

RESIDENCY AND FELLOWSHIP TRAINING PROGRAMS

DEPARTMENT OF RADIOLOGY

THOMAS JEFFERSON UNIVERSITY HOSPITAL

PHILADELPHIA, PA

<http://www.jefferson.edu/radiology/>

Revised 10/15/19

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INTRODUCTION

One of the major strengths of the Department of Radiology of Thomas Jefferson University Hospital is its strong and balanced underpinning in all three of the traditional missions of academic medicine – clinical practice, education, and research. Because of the solid expertise and national reputation of many of its faculty members, the department has been able to build a huge practice, encompassing over 500,000 studies per year. Our residency program is recognized nationally as one of the best, and our fellowship programs are also highly desirable. We regularly compete successfully with other top academic departments in the country for the best applicants at both the residency and fellowship levels. Extensive research programs, as summarized later in this booklet, cover virtually all aspects of radiology and lead every year to a large number of publications and presentations at major national radiology meetings

DEPARTMENT OF RADIOLOGY OVERVIEW

Divisions

Directors

Body CT/Abdominal Imaging	Christopher Roth, MD
Breast Imaging	Lydia Liao, MD, PhD
Cardiothoracic Radiology	Baskaran Sundaram, MD
Community Radiology Specialists @ NJ	Sandeep Deshmukh, MD
Community Radiology Specialists @ NE	Richard Beck, MD (interim)
Emergency Radiology	Santosh Selvarajan, MD
Interventional Radiology	David Eschelman, MD Carin Gonsalves, MD
Magnetic Resonance Imaging	Donald G. Mitchell, MD
Musculoskeletal Radiology	William Morrison, MD
Neuroradiology/ENT Radiology	Adam Flanders, MD David P. Friedman, MD
Nuclear Medicine	Charles Intenzo, MD
Ultrasound	Laurence Needleman, MD

The faculty consists of 91 attending staff radiologists and 8 basic scientists in full-time research – 7 with expertise in medical physics and 1 in radiopharmaceutical drug development.

The Department performs over ~500,000 examinations per year. Nearly ~200,000 general diagnostic studies are performed, including plain film examinations of the gastrointestinal and genitourinary tracts. In the subspecialties, roughly ~15,000 pediatric examinations, ~80,000

ultrasound examinations, ~50,000 magnetic resonance imaging (MRI) examinations, ~15,000 nuclear medicine scans, ~1,000 in vitro isotope studies, ~50,000 mammograms, ~75,000 CT scans, and ~8000 arteriograms and interventional procedures are performed yearly.

At present, the Department's equipment consists of 11 multi slice CT scanners, 5 all-digital angiographic suites, 2 remote control fluoroscopic units, 46 ultrasound scanners, 12 nuclear medicine cameras, 1 PET-MR Scanner, 2 PET-CT Scanners (1 mobile, 1 fixed) 15 general radiographic rooms, 15 portable x-ray units, 10 dedicated digital mammography units, and breast biopsy equipment. In MRI, we interpret for 21 MRI's. Most of this equipment is housed on the Jefferson campus, but some is located at 9 outpatient imaging centers, which are operated by the Department. The Department has several of its own specialty designed conference rooms with facilities for videotape recording, radiographic and slide projection and video projection.

The Department is very active in research with many projects in progress. During the last academic year, these resulted in 124 publications in medical journals and textbooks, 93 published abstracts, and 268 presentations at scientific meetings. Also during the last academic year, the department had 22 separate grants in force – 14 from the NIH or other federal agencies, 1 from a nonprofit medical organization, and 7 industry-supported clinical trials. The total level of grant support during the course of the year was over \$1.6 million. Thus, Jefferson trainees in radiology can be assured that the department is staying at the very forefront of new developments in the field.

RESIDENCY TRAINING PROGRAM

The Diagnostic Radiology Residency Program at Jefferson has an outstanding national reputation. The principal objective of our program is to produce well-trained, competent radiologists who will find themselves highly competitive for successful careers in both academic and private practice sectors. This objective is achieved by promoting a friendly and stimulating environment conducive to learning. The educational curriculum is continually updated in order to keep pace with the rapid advances in radiology. The design of the resident rotation schedule prioritizes the educational needs of the residents over the service needs of the department.

