

Resident Core Curriculum Thoracic Imaging

General Goals: The subspecialty of thoracic radiology is considered one of the six basic areas that every Radiology residency-training program should include in their curriculum, as defined by the ACGME. The Society of Thoracic Radiology recognizes that it is difficult to draw clear boundaries between subspecialties, but thoracic radiology should be learned as a specific subspecialty, and not as part of the general “body imaging” rotation.

The thoracic imaging curriculum is intended to reflect a balance between the different imaging techniques, including chest radiography, chest CT, chest MRI and thoracic procedural experience. Only adult thoracic radiology will be considered, as pediatric radiology is recognized as a separate subspecialty.

The main objective of the thoracic imaging rotation in every level during residency is to help the resident becoming progressively knowledgeable about normal radiographic anatomy, physiology of cardiothoracic organs, physiopathology of thoracic diseases and the typical and uncommon radiologic appearances of main entities, all these in order to provide the trainee with the right tools to create an accurate differential diagnosis, accurately recommend additional imaging studies if needed to clarify the diagnosis, and serve as a guide to clinicians to further follow-up for their patients.

Resident Daily Work Responsibilities (OVERALL BENCHMARKS/OBJECTIVES for Self-Evaluation)

1. During weekdays, residents are expected to be on service from 8 am to 5 pm, excluding times of teaching conferences, residency group activities or other academic-related activities that they may be expected to attend.
2. Residents assigned to thoracic imaging will be available for consultations by technologists, clinicians, and other health care providers, except during conference times, when the attending faculty will cover.
3. Resident questions will be referred to the supervising faculty, upper level resident or fellow instructor on the chest radiology service.
4. Resident review of cases with the supervising faculty will be conducted as many times in the day as necessary to maintain an efficient workflow. Emergency department cases will be checked out in a timely manner to comply with the designated turnaround time.
5. All resident examinations will be dictated and staffed by the end of every working day.
6. Residents will check and sign his/her reports prior to final verification by supervising faculty.
7. Residents must be familiar with the operation of all thoracic imaging equipment.
8. Residents must acquire knowledge of radiation protection and ways to reduce radiation exposure to both patients and hospital personnel. The resident will be supervised to assure that safe practices are followed.
9. Residents will learn the techniques for performing high quality, state-of-the art diagnostic examinations during imaging of the chest. Examinations will be checked

before the patient leaves the department if requested to do so by the supervising faculty.

10. Residents will become knowledgeable about the use of different radiographic contrast agents (including their indications, contraindications, dosages, and side effects).
11. Residents will acquire an understanding of the proper preparation of patients for examinations and appropriate follow-up. At the start of every working day, the resident rotating on Chest CT will be familiar with the patient schedule and anticipate need for any procedures. The resident will check requisitions for the next working day to evaluate for appropriateness of the requested procedure or if additional exams/protocols need to be performed. Absent clinical indication or seemingly inappropriate requests will be clarified and discussed with the referring physician or patient information systems as Epic.
12. Residents will serve as a secondary consultant to referring physicians regarding thoracic imaging. This will strengthen the confidence of the resident in the very important role every radiologist must perform throughout his/her career as a consultant to clinicians.
13. Residents will teach and share knowledge with medical students, radiologic technologist students, and junior residents.
14. Residents will participate in the presentation of imaging studies at the scheduled Chest Case Conferences (conference schedules sent weekly).

Supervising Faculty Responsibilities:

1. Supervising faculty will be available at all times for any consultations needed by the resident as well as for EARLY reads from inpatients, outside exam interpretations and ER films.
2. Supervising faculty will review all cases with the residents before the end of the day.
3. Supervising faculty will provide the resident with constructive feedback in any problem areas encountered during the rotation.
4. Supervising faculty will verify resident-generated reports in a timely manner and inform the resident of any significant changes made.
5. Supervising faculty will teach at readouts and instruct in the areas of patient care, communication of important results, development of a differential diagnosis, and the ethical responsibilities of the profession.
6. Dedicated thoracic imagers will be in charge of teaching and review of topics. On regular intervals, interesting case conference will be held, where each resident will either show an interesting case that appeared during the week or will be presented with an interesting case, and will go through the main radiologic findings, relevant anatomy, physiopathology of disease, and discuss management and follow-up recommendations.
7. Supervising faculty have the responsibility to be up to date on latest imaging techniques, guidelines and specialized knowledge in their subspecialty.
8. Faculty responsible for reading out residents in their chest rotation are responsible for giving them constructive feedback on their performance in the different areas such as patient care, medical and radiologic knowledge, practice-based learning, communication skills and professionalism.

