ACGME milestones allow for continuous monitoring of training programs and increased public accountability by facilitating reporting of national aggregate competency outcomes according to each subspecialty.

This cardiothoracic curriculum for radiology residents operates in conjunction with the ACGME milestones project that serves as a framework for semiannual evaluation of resident physicians as they progress through their training in an ACGME-accredited residency or fellowship program. This cardiothoracic curriculum document is meant to serve not only as a more detailed guide for radiology trainees, educators, and program directors but also is complementary to and guided by the ACGME milestones.

The Entrustable Professional Activities (EPAs) are "units of professional practice, defined as tasks or responsibilities that trainees are entrusted to perform unsupervised once they have attained competence. EPAs are independently executable, observable, and measurable in their process and outcome, and, therefore, suitable for entrustment decisions." EPAs may incorporate multiple competencies as they describe the tasks a particular specialist should be able to complete without supervision upon graduation from residency and fellowship. The medical knowledge, interpretative, and procedural skills outlined in this cardiothoracic curriculum document reflect the EPAs outlined by the ACGME milestones project that should be achieved by a radiology resident during the course of the residency.

This curriculum document is based on three 4-week rotations in cardiothoracic imaging. Residency training programs may organize these blocks into different numbers of cardiac, thoracic, or cardiothoracic blocks of varying length. It is the hope of the STR Education Committee that this document will be comprehensive yet adaptable across many variations in residency training programs worldwide. Because the timing of the rotations and whether they are purely thoracic, cardiac, or cardiothoracic in nature may vary across training programs, individual training programs may adapt this document to their practice, as needed.

The sections that have been significantly revised and expanded or newly added to the previously published curriculum are (1) lung cancer screening, (2) lung cancer genomic profiling, (3) lung adenocarcinoma revised nomenclature, (4) lung biopsy technique, (5) thoracic magnetic resonance (MR), (6) updates to the idiopathic interstitial pneumonias, (7) cardiac computed tomography (CT) updates, (8) cardiac MR updates, and (9) new and emerging techniques in cardiothoracic imaging (Table 1).

Lung cancer screening programs have developed since the last publication of the cardiothoracic resident curriculum based on results of large population-based studies such as the National Lung Screening Trial. This landmark trial demonstrated a 20% relative reduction in lung cancer mortality using low-dose CT lung cancer screening as compared to single-view, posteroanterior chest radiography (4). It is therefore important for radiology residents to be familiar with not only the benefits of CT lung cancer screening but also the reporting terminology and management recommendations according to the American College of Radiology (ACR)-endorsed Lung Imaging Reporting and Data System (5,6).

In recent years, the treatment of lung cancer has become more tailored to the specific genetic mutations expressed by the lung tumors. For example, for patients with metastatic non–small cell lung cancers (especially adenocarcinoma), testing for epidermal growth factor receptor (EGFR) mutations has helped identify patients who will benefit from EGFR (tyrosine kinase) inhibitors (ie, gefitinib) rather than standard chemotherapy. For the radiologist and the radiology trainee, it is important to understand that more cellular content in the fine needle aspirate or more core tissue biopsy samples are required to allow for genetic testing. More detail on lung biopsy technique