The American Board of Radiology requires four years of training in Diagnostic Radiology and a one-year clinical internship prior to radiology training. We receive over 700 applicants each year, from which approximately 10% are selected for interviews. Our program is fully accredited for ten residents per year.

As per new ABR guidelines, the core curriculum consists of 36 months divided among musculoskeletal radiology, gastrointestinal radiology, pulmonary radiology, pediatric radiology, cardiovascular/interventional radiology, ultrasound, body CT and MRI, breast imaging, genitourinary radiology, emergency radiology; neuroradiology/head and neck, and nuclear medicine. During the third year, residents spend four weeks at the Radiologic Pathology course given by the American Institute for Radiologic Pathology (AIRP) in Silver Spring, MD. In addition, there are six months of elective time in the senior year.

In the first two months of the academic year, an introductory course is given to first year residents in general diagnosis. This program includes formal lectures in normal radiographic anatomy, basic diagnostic principles, and radiographic technique. For the remainder of the year, one hour of

teaching conferences in diagnostic interpretation are given daily, Monday through Friday, by the attending staff. These conferences are in each of the major radiology subspecialties, and include a mixture of didactic lectures and case presentations. During case presentation, the residents have the opportunity to discuss the radiographic findings and differential diagnoses. An intensive course in radiologic physics will be given to prepare residents for the new ABR exam. The Departmental Radiology Conferences are held every Wednesday of the month. These consist of: 1) Our chairman-lead conference series regarding non-clinical radiology that focuses on the business of radiology, professionalism, quality and safety, among other topics. 2) Quality assurance conferences, 3) Grand Rounds covering topics of interest in all radiology subspecialties. These are presented either by the departmental faculty or by invited outside speakers, and 4) Radiology research conferences presented in a unique Journal Club type format. This allows everyone in the department the opportunity to present the results of their research activities to the Radiology Department. Residents are required to complete and present at several stages at least one research project at this conference and to submit their work to a national meeting.

During each workday, all studies are reviewed by the resident and staff together prior to dictation. Thus, each case becomes a teaching exercise. This type of review demands extra effort from the radiology staff, but is worthwhile in its end result of training and patient care.

Night call responsibilities begin in the second year of Radiology residency. Two residents (1 Junior and 1 Senior) are on call every evening using a night float system from 9PM to 8AM on Weekdays, and 8PM to 8AM on Weekends and Holidays. On-call residents are responsible for all general radiology, neuroradiology, body CT and US, and Nuclear Medicine.

There are four full time, academic, fellowship-trained, radiology faculty members dedicated to the interpretation of overnight Emergency Department imaging. The Emergency Radiology attending

and on-call residents read studies independently but side by side. This team approach was designed to maintain independent resident study interpretation while allowing for more immediate attending feedback and back-up. Back-up is also available by both on call subspecialty fellows and attending staff.

The vast majority of our residents easily pass the American Board of Radiology Examination. September 2013 was the first administration of the computer based American Board of Radiology (ABR) Diagnostic Radiology Core Exam (for residents who began their training in 2010 or later) which took the place of the traditional written physics and general radiology portions of the Radiology Board examination. 100% of our residents to date have passed the Core examination. The Core Exam is a computer-based, image-rich exam taken 36 months after the beginning of radiology residency. Timing and content of the radiology curriculum has been modified in preparation for the Core Exam. Our department funds 3rd year radiology resident use of “RADPrimer”, an expert-guided comprehensive curriculum including assessment questions covering a range of topics including radiologic differential diagnosis, anatomy, procedures, physics, safety, and appropriateness criteria. In addition, our department funds each senior resident to attend a physics review course prior to the Core examination.

The ABR Certifying Exam is taken 15 months after completion of diagnostic radiology residency and 100% of our graduates to date have passed this examination.

Following residency, most residents elect to take fellowships either at Thomas Jefferson University Hospital or some other outstanding academic institution, before going on to academic or private practice careers. The Department faculty is active in counseling residents about their career choices and helping residents and fellows secure the best possible positions upon completion of their training.