Educational Milestones (First Year Residents):

Patient Care

PC1: Reporting

- Generate chest radiograph reports with appropriate elements core coding and billing
- Describes findings with appropriate thoracic radiologic lexicon (Fleischner Society Lexicon)
- Uses appropriate chest plain film structured reporting templates

PC2: Clinical Consultation

- Obtain relevant patient history from electronic records, dictated reports, or by communicating with referring clinicians
- Demonstrate knowledge of the ACR practice guidelines and technical standards for thoracic imaging

PC3: Image Interpretation

- Identify and describe primary chest radiographic imaging findings
- Recognize the normal and abnormal position of common support devices, lines and tubes on inpatient radiographs

PC4: Competence in Procedures

- Discusses indications for procedures such as percutaneous biopsy of lesions found on imaging studies
- Assists with procedures
- Discusses potential complications and impact to patient care

Medical Knowledge:

MK1: Diagnostic Knowledge

- Demonstrate knowledge of basic chest radiographic anatomy
- Demonstrate the ability to recognize and describe the pathophysiology of common medical conditions depicted on chest imaging studies
- Recognize the normal and abnormal position of supporting devices, lines and tubes on inpatient radiographs

MK2: Physics

- Learn the basic physics of thoracic radiography, computed tomography, ultrasound and magnetic resonance imaging and their relevance in the diagnosis and treatment of thoracic diseases
- Observe and learn the techniques to achieve high-quality diagnostic examinations of the chest

MK3: Protocol Selection and Contrast Agent Selection/Dosing

- Demonstrate understanding of the relative roll of chest radiography, computed tomography, magnetic resonance, and ultrasound in diagnosis of common thoracic diseases
- Describe patient positioning and indications for posteroanterior, anteroposterior, lateral, decubitus, and lordotic chest radiographs

MK4: Imaging Technology and Image Acquisition

- Demonstrate the ability to recommend additional imaging studies, as appropriate per ACR appropriateness criteria, to better assess findings on chest imaging studies

- Discuss which imaging studies may/may not be appropriate to further clarify a clinical condition
- Determine when to request a repeat examination because of technical inadequacy. Notify technical staff and inform them why the radiograph is not of diagnostic quality

System-Based Practice:

SBP-1: Patient Safety

- Demonstrate knowledge of common safety events, such as mislabeled radiographs or wrong-patient radiographs
- Demonstrate ability to use Be Safe reporting system

SBP2: Quality Improvement

- Familiarity with departmental procedures, contrast safety, and sedation required in the performance of examinations
- Make suggestions to improve methods and systems utilized in radiology whenever appropriate

SBP3: System Navigation for Patient-Centered Care

- Demonstrate knowledge of care coordination in radiology imaging/procedures, including how to contact procedure nurse coordinator and chief technologists in inpatient, outpatient and ICU radiography
- Be able to identify key elements for safe and effective transition of care and hand-offs to swing shift and on-call residents of pending or in-progress examinations or communications of results
- Demonstrate knowledge of population and community health needs and disparities by appropriately communicating with our regional teleradiology health clinics with appropriate radiologic results

SBP4: Physician Role in Health Care Systems

- Identify key components of complex healthcare systems (hospital practice, finance, equipment/technology, personnel)
- Demonstrate knowledge of ACR appropriateness criteria and cost-effective imaging evaluation of common disorders
- Show ability to interact with clinicians regarding cost effective and streamlined evaluation for differing clinical entities

SBP5: Contrast Agent Safety

- Demonstrate knowledge of contrast reactions and their treatment by attending the annual contrast reaction & safety sessions

SBP6: Radiation Safety

- Demonstrate knowledge of the mechanisms of radiation injury and the ALARA concept
- Show awareness of the basic principles of radiation protection in order to reduce as much as possible the radiation dose to the patient and reduce exposure to healthcare provider

SBP7: Magnetic Resonance (MR) Safety

- Demonstrate knowledge of safety considerations in MR imaging
- Understand the four MR safety zones and importance of pre-MRI patient screening