TABLE 1. Nine New Content Sections in the Cardiothoracic Resident Curriculum

Content	Comment
Lung cancer screening	With results of the National Lung Cancer Screening Trial available and lung cancer screening programs being developed in North America and internationally, residents should have some awareness of the evidence and mortality benefit behind lung cancer screening with CT and the LUNG-RADS reporting system.
Lung cancer genomic profiling	Genetic profiling of lung cancer performed on lung biopsy specimens provides useful information about endothelial growth factor receptor status especially for adenocarcinoma subtype as well as common genetic mutations such as anaplastic lymphoma kinase (ALK) and kirsten rat sarcoma (K-RAS) that help with targeted therapy with EGFR/tyrosine kinase inhibitors versus standard chemotherapy.
Revised nomenclature for primary lung adenocarcinoma	The International Association for the Study of Lung Cancer (IASLC) revised the adenocarcinoma classification in 2011 to include adenocarcinoma in situ (AIS, formerly known as bronchioloalveolar carcinoma) and added "minimally invasive adenocarcinoma" with reclassification of invasive adenocarcinoma subtypes.
Lung biopsy techniques	More detail on lung biopsy technique and management of complications were added.
Thoracic MR	Thoracic MRI applications have been expanded to include protocols such as chemical shift sequences to help differentiate thymic hyperplasia from thymoma.
Updates on idiopathic interstitial pneumonias (IIP)	Updates on idiopathic interstitial pneumonias have been added.
Cardiac CT updates	More content on cardiac CT have been added to include more specific knowledge requirements.
Cardiac MR updates	Cardiac MRI applications have been expanded and more detail on clinical applications and disease specific knowledge has been added.
New and emerging techniques	Since the last curriculum document, new and emerging techniques have developed. Although residents are not expected to have detailed knowledge of these emerging new techniques, an awareness of such techniques is encouraged.

CT, computed tomography; EGFR, epidermal growth factor receptor; LUNG-RADS, Lung Imaging Reporting and Data System; MRI, magnetic resonance imaging.

and management of complications has also been added to this revised curriculum document.

In 2011, the International Association for the Study of Lung Cancer has revised the adenocarcinoma classification to include adenocarcinoma in situ (formerly known as bronchioloalveolar carcinoma) and added "minimally invasive adenocarcinoma" with reclassification of invasive adenocarcinoma subtypes. It is important for the radiology resident to be familiar with the revised nomenclature of lung adenocarcinoma and have an understanding of the corresponding CT appearance and impact on sub-solid nodule management.

Applications for thoracic magnetic resonance imaging (MRI) have expanded to include thymic and nonvascular indications, and these are outlined in this cardiothoracic curriculum document. Furthermore, some updates to reporting of idiopathic interstitial pneumonias and other interstitial lung diseases have been added. More detailed updates to cardiac CT and MRI have been included. Cardiac imaging is an area that has significantly developed in the last 10 years since the last cardiothoracic curriculum publication in 2005. Increasingly, the ABR resident syllabus and study guide has included cardiac imaging content. This curriculum document has taken into account the ABR syllabus/resident study guide and is concordant with it.

Finally, brief mention of some new and emerging cardiothoracic imaging techniques has been included. Although radiology residents are not expected to have comprehensive knowledge of these new and "under development" imaging modalities, some awareness of them is desirable.

Attendance at departmental and interdepartmental educational conferences and rounds, as well as local, national, and international meetings, is also an important aspect of cardiothoracic education. Because these will vary from institution to institution, they are not listed here. However, selected useful resources for the trainee are provided in Appendix S1 relating to the material that has been newly added or revised.

YEAR 1 (FIRST 4-WEEK ROTATION)

Goals

After completion of the first cardiothoracic radiology rotation, the resident will be able to:

1. demonstrate learning of the knowledge-based objectives
2. dictate a chest radiographic report accurately and concisely
3. communicate effectively with referring clinicians and supervisory staff
4. understand standard patient positioning in cardiothoracic radiology
5. obtain pertinent patient information relevant to radiologic examinations
6. demonstrate knowledge of the clinical indications when obtaining chest radiographs and when CT or MR may be necessary

7. demonstrate a responsible work ethic
8. perform image-guided procedures of the chest
9. participate in quality improvement/quality assurance and other operational activities

Objectives

A. Knowledge based
At the end of the first cardiothoracic radiology rotation, the resident will demonstrate learning of at least one-third of the knowledge-based objectives in the Addendum of this document (PC, MK).