FELLOWSHIP TRAINING PROGRAMS

For residents completing their training program, the Department of Radiology offers one- or two-year fellowships in each of the following areas: Abdominal Imaging, Body MRI, Combined MRI (Musculoskeletal/Neuro), Neuroradiology, Breast Imaging, and Musculoskeletal Radiology.

Candidates must be board eligible or board certified in Diagnostic Radiology.

The Abdominal Imaging Fellowship, which is accredited by the Accreditation Council for Graduate Medical Education (ACGME), consists of comprehensive training in MR, CT and Ultrasound. There is also elective time in which fellows may choose clinical rotations to supplement their fellowship experience or to work on a research project, which is required. The projected number of weeks in each rotation are:

Body MR	16 weeks
Body CT	8 weeks
PET CT	4 weeks
Ultrasound	16 weeks (includes 4-8 weeks of interventional US)
Elective	4 weeks (flexible clinical schedule and/or research)
Vacation	4 weeks
Total	52 weeks

Weeks on Body MRI PET CT (up to 2 weeks), and Elective may be exchanged depending on each fellow's individual interests. Therefore, for example, up to 22 weeks may be spent on Body MRI.

MRI includes state of the art studies of the abdomen and pelvis. CT includes multidetector imaging and volumetric reconstructions for chest, abdominal and pelvic scanning as well as advanced applications. Ultrasound includes general inpatient and outpatient diagnostic studies as well as dedicated vascular, musculoskeletal, obstetric and gynecology, and prostate training. State of the art GI/GU imaging is incorporated into US, CT and MRI rotations, including virtual colonoscopy, angiography, urography, enterography, MRCP, prostate ultrasound and sonohysterography. The didactic curriculum includes daily lectures from July through September on all basic aspects of abdominal imaging. During the remainder of the year, there are one or two morning fellow-oriented conferences per week, distributed among ultrasound, body CT, body MR and GI/GU. Fellows also attend the weekly radiology grand rounds, and several weekly and monthly multidisciplinary conferences. Some conferences are semi-didactic conferences presented by faculty, while others are case conferences led by abdominal fellows and augmented by attending-led discussion.

The **Body MRI Fellowship** is a dedicated one-year program for one fellow, providing clinical and leadership training designed to enable this physician to run a body MRI service upon completion of the fellowship. It incorporates all aspects of Body MRI (both clinical and research), including basic and advanced principles of MRI, as well as integral participation in leadership and continuous improvement of a busy and comprehensive body MRI service. The clinical body MR imaging focus includes abdomen, multiparametric prostate, gynecologic and other pelvic, and body and extremity vascular (MR angiography) applications, as well as MR elastography, MR cholangiopancreatography, MR enterography and use of new contrast agents. Four weeks are designated for elective time in other radiology services. The Body MRI service has high volume (typically about 40 cases per day), including inpatient tertiary care as well as interpretation of community-based imaging. The Body MRI fellow will help plan protocols, monitor studies, assist

with supervising rotating residents, and provide appropriate diagnoses and consultations to the referring clinical services. The fellowship provides ample time and opportunity for research, leading educational and multidisciplinary conferences, and attending monthly body MRI divisional staff meetings. Jefferson operates more than 20 MRI units—including four at 3T (one of which is a PET-MRI unit), and the others at 1.5T, at multiple locations on campus as well as at other locations in surrounding communities, and a few in other countries. Images from all MRI facilities are sent to our PACS system for on-campus filmless interpretation. We also maintain a busy consult service, receiving into our PACS many cases per day for second-opinion interpretations, improving understanding of the range of MRI practices in other locations.

The **Breast Imaging Fellowship** is a one-year program that includes intensive experience in interpretation of problem-solving mammography, screening mammography, breast ultrasound and breast MRI as well as extensive training in the performance of image guided percutaneous breast biopsy using stereotactic, ultrasound, and MRI guidance, as well as pre-surgical lesion localizations using mammographic, sonographic, and MRI guidance. The fellow will participate in teaching of residents and medical students, participates in a weekly mammographic-pathologic conference, and presents cases at a weekly multidisciplinary breast tumor board. Research opportunities are available in mammography, breast ultrasound, MRI, molecular imaging as well as outcomes.