SBP8: Informatics

- Show familiarity with UVA information systems, including the Epic EMR and Carestream/Philips PACS

Practice-Based Learning and Improvement:

PBLI1: Evidence-based and Informed Practice

- Demonstrate how to use available evidence to determine the best imaging examination for a particular patient diagnosis/condition, such as the ACR Appropriateness Criteria

PBLI2: Reflective Practice and Commitment to Professional Growth

- Show evidence of independent study using textbooks from reading list
- Demonstrate appropriate follow up of interesting cases
- Research interesting cases as directed by faculty
- Identify, rectify, and learn from personal errors
- Incorporate feedback into improved performance
- Able and willing to participate in clinical conferences in which imaging studies are used to guide patient care/evaluations and be able to demonstrate understanding of how imaging relates to the clinical care of the patient

Professionalism:

PROF1: Professional Behavior and Ethical Principles

- Know the expectations for professional behavior
- Describe how to appropriately report observed lapses in professional behavior
- Understand and demonstrate principles of informed consent, surrogate decision making and advanced patient directives
- Understand and demonstrate principles of protected patient information confidentiality
- Understand and demonstrate good stewardship of limited resources

PROF2: Accountability/Conscientiousness

- Respond promptly to requests and reminders to complete professional responsibilities
- Complete dictations/reports and send to the proper attending in a timely fashion, prioritizing emergent and urgent cases expeditiously

PROF3: Self-Awareness and Help Seeking

- Recognize one's own personal and professional well-being, with assistance if necessary, and be aware of available wellness resources such as the UVA FEAP program
- Recognize one's own limits in knowledge and skill set, or the knowledge and skill set of the team on which you are assigned

Interpersonal and Communication Skills:

ICS1: Patient and Family-Centered Communication

- Accurately communicate one's own role as a resident in the health care system
- When clinically necessary, the resident will communicate with the patient during or after the examination to ensure that patient understands the procedure, important findings, and remains comfortable
- When required, adequately explain each examination to the patient to ensure that the patient feels comfortable and to provide patient care that is compassionate, appropriate, and effective

ICS2: Interprofessional and Team Communication

- When assisting referring clinicians with imaging interpretation and patient management, decide when it is appropriate to obtain help from supervisory faculty
- Use appropriate chest radiograph, CT, and MRI terminology when dictating reports and consulting with health care professionals.
- Communicate effectively with all members of the health care team (technologists, medical students, fellows, residents, allied health providers, support staff, and attending physicians/radiologists)
- Work together with clinicians when reviewing thoracic imaging studies and demonstrate ability to provide preliminary readings, follow up with attending radiologists, formulate a plan for complex cases, and communicate any changes to referring clinicians
- Dictate accurate and concise chest radiograph reports that include patient name, patient medical record number, date of exam, date of comparison exam, type of exam, indication for exam, brief and concise description of the findings and short impression
- Communicate with ordering physicians about all significant or unexpected radiologic findings and document who was called and the date and time of the call in the dictated report
- Thorough dictations will be made with indications, techniques, findings, and conclusions

ICS3: Communication within Health Care Systems

- Communicate with ordering physicians about all significant or unexpected radiologic findings and document who was called and the date and time of the call in the dictated report according to UVA institutional policy
- Dictate and correct reports in a timely fashion to avoid delay in patient disposition

Monitoring and Assessment of Resident Performance

The resident's progress will be monitored by the faculty on the service and by the Residency Program Director. The evaluation must concern itself with intellectual abilities, attitudes and character skills, and clinical and technical competence, in addition to the different competencies listed previously. At the end of each rotation, the resident will receive a consensus evaluation of performance collectively from the thoracic imaging faculty. Deficiencies or substandard performance will be discussed personally and privately with the resident and will be brought to the attention of the Residency Program Director by the attending radiologist.

Resident performance is also evaluated through direct observation, case logs, multi-source professional evaluations, structured case discussion, review of patient outcomes, and other performance evaluation methods as determined.