B. Technical, communication, and decision-making skills
At the end of the first cardiothoracic radiology rotation, the resident will demonstrate the following technical, communication, and decision-making skills:
   1. Dictate accurate and concise radiographic and cardiothoracic CT reports that include patient name, medical record number, date of examination, date of comparison examination, type of examination, clinical indication, concise description of findings, and short conclusion (ICS).
   2. Communicate with the ordering physician regarding all significant or unexpected radiologic findings (especially those that require immediate action by the ordering physician) and document who was called and the date and time of the call in the dictated report (IPC, PC).
   3. Obtain relevant patient history from the electronic medical record, previously dictated reports, or by communicating with referring clinicians (PC).
   4. Describe patient positioning and indications for posteroanterior, anteroposterior, lateral decubitus, and lordotic chest radiographs (PC, MK).
   5. Decide when it is appropriate to obtain help from supervisory faculty (P) when assisting referring clinicians with imaging interpretation and patient management.
   6. Arrive at the rotation assignment on time and prepared after reviewing recommended study materials (P).
   7. Successfully perform thoracic biopsies and image-guided therapies (eg, pleural drainage, if performed at the institution) with faculty supervision commensurate with experience and individual competence (PC).
   8. Counsel patients and obtain informed consent (eg, explain conduct and purpose for procedure, explain risks, benefits and alternatives, solicit and answer patient questions) before performing interventional procedures without discriminating based on religious, ethnic, sexual, or educational differences and honoring patient confidentiality (ICS, P).
   9. Document (via electronic or written format) the performance, interpretation, and complications of all procedures performed (PBLI).
   10. Participate in discussions with faculty regarding operational challenges and potential systems solutions regarding all aspects of radiologic service and patient care (SBP).
   11. Use appropriate chest radiograph, CT, and MR terminology when dictating reports and consulting with health-care professionals (ICS).

Conferences and Study Materials

A. Conferences
The ACGME requires didactic conferences as part of the radiology residency training program. Examples of conference types that should be part of a resident's educational program are listed in the following section. Thoracic radiology teaching conferences are mandatory. Other conferences, such as a lung transplant conference, are not available at all training programs but, when available, should be considered for inclusion into the curriculum. Some conferences may be sponsored by other departments such as medicine or surgery. It is important for the resident to attend these multidisciplinary conferences to learn the role of medical imaging in making decisions that affect patient care. Ideally, the residents should be actively involved in preparing and presenting cases at these multidisciplinary conferences (MK, PBLI, SBP, PC, ICS). Some examples include:
   - Resident-specific cardiothoracic radiology teaching conferences
   - Journal review/club
   - Radiology grand rounds
   - Pulmonary medicine conference
   - Intensive care unit conference
   - Thoracic oncology conference
   - Cardiothoracic surgery conference
   - Cardiology conference
   - Lung transplant conference
   - Interstitial lung disease conference
   - Quality assurance/quality improvement conference
   - Other

B. Teaching
Supervise or act as consultants to medical students (PBLI).

C. Study Materials
Many types of educational materials may be included in this portion of a curriculum document, including textbooks, book chapters, and review articles. Hard copy teaching files (eg, ACR or individual department files), computer-based educational programs, and radiology education websites or teaching files (eg, ACR compact discs (CDs)) should also be included, as recommended by the residency program director or designated faculty within the subspecialty of cardiothoracic radiology (MK).

YEAR 2 (SECOND 4-WEEK ROTATION)

After completion of the second cardiothoracic radiology rotation, in addition to the goals listed for Year 1, the resident will:

1. demonstrate learning of the knowledge-based objectives
2. continue to build on chest radiograph interpretive skills
3. develop skills in protocoling, monitoring, and interpreting cardiothoracic CT studies
4. demonstrate an understanding of ACR Appropriateness Criteria and ACR Practice Standards and Technical Guidelines for thoracic radiology
5. demonstrate ability to generate and interpret multiplanar reformatted, curved planar reformatted, three-dimensional shaded surface display, and volume-rendered reconstructions and other reconstructions, as appropriate