The **Combined MRI (Musculoskeletal/Neuro) Fellowship** is a dedicated one-year program for three or four fellows incorporating all aspects of clinical magnetic resonance imaging. This includes brain, ENT, spine, and extremity applications. There are separate rotations to the

neuroradiology and musculoskeletal services. Opportunities are also available for clinical and basic research.

The **Musculoskeletal Radiology Fellowship** is a one-year ACGME-accredited clinical program. There are three funded positions available yearly, and externally-funded and research positions are also available. The curriculum includes intensive training in musculoskeletal imaging modalities with MRI being the primary focus, but also including CT, CR, arthrography, and MSK ultrasound. MRI volume is approximately 100 cases per day from over 20 MR systems at multiple field strengths including 3.0 Tesla, and all interesting cases are reviewed weekly. Approximately one fourth of the year is dedicated to procedures including image guided MSK biopsy, vertebroplasty/kyphoplasty, pain procedures including selective nerve blocks and facet injections, discography and radiofrequency ablation. A comprehensive conference schedule includes two dedicated MSK radiology conferences weekly, as well as correlation conferences with orthopaedics and sports medicine specialists including spine, shoulder, hand/wrist, foot/ankle, and MSK oncology. Fellows also participate in office hours with orthopaedics subspecialists at the Rothman Institute. Members of the musculoskeletal radiology section are active in clinical research in the fields of musculoskeletal MRI, radiology-oncology-orthopedic correlation, bone and joint diseases, orthopedic trauma and sports medicine, and fellow participation in research endeavors is strongly encouraged.

The **Neuroradiology/Head and Neck Imaging Fellowship** offers an ACGME accredited one-year program with up to four positions. One fellow can spend an additional year at The Children's Hospital of Philadelphia in a combined adult-pediatric program. The Division has access to six multidetector CT scanners, over fifteen MRI scanners (including two 3.0T units, two 1.5T wide

bore units, and one 0.3T open unit), two dedicated bi-plane angiographic and interventional units, a linear accelerator, a Gamma Knife, a PET-CT scanner, and a PET-MRI scanner.

Extensive training is given in interpretation of plain films, CT, CT angiography, CT perfusion, MRI, and advanced MR techniques (including functional MRI), as well as in the technical aspects and interpretation of myelograms, cerebral angiograms, and interventional neuroradiologic procedures. Case interpretation and reporting are conducted daily under the guidance of the neuroradiology staff. In addition, there is a rotation for each fellow at The Children's Hospital of Philadelphia for concentrated, in-depth experience in pediatric neuroradiology. Consultation with referring physicians from Neurology, Neurosurgery, Orthopedic Surgery, Head and Neck Surgery, Rehabilitation Medicine, Medical Oncology, and Radiation Oncology is an ongoing responsibility and learning opportunity. There is weekly active participation in Neurosurgery Grand Rounds, Neurology Grand Rounds, Stroke Conference, Brain Tumor Conference, ENT Grand Rounds, Head and Neck Tumor Conference, as well as two weekly Neuroradiology Conferences for residents and fellows and a weekly conference with the clinical staff of the Regional Spinal Cord Trauma Center based at Thomas Jefferson University Hospital. An extensive on-line teaching file of proven examples of neurologic abnormalities is available. Ample opportunities exist for research at the clinical level.

DIVISIONS OF THE DEPARTMENT OF RADIOLOGY

The **Body CT Division** performs over 20,000 CT examinations per year, consisting of chest, abdomen, and pelvis studies. Included in these examinations are CT angiography, CT colonography, CT urography, and CT enterography. Additionally, advanced 3D post processing is performed for many of these studies using a third party thin client system. All the studies are supervised and read by the CT division members. The examinations are performed on one 64-slice scanner, one 256-slice scanner, two 512-slice scanners, and a 16 wide bore interventional scanner, located at the main hospital as well as additional hospital and outpatient sites. Didactic lectures, in conjunction with ultrasound and MRI, are given during summer (July-September) with additional monthly didactic and case conferences. Close correlation is obtained between CT and the other imaging modalities. Research opportunities are available for the residents and fellows rotating through the division.