Educational Milestones (Second Year Residents):

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

1. Demonstrate learning of the knowledge-based learning objectives.
2. Continue to build on chest radiograph interpretive skills.
3. Develop skills in protocoling, monitoring, and interpreting chest CT and MR scans and further develop skills in contrast safety, and recognition and management of contrast reactions. Residents will actively undertake protocoling scheduled CT and MR exams.
4. Demonstrate an understanding of ACR Appropriateness Criteria and ACR Practice Standards and Technical Guidelines for thoracic radiology.
5. Demonstrate an ability to generate and interpret multiplanar reformatted (MPR) or three-dimensional images of CT or MR studies as appropriate.

Patient Care

PC1: Reporting

- Generate chest radiograph reports which do not require substantive correction
- Further enhance use of appropriate thoracic radiologic lexicon (Fleischner Society Lexicon)
- Uses appropriate chest CT and MR structured reporting templates

PC2: Clinical Consultation

- Includes appropriate clinical recommendations or next steps in reports, with assistance when necessary, using evidence-based guidelines (Fleishner Society follow-up guidelines, for example)

PC3: Image Interpretation

- Identifies secondary and critical findings and appropriately communicates those findings
- Formulates appropriate differential diagnoses

PC4: Competence in Procedures

- Performs procedures under direct supervision
- Recognizes common complications of procedures and enlists help from supervising physician

Medical Knowledge:

MK1: Diagnostic Knowledge

- Applies advancing knowledge of anatomy and pathophysiology to make common imaging diagnoses

MK2: Physics

- Demonstrates knowledge of basic physics and radiobiology of thoracic radiography, computed tomography, ultrasound and magnetic resonance imaging

MK3: Protocol Selection and Contrast Agent Selection/Dosing

- Selects appropriate protocols and contrast agent and dosing for routine and emergent thoracic CT/MR imaging

MK4: Imaging Technology and Image Acquisition

- Demonstrates knowledge of CXR, CT and MR image acquisition and processing
- Recognizes common imaging artifacts and technical problems

System-Based Practice:

SBP-1: Patient Safety

- Identify system factors that can lead to patient safety events
- Reports patient safety events through the Be Safe reporting system

SBP2: Quality Improvement

- Demonstrates awareness of divisional and departmental quality improvement initiatives, such as turn-around time monitoring and critical result reporting

SBP3: System Navigation for Patient-Centered Care

- Coordinates care of patients in routine radiologic imaging by communicating directly with managing team and technologist or procedure nurse coordinator when necessary
- Performs safe and effective transitions of care and hand-offs with evening or night on-call radiology teams
- Can identify specific populations and community health needs and inequities, such as access to lung cancer screening CT
- Understands UVA initiatives to bring accessible care such as lung cancer screening to these underserved populations

SBP4: Physician Role in Health Care Systems

- Describes how components of a complex health care system are inter-related and how it impacts patient care
- Demonstrate knowledge of relative costs of common thoracic imaging examinations

SBP5: Contrast Agent Safety

- Recognizes contrast reactions

SBP6: Radiation Safety

- Demonstrates ability to access exam-specific radiation dose information on the PACS system

SBP7: Magnetic Resonance (MR) Safety

- Demonstrates ability to access resources necessary to determine MR safety of implanted devices and retained foreign bodies

SBP8: Informatics

- Demonstrates familiarity with information technology standards in radiology and applies their principles

Practice-Based Learning and Improvement:

PBLI1: Evidence-based and Informed Practice

- Articulates clinical questions and elicits patient preferences and values to guide evidence-based imaging

PBLI2: Reflective Practice and Commitment to Professional Growth

- Shows receptivity to performance data and feedback at the workstation and in written evaluations
- Analyzes and reflects on factors which contribute to gaps between expectations and actual performance
- Designs and implements a learning plan

Professionalism:

PROF1: Professional Behavior and Ethical Principles

- Demonstrates insight into professional behavior in routine situations
- Takes responsibility for one's own lapses in professionalism
- Demonstrates ability to analyze common situations using ethical principles

PROF2: Accountability/Conscientiousness

- In routine situations, performs responsibilities, such as reviewing, dictating and communicating results of examinations, in a timely fashion to ensure the needs of the patients, healthcare teams and healthcare system are met

PROF3: Self-Awareness and Help Seeking

- Independently recognizes status of personal and professional well-being, using appropriate UVA resources such as FEAP, when appropriate
- Independently recognizes limits in the knowledge or skills of one's self or one's team, and seeks guidance as appropriate