Objectives

A. The resident will demonstrate learning of at least two-thirds of the knowledge-based objectives listed for Year 1 (see Appendix: Supplementary Material), in addition to identifying the following structures on cardiothoracic CT and MRI (MK):
   - Lungs—right, left, right upper, middle, and lower lobes, left upper (including lingula) and lower lobes; secondary pulmonary lobule
   - Pleura—fissures such as major, minor, azygos, accessory (superior and inferior)
   - Inferior pulmonary ligaments
   - Extrapleural fat
   - Airways—trachea, carina, mainstem bronchi, lobar, and segmental bronchi
   - Heart—left ventricle, right ventricle, left atrium, right atrium, mitral valve, aortic valve, tricuspid valve, pulmonic valve, coronary arteries (left main, left anterior descending, left circumflex, right, posterior descending), coronary veins, and coronary sinus
   - Pericardium—including pericardial recesses
   - Pulmonary arteries—main, right, left, lobar, interlobar, segmental
   - Aorta—aortic root, ascending, arch, descending
   - Arteries—brachiocephalic (innominate), common carotid, subclavian, axillary, vertebral, internal mammary, intercostal
   - Veins—pulmonary, superior vena cava, inferior vena cava, brachiocephalic, subclavian, axillary, internal jugular, external jugular, azygos, hemiazygos, left superior intercostal, internal mammary
   - Bones—ribs and costochondral cartilages, clavicles, scapulae, sternum, vertebrae
   - Esophagus
   - Thymus
   - Thyroid gland
   - Muscles—sternocleidomastoid, anterior and middle scalene, infrahyoid, pectoralis major and minor, deltoid, trapezius, infraspinatus, supraspinatus, subscapularis, latissimus dorsi, serratus anterior
   - Aortopulmonary window
   - Azygoesophageal recess
   - Gastrohepatic ligament, celiac axis
   - Diaphragm

B. At the end of the second cardiothoracic radiology rotation, the resident will demonstrate the following technical, communication, and decision-making skills, in addition to those listed for Year 1:
   1. Appropriately protocol all requests for cardiothoracic CT to include thin-section images, high-resolution images, expiratory images, or prone images when appropriate, and use of intravenous contrast, tailored to the patient history and clinical question (PC).
   2. Monitor all cardiothoracic CT examinations and determine if additional imaging is needed before the examination is completed (if this is an institutional practice) (PC).
   3. Demonstrate the ability to effectively present thoracic radiology cases to other residents in a conference setting by appropriately selecting cases, interacting with residents, and presenting a brief discussion of the diagnosis for each case (PBLI).
   4. Demonstrate the ability to manage an intravenous contrast reaction that occurs during a cardiothoracic CT or MR examination (PC).
   5. Act as a consultant for referring clinicians and recommend the appropriate use of imaging studies (ICS).
   6. Describe the principles of chest fluoroscopy, including the assessment of the diaphragm (PC).
   7. Demonstrate knowledge of CT parameters contributing to patient radiation exposure and techniques that can be used to limit radiation exposure (PC).

Conferences and Study Materials

A. Conferences—same as for Year 1

B. Teaching
   Supervise or act as consultants to junior residents and medical students (PBLI).

C. Study Materials
   Compared to the first rotation, more advanced educational resources should be provided for the second rotation in cardiothoracic radiology. Although materials for the first rotation may consist of textbooks, book chapters, or teaching files based primarily on thoracic radiography, more advanced rotations should incorporate additional journal articles, book or book chapters, or teaching files specific to advanced modalities (eg, chest CT, MRI) or thoracic interventions (eg, lung biopsy).