The **Body Magnetic Resonance Imaging Division** is responsible for all body MRI studies. The volume of body studies interpreted daily by this service is among the highest in the country, frequently more than 40 per day. It is staffed by six body MRI specialists. There are 4 abdominal imaging (MRI/CT/US) fellows, and one dedicated body MRI fellow. There are more than 20 clinical MRI units in operation, including four 3T scanners (one of which is a PET-MRI unit) and several 1.5T scanners from 4 different MRI vendors. 1.5T and 3T inpatient units are present side-by-side in the Gibbon Building. Two updated 1.5T units are located in an MRI facility in the Clinical Office Building (COB) at 909 Walnut Street, a block from the hospital. Three 1.5T MRI units, two of which are short/wide bore systems and one an extremity MRI system, are present in our Imaging Center (JCCI) located at 850 Walnut St. (Walnut Towers) on campus. Other on-campus facilities with MRI scanners include the Jefferson Hospital for Neuroscience (3T and

open-bore 1.5T systems), Methodist Hospital and at the Rothman Institute (1.5T). Outpatient satellite MRI centers are located in Malverne, Bryn Mawr, Doylestown, Collegeville, East Norriton, Philadelphia Navy Yard, Armenia and Virgin Islands (facilities at St. Croix and St. Thomas). A 3T PET-MRI scanner is located in an outpatient clinic in Villanova.

The **Division of Breast Imaging** has seven faculty members and performs approximately 40,000 procedures annually, making it one of the most active academic services in the country. Procedures include mammograms, hand-held and automated breast ultrasound, breast MRI, breast specific gamma imaging, wire localization, cryoablation therapy, and core biopsy using stereotactic, digital breast tomosynthesis, MRI and ultrasound guidance. All diagnostic breast imaging studies are performed at the Jefferson-Honickman Breast Imaging Center (BIC), a state-of-the-art facility with four digital breast tomosynthesis units and 3 ultrasound units. Screening mammography is performed at the Breast Screening Center (BSC), with two digital breast tomosynthesis units. Both the BIC and BSC are modern patient centered facilities located in the Comprehensive Breast Center of the Kimmel Cancer Center, in the Medical Office Building adjacent to the main hospital.

The **Cardiothoracic Imaging division** consists of 5 Board-certified and fellowship-trained radiologists. We provide clinical service for multiple hospitals in the Jefferson Health System. We report approximately 100,000 CXRs, 17,000 thoracic CTs, 1000 cardiac CTs, and 200 cardiac MRI exams per year. Our radiology examinations are digitally acquired, and we interpret them using high-quality PACS monitors.

Cardiothoracic Imaging division has close ties with multiple clinical specialties, including pulmonary medicine, medical oncology, radiation oncology, cardiology, cardiovascular surgery, thoracic surgery divisions, and Emergency Department. We also provide the second opinion for

imaging studies for patients coming to us from outside hospitals that include patients from outside the country. Our clinical colleagues manage a wide variety of pathology that include the following:

- Acute and non-acute cardiothoracic Diseases
- Lung cancer (screening, cancer management, and surveillance)
- Airway diseases
- Diffuse interstitial lung diseases
- Pulmonary vascular disorders (acute/chronic pulmonary embolism and pulmonary hypertension)
- A broad spectrum of cardiovascular conditions including coronary artery diseases, emergency Triple rule-out CT, Trans-catheter aortic valve insertion planning, robotic cardiac surgery, atrial septal defect, cardiomyopathies, and non-invasive CT/MRI angiography

Our division's resident rotations are a) CXR rotation, b) thoracic CT rotation, and c) cardiac imaging focused rotation (CT, and MRI). Our residents typically do CXR rotation during the initial stages of PGY 2, and thoracic CT and focused cardiac imaging rotations during the PGY 3 and 4. PGY 2 also get brief thoracic and cardiac imaging exposure during the later stage of their CXR rotation. During PGY 5, they also elect cardiothoracic focused training (mini-fellowship) to prepare for fellowship and attending jobs.

Providing exceptional patient care, and high-quality trainee education are essential parts of our missions. We design the goals and objectives of our trainee education based on the Society of Thoracic Radiology and the American Board of Radiology (ABR) curriculum guidelines. We provide on service clinical teaching, lectures, and hands-on training in post-processing of advanced cardiothoracic imaging software.