Interpersonal and Communication Skills:

ICS1: Patient and Family-Centered Communication

- Identifies barriers to effective communication, such as language barriers, health literacy or cultural differences
- Initiates and organizes communication with the patient and/or family, verifies understanding of the situation, and engages system resources, such as translator services, when necessary

ICS2: Interprofessional and Team Communication

- Clearly and concisely responds to a consultation request in a timely fashion
- Communicates critical findings according to departmental guidelines in a timely fashion

ICS3: Communication within Health Care Systems

- Communicates appropriately as required by institutional policies

Monitoring and Assessment of Resident Performance

Faculty on service will monitor resident's progress. At the end of each rotation, the resident will receive a consensus evaluation of performance based on feedback from section faculty. Deficiencies or substandard performance will be discussed personally and privately with the resident and will be brought to the attention of the Residency Program Director by the attending radiologist. Resident performance is also evaluated through direct observation, case logs, multi-source professional evaluations, structured case discussion, review of patient outcomes, and other performance evaluation methods as determined.

Educational Milestones (Third and Fourth Year Residents):

At the completion of the second thoracic radiology rotation, and in addition to those goals listed for Year 1 and 2, the resident will:

Patient Care

PC1: Reporting

- Efficiently generates clear and concise reports which rarely require correction
- Tailors reports to meet the specific needs of the referring provider
- Appropriately uses structured reporting and proficiently uses standardized lexicon

PC2: Clinical Consultation

- For complex radiology consultations, delineates the clinical question, obtains appropriate clinical information, and uses evidence-based guidelines to recommend next steps
- Demonstrates ability to manage radiology consultations independently
- Able to take into consideration the cost effectiveness of recommendations

PC3: Image Interpretation

- Prioritizes differential diagnoses into appropriate order and recommends management options
- Can provide a single diagnosis with good degree of certainty when appropriate

PC4: Competence in Procedures

- Competently performs procedures with indirect supervision
- Recognizes and manages common and uncommon complications of procedures with direct and indirect supervision
- Anticipates complications and plans for management proactively

Medical Knowledge:

MK1: Diagnostic Knowledge

- Proficiently integrates advanced knowledge of anatomy and pathophysiology to make uncommon imaging diagnoses

MK2: Physics

- Applies knowledge of medical physics and radiobiology to imaging and optimization of image quality and dose reduction strategies

MK3: Protocol Selection and Contrast Agent Selection/Dosing

- Selects appropriate protocols and contrast agent and dosing for complex thoracic CT/MR imaging
- Appropriately modifies protocols and contrast agents/dosing as required by clinical scenario

MK4: Imaging Technology and Image Acquisition

- Demonstrates knowledge of instrument quality control
- Troubleshoots for artifact reduction and optimization in collaboration with the technologists

System-Based Practice:

SBP-1: Patient Safety

- Participates in or conducts analysis of patient safety events and in disclosures of safety events to patients and families
- Offers error prevention strategies

SBP2: Quality Improvement

- Participates as part of team or independently conducts a quality improvement initiative

SBP3: System Navigation for Patient-Centered Care

- Coordinates care of patients in complex radiologic imaging examinations or procedures
- Performs and role-models safe and effective transitions of care and hand-offs with evening or night on-call radiology teams
- Identifies specific resources required to need of a patient population and community
- Participates in adapting the practice to provide for the needs of specific populations

SBP4: Physician Role in Health Care Systems

- Can discuss how the individual practice can affect the broader system
- Describes the technical and professional components of imaging costs
- Understand and describes the radiology revenue cycle and measurement of productivity

SBP5: Contrast Agent Safety

- Recognizes and manages contrast reactions with a team and independently

SBP6: Radiation Safety

- Ability to communicate the relative radiation risk of specific exams and relative radiation exposure.
- Applies principles of ALARA in daily practice
- Understands and selects low-dose thoracic CT protocols where appropriate

SBP7: Magnetic Resonance (MR) Safety

- Communicates MR safety, including presence of implants and foreign bodies, to patients and referring practitioners
- Applies principles of ALARA in daily practice

SBP8: Informatics

- Utilizes data from radiologic examinations into medical decision making
- Applies knowledge of information system and data to support radiology initiatives, as appropriate