YEARS 3–4 (THIRD 4-WEEK ROTATION TO OCCUR IN YEAR 3 OR EARLY IN YEAR 4 BEFORE CORE EXAMINATION FOR THE ABR EXAMINATION)

Goals

After completion of the third cardiothoracic radiology rotation, in addition to the goals listed for Years 1 and 2, the resident will:

1. demonstrate learning of the knowledge-based objectives
2. refine skills in interpretation of radiographs and cardiothoracic CT studies
3. develop skills in protocoling, monitoring, and interpreting cardiothoracic MR studies
4. become a more autonomous consultant and teacher
5. correlate pathologic and clinical data with radiographic, cardiothoracic CT, and MR findings

Objectives

A. At the beginning of the third cardiothoracic radiology rotation or senior year of radiology residency, the resident will demonstrate knowledge of all of the knowledge-based objectives introduced in Years 1 and 2 (MK)

B. Technical and communication skills
After completion of the third cardiothoracic radiology rotation, the resident will demonstrate the following technical, communication, and decision-making skills, in addition to those listed for Years 1 and 2:

1. Dictate accurate, concise plain radiography, cardiothoracic CT and MR reports with at least 75% accuracy; the reports will contain no major interpretive errors (ICS).
2. State the clinical indications for the performance of cardiothoracic CT and MR (MK, PC).
Thoracic MR indications primarily involve further tissue characterization of thoracic masses that are indeterminate on CT or radiography, scenarios with examples including:
   - distinguishing cystic lesions and hematomas from solid lesions
   - detecting blood products, fibrous material, smooth muscle, microscopic fat, and/or macroscopic fat within lesions
   - differentiating normal and hyperplastic thymus from thymic neoplasms, including lymphoma
   - evaluating the nature and extent of indeterminate pleural disease on CT
   - differentiating tumor from atelectasis
   - evaluating neurovascular and chest wall involvement by thoracic masses
   - using signal characteristics, apparent diffusion coefficient (ADC) values, and dynamic contrast enhancement patterns to help differentiate mediastinal lesions, including hemangiomas, paragangliomas, thymomas, and lymphomas, from one another.
3. Describe cardiothoracic CT protocols optimized for the evaluation of each of the following (MK, PC):
   - thoracic aorta and great vessels
   - coronary calcium
   - pulmonary vein anatomy
   - suspected pulmonary embolism
   - tracheobronchial tree
   - suspected bronchiectasis
   - lung cancer screening
   - lung cancer staging
   - esophageal cancer staging
   - suspected pulmonary metastases
   - suspected pulmonary nodule on chest radiograph
   - shortness of breath
   - hemoptysis
   - cardiac mass
   - coronary arteries
   - suspected pericardial disease
   - ischemic heart disease, including function and viability
   - valvular heart disease
   - right ventricular dysplasia
   - adult congenital heart disease
   - superior sulcus tumor
   - mediastinal mass
   - diffuse and focal pleural disease
   - diaphragmatic rupture or hernia
   - screening for lymphadenopathy, paragangliomas, thoracic endometriosis
4. Understand (1) MR's advantages over CT regarding tissue characterization—more definitive detection of solid, cystic/necrotic, and hemorrhagic tissue, microscopic fat, fibrous tissue and smooth muscle (eg, esophageal leiomyoma); (2) varied dynamic enhancement patterns and diffusion-weighted signal/ADC values of mediastinal and other thoracic masses; (3) resultant added diagnostic specificity of MRI; (4) ability to detect flow on MR sequences. However, CT also has advantages over MRI in the setting of acute trauma for the identification of bony and acute lung trauma. In general, visualization of lung parenchyma with high-resolution detail is superior with CT as compared to MR.
5. Understand the technical principles of thoracic MRI, including techniques to compensate for and/or eradicate cardiorespiratory motion to ensure high-quality vascular and nonvascular thoracic MR imaging.
6. Understand the concept and rationale for focused thoracic MR imaging of focal lesions.
7. Describe thoracic MR protocols optimized for evaluation of (MK, PC):
   - thymic lesions
   - other mediastinal masses
   - diffuse and focal pleural disease
   - well-circumscribed pulmonary nodules ≥1 cm to help distinguish between hamartoma, granuloma, carcinoid, and malignancy
   - lung cancer recurrence versus postobstructive pneumonitis/radiation fibrosis
   - diaphragmatic rupture or hernia
   - thoracic lymphadenopathy
8. Describe MR protocols optimized for the evaluation of each of the following (MK, PC):
   - thoracic aorta
   - pulmonary arteries