We provide multiple trainee interactive lectures in cardiothoracic imaging. We create these lecture topics and contents according to the ABR core exam guide to avoid overlaps and redundancies.

Also, external guest faculty members deliver resident lectures on cardiothoracic imaging topics. Many of our resident conferences use interactive “RSNA Diagnosis live” to actively involve resident and to receive instant audience feedback. We record and store these lectures in a digital lecture library. We have an extensive collection of cardiothoracic cases in our teaching files. Our division faculty members participate in weekly multidisciplinary lung cancer management conferences that trainees are encouraged to attend.

Members of the Cardiothoracic Radiology Division are also committed to actively mentoring trainee research activities. Throughout the year, we do multiple cardiothoracic imaging-related research projects, including the use of Artificial Intelligence (AI) in radiology. Residents complete these cardiothoracic imaging research projects and present their research work at various prominent national meetings and write manuscripts.

The educational goal of the **Interventional Radiology Division** is to provide a comprehensive world-class educational experience with deep-rooted foundations in diagnostic imaging, image-guided interventions, and clinical patient care. The curriculum provides a strong core foundation in diagnostic imaging that will serve as the knowledge base to allow for accurate diagnosis and planning of image guided interventions. The program will provide extensive technical and clinical training to allow for proficiency in the treatment of a broad array of diseases through image-guided interventions. It will do so in the context of engendering principles of teamwork, system-bases practice, professionalism, and lifelong learning. Importantly, the longitudinal care of patients before and after intervention will be emphasized, in the larger context of the multidisciplinary health care team and health system. Broad exposure to multiple subspecialty areas will be provided, including but not limited to, image-guided interventions in: interventional oncology, hepatobiliary, advanced portal hypertension management, peripheral vascular (arterial) disease, endoleak repair, endovascular thrombolysis, venous insufficiency, women’s health (uterine artery

embolization and pelvic congestion syndrome), venous access, hemodialysis access maintenance, lymphatic intervention, percutaneous tumor ablation, abscess drainage, and urologic intervention.

Jefferson's pulmonary embolism response team (**PERT**) was created in 2017 in an effort to coordinate and expedite the treatment of pulmonary embolus with a team of physicians from a variety of specialties. The multidisciplinary approach allows for rapid patient risk stratification, formulation of a treatment plan and mobilization of the appropriate resources to provide the highest possible level of care for pulmonary embolism patients. The team consists of interventional radiologists, vascular medicine physicians, pulmonary and critical care physicians, cardiothoracic surgeons and cardiologists. The interventional radiology team plays an active role in all aspects of patient care and is responsible for all catheter-directed interventions (thrombolysis and thrombectomy).

Ronald Winokur, MD, FSIR, RPVI (Jefferson Medical College – Class of 2007 and Jefferson Diagnostic Radiology Residency – 2012), joined the faculty at Jefferson as Director of ***Venous Interventions*** in April 2019. He leads a comprehensive treatment program of venous disorders including varicose veins, spider veins, pelvic congestion syndrome, pelvic venous disorders, varicocele, deep vein thrombosis (DVT), pulmonary embolism (PE), and vascular malformations. We recently have opened our outpatient Vein practice in a new, state of the art facility on the Jefferson Campus in Center City.

The training program is organized to support the ACGME core competencies and foster graduated levels of responsibility and milestone achievement. Upon completion of the program, graduates will have achieved the skill sets necessary for the independent practice of Interventional Radiology and will be well equipped to do so in the larger complex context of the healthcare team.

ACGME accredited:

Integrated IR/DR Residency - 2 Integrated Radiology residents per year. (see attached block diagram).

- **PGY1** – General Surgery Internship – Jefferson
 - Surgery – Radiology Linkage Program
 - Matched IR-DR Residents will automatically link to complete their surgical internship at Jefferson.

Independent IR Residency – up to 2 Independent IR Residents per year – starting 2020.

ACGME accreditation **pending** –

Early Specialization in Interventional Radiology (ESIR) – up to 1 designated resident per year.

IR Program Highlights:

1. 9 IR attending faculty.
2. 4 state of the art Philips angiography suites, a dedicated interventional CT-scanner with CT-fluoroscopy, and a IR clinic in the main hospital
3. Three of the 4 rooms have cone-beam capability (XperCT, XperGuide) and all 4 rooms are lose-dose *Clarity*® equipment.
4. We have 4 ultrasound machines, one for each procedure room; 3 CX50 Phillips, and an EPIQ Phillips ultrasound machine as well.
5. We perform over 900 embolizations per year for primary and metastatic tumors of the liver. Because of our unique Metastatic Uveal Melanoma program, the number of hepatic embolizations is greater than most, if not all, of the academic centers in the country.
6. We perform a wide-variety of cases such as microwave, cryoablation and radiofrequency ablation of hepatic and extrahepatic tumors, immunoembolization, chemoembolization, SIR-spheres and Theraspheres for hepatic tumors, EVLT, sclerotherapy for spider veins, ambulatory phlebectomy, TIPS, thoracic duct embolizations, IVC filters, abscess drainages, PCNs, PTBDs, endoleak repairs and UAEs. Jefferson is also a Level 1 trauma center and

regional spinal cord injury center, which leads to many interesting cases throughout training.

7. We have a dedicated *Interventional Biopsy Service* consisting of three procedure rooms located on the 3rd floor of the main hospital directly adjacent to the interventional CT-suite. Because we do not perform routine biopsies, paracenteses and thoracenteses in our IR suites, IR trainees rotate through the biopsy service on a routine basis with a IR attending.
8. A trainee and an attending are assigned to a procedure room each day. There are 2 technologists and one nurse per procedure room. The technologists prep the patients and turn over the rooms between cases. Room turnover time is incredibly efficient, averaging just 5-10 minutes.
9. The IR service has admitting privileges and we routinely admit our own patients (i.e. UAE and chemoembolization patients). If the patient requires complex medical care, the patient will be admitted to medicine or surgery as deemed appropriate.
10. IR trainees rotate through noninvasive vascular imaging including coronary/peripheral CTA and vascular ultrasound on a routine basis. Vascular ultrasounds and CTAs are read by radiology attendings only, not vascular surgery, etc.
11. Dedicated IR clinic where we see patients on a daily basis. Most of the patients seen in the IR clinic are UAE, EVLT, TIPS, ablation, and chemoembolization patients.
12. We have multi-disciplinary clinics with hepatology (HCC), urology (RCC) and oncology (metastatic uveal melanoma). Coming soon, a new Fibroid Center will be up and running where the interventional radiologists will see patients with the OB/GYNs.
13. We have multidisciplinary conferences with hepatology, oncology, nephrology, surgery and transplant surgery. These include HCC conference, dialysis access conference and metastatic uveal melanoma conference.
14. We conduct Journal Club and morbidity and mortality conferences on a routine basis.

15. We have 2 full-time and 2 part-time physician assistants. The physician assistants evaluate patients in clinic, conduct rounds on inpatients, schedule patients, teach patients how to care for catheters, discharge patients, write scripts, etc. Additionally, we have a Nurse Practitioner on the Interventional Biopsy service.
16. Call is shared equally between fellows and residents on service. We have implemented a 'buddy' system in which residents pair up with fellows. Call typically averages every 5th night. Call is *home call* with service cell/pager.
17. Dedicated team of PICC nurses *five days a week*.
18. Multiple ongoing active clinical trials.

The **Division of Musculoskeletal Radiology** is one of the largest in the country. Each year approximately 30,000 radiographic musculoskeletal exams are performed, in addition to 10,000 musculoskeletal MR exams; staff serve as consultants to the Eagles, Phillies, Sixers and Flyers, as well as local college athletes and the Pennsylvania Ballet. The division is very active in procedures as well. Each year, approximately 300 arthrograms (mostly MR arthrograms) are performed in addition to over 300 bone biopsies. The division also performs interventional spinal procedures, including discography, facet injections, selective epidural injections, vertebroplasty, kyphoplasty and nucleoplasty. Radiofrequency ablation of osteoid osteomas and metastatic lesions is also provided. The staff is active in research, having published approximately 100 articles over the past five years, most with fellows, residents or other trainees as the primary author. Staff train three to four musculoskeletal fellows each year, in addition to residents, cross-sectional fellows and other MRI fellows. Education is a priority, and staff provide numerous didactic and case conferences throughout the year, in addition to clinical conferences with the orthopedic surgeons, musculoskeletal journal club, and the regional Orthopedic-Radiology-Pathology conference.

The **Division of Neuroradiology/Head and Neck Radiology** performs radiological and imaging procedures related to the nervous system, head, neck and spine. It is staffed by eight neuroradiologists and up to four neuroradiology fellows. In addition, the department chair is a nationally recognized head and neck radiologist. State of the art equipment, including over fifteen MRI scanners, six multidetector CT scanners, a PET-CT scanner, and a PET-MRI scanner are housed either on campus or at our outpatient centers. The nearby Jefferson Hospital for the Neurosciences has two dedicated bi-plane angiographic and interventional units, a multidetector CT, a linear accelerator, a Gamma knife unit, a 1.5 Tesla MRI unit, and a 3.0 Tesla MRI unit. Jefferson neuroradiologists cover this facility. An active MRI physics group collaborates with the division, and is involved with research pertaining to fMRI.

The Neuroradiology/Head and Neck Radiology Division is highly active clinically and works in close collaboration with the departments of Neurosurgery, Neurology, Otolaryngology, Orthopedic Surgery, and Rehabilitation Medicine (which runs a widely recognized spinal cord injury service). There are multiple departmental and interdepartmental conferences held each week. Approximately 600 selective cerebral arteriograms, 100 myelograms, and 16,000 CTs of the head and spine are performed each year. In addition, approximately 28,000 MRI scans of the head and spine are performed yearly. The division has been very productive in research activities, partly as a result of joint efforts involving the clinical services mentioned above.

Head and neck radiology is part of the division. A large variety and volume of facial, sinus, orbit, temporomandibular joint and neck cases are referred for radiologic evaluation from the busy Department of Otolaryngology/Head and Neck Surgery and the Department of Oral and Maxillofacial Surgery. The residents learn to interpret plain films, CT and MRI studies, and receive extensive one-on-one teaching by a staff radiologist. During their rotation, the residents

can attend weekly head and neck tumor conference, where correlation of the physical examination with the radiologic findings is performed.

The **Nuclear Medicine Division** is located on the 8th floor of the Thompson and Main Buildings. It provides nuclear medicine training for diagnostic radiology residents. The teaching responsibilities are shared by two staff physicians, one adjunct physician, and a nuclear medicine basic science educator. The Division performs approximately 12,000 nuclear medicine procedures annually. There are seven 7 dual-headed SPECT scanners, one single-headed large-field-of-view gamma camera, one DEXA scanner, a 7-day per week operating PET/CT scanner housed in our outpatient imaging center, and a state-of- the-art SPECT/CT camera as well.

The scope of the nuclear medicine services includes in vitro tests, in vivo imaging, and therapeutic uses of unsealed radioisotopes sources. There are active research activities within the Division, both basic and clinical in nature. The basic research is performed in the radiochemistry section and clinical research is conducted by the clinical staff. Current interests include non-FDG PET isotopes in gastrointestinal and breast malignancies, as well as outcome projects in radioiodine therapy of thyroid cancer.

The **Division of Diagnostic Ultrasound** has fifteen staff physicians along with abdominal imaging fellows and dozens of talented sonographers. Physician staff includes abdominal imagers who do CT or MR and ultrasound and others who concentrate on ultrasound. There is a large research group including three Ph.D.s, research physicians, postdocs and grad students. The main clinical and research site is over 30,000 square feet on the 7th floor of the Main and Thompson Buildings. There are more than 20 examination rooms and over 30 modern pieces of clinical ultrasound equipment in the three hospitals' ultrasound facilities and two vascular laboratories. In addition,

multiple outpatient facilities on and off campus performs outpatient examinations.. The Division performs all aspects of ultrasound, including abdominal and superficial scanning, obstetrics and gynecology, brain, breast, peripheral vascular, elastography, interventional and musculoskeletal ultrasound. Contrast enhanced ultrasound is integrated into the clinical workflow. The fellowship