Practice-Based Learning and Improvement:

PBLI1: Evidence-based and Informed Practice

- Locates and applies the best available evidence and integrates it with patient preferences, tailored to the care of complex patients

PBLI2: Reflective Practice and Commitment to Professional Growth

- Actively seeks performance data and feedback
- Can analyze and reflect upon feedback and behavioral performance to narrow gap between expected and actual performance
- Independently designs and implements a learning plan

Professionalism:

PROF1: Professional Behavior and Ethical Principles

- Demonstrates professional behavior in complex or stressful situations
- Recognizes situations that may trigger professionalism lapses in self or others
- Recognizes and appropriately seeks help in managing and resolving complex ethical situations

PROF2: Accountability/Conscientiousness

- Performs tasks and responsibilities in a timely manner in complex or stressful situations
- Recognizes and raises awareness of situations that may impact others' ability to complete their tasks in a safe and timely manner

PROF3: Self-Awareness and Help Seeking

- With assistance or independently proposes plans to optimize personal and professional well-being
- With assistance or independently proposes plans to remediate or improve limits of knowledge or skills of self or team

Interpersonal and Communication Skills:

ICS1: Patient and Family-Centered Communication

- Identifies biases that may hinder effective communication and actively minimizes them
- Delivers medical information in a sensitive, compassionate manner
- Elicits patient goals and expectations

ICS2: Interprofessional and Team Communication

- Checks understanding of recommendations when providing consultation with care providers
- Communicates non-emergent findings where failure to act may adversely affect patient outcome
- Appropriately utilizes departmental Epic follow-up management system for important incidental findings

ICS3: Communication within Health Care Systems

- Communicates system concerns in a respectful and constructive manner
- Offers suggestions to improve departmental communication systems

Monitoring and Assessment of Resident Performance

Faculty on service will monitor Resident's progress. At the end of each rotation, the resident will receive a consensus evaluation of performance based on feedback from section faculty. Deficiencies or substandard performance will be discussed personally and privately with the resident and will be brought to the attention of the Residency Program Director by the attending radiologist. Resident performance is also evaluated through direct observation, case logs, multi-source professional evaluations, structured case discussion, review of patient outcomes, and other performance evaluation methods as determined.

Reading List for Each Year

A dedicated reference folder was created with key articles and reviews of the main topics in thoracic imaging. This is available to access on the Shared drive / Residents/ Rotations/ Chest/ Chest References. References on every topic and level of training will be found here and residents are encouraged to use this resource.

Additional references:

First Year

1. Ella A. Kazerooni and Barry H. Gross. *The Core Curriculum: Cardiopulmonary Imaging*. Lippincott Williams & Wilkins, 1st Edition, 2003 (Chapter 1)
2. W. Richard Webb and Charles B. Higgins. *Thoracic Imaging: Pulmonary and Cardiovascular Radiology*. Lippincott Williams & Wilkins, 3rd Edition, 2016 (Chapter 1-2, 4-6, 8-9)

Second, Third and Fourth Year

1. W. Richard Webb and Charles B. Higgins. *Thoracic Imaging: Pulmonary and Cardiovascular Radiology*. Lippincott Williams & Wilkins, 1st Edition, 2004 (Chapter 1,3-5,8-11,13)
2. Peter Armstrong, Alan G. Wilson, Paul Dee, and David M. Hansell. *Imaging Diseases of the Chest*. C.V. Mosby, 3rd Edition, 2000.
3. Theresa C. McLoud. *Thoracic Radiology: The Requisites*. Mosby, 2nd Edition, 2010.
4. Nestor L. Muller, Richard S. Fraser, Neil C. Coleman, and P.D. Pare. *Radiologic Diagnosis of the Diseases of the Chest*. Saunders, 1st Edition, 2001. (Chapters 5, 6, 9, 14, 15, 19, 21, 22).

Reference for All Years

1. Eric J. Stern and Charles S. White. *Chest Radiology Companion: Methods, Guidelines, and Imaging Fundamentals*. Lippincott Williams & Wilkins. 1st Edition, 1999.
2. UVA Radiology Tutorials - <http://www.med-ed.virginia.edu/courses/rad/>
3. James C. Reed. *Chest Radiology: Patterns and Differential Diagnosis*. Elsevier. 7th Edition, 2017.