- thoracic veins (superior vena cava, brachiocephalic veins)
- pericardium
- cardiomyopathy
- cardiac and paracardiac masses

9. Cardiac CT general technical and communication objectives (PC, MK):

Understand currently accepted indications for cardiac/coronary computed tomography angiography (CTA), including recent evidence-based guidelines on use of coronary CT for evaluation of acute chest pain in the emergency setting.

Understand contemporary cardiac CTA acquisition methods, including electrocardiogram (ECG) gating techniques, typical medications administered, radiation dose reduction techniques, and common imaging artifacts encountered in cardiac CT.

Describe coronary artery, cardiac chamber, cardiac valve, and pericardial disease on cardiac CT.

Understand the role of cardiac CT in preprocedural planning and assessment of postprocedural complications for selected techniques, such as transcatheter aortic valve implantation, pulmonary vein isolation/ablation, and ventricular assist devices.

10. Technical and communication skill objectives for lung biopsy (PC, MK):

Discuss the different types of lung biopsy techniques (ie, FNA and core needle) and review common indications. Discuss preprocedural assessment of patients referred for lung biopsy. Know when EGFR mutation analysis may be required and its impact on acquiring more tissue during CT-guided fine needle aspiration (FNA) or core needle biopsy.

Describe special instructions to the patient before and following lung biopsies.

List complications specific to lung biopsies, including pneumothorax, hemorrhage, hemoptysis, and air embolism.

11. Genomic profiling of lung cancer objectives (PC, MK):

Understand the importance of genomic profiling in lung cancer diagnosis, treatment, and tumor response (PC, MK, SBP).

Learn the recent genomic discoveries in lung cancer and their implications in imaging and therapeutic decision-making (PC, MK).

Learn the importance of imaging in the assessment of therapeutic response in patients treated with targeted therapies for non–small cell lung cancer (PC, MK).

Understand the roles of the different imaging modalities in the assessment of therapeutic response (PC, MK).

Understand the limitations in the use of conventional assessment imaging criteria (ie, Response Evaluation Criteria in Solid Tumors (RECIST), World Health Organization (WHO)) in patients treated with targeted therapy (PC, ICS, MK).

In collaboration with a pathologist, present an interesting cardiothoracic imaging case, with a confirmed diagnosis, correlating clinical history with pathologic and radiologic findings, to residents and faculty (MK, ICS, P, PBLI).

Work in the reading room independently, assisting clinicians with radiologic interpretation (PC, MK, ICS, P).

Teach other residents and medical students assigned to the service (PC, ICS, P, PBLI).

12. New and emerging imaging technology objectives (PC, MK, PBLI, P, SBP):

Radiology residents should be exposed to advances in imaging technologies and their potential applications. Research and development of new modalities, techniques, and clinical applications is crucial to our subspecialty and mandates life-long continuing education to provide the highest quality of patient care and imaging services. Recognizing that not every training program will have experience or expertise in emerging technologies, we should make efforts to expose trainees to new developments through didactic lectures, visiting speakers, and journal clubs, among other resources.

Conferences and Study Materials

A. Conferences
Same as for Year 1; may additionally require preparation and presentation at multidisciplinary conferences.

B. Teaching
Supervise or act as consultants to junior residents and medical students (PBLI).

C. Study Materials
In addition to the materials listed for the first two rotations, more detailed technical references should be assigned, whether in books or in state-of-the-art technical publications in radiology journals (MK).

D. A detailed study guide is provided in the Appendix: Supplementary Materials located online.

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APPENDIX. SUPPLEMENTARY MATERIAL

Supplementary data to this article can be found online at doi:10.1016/j.acra.2016.01.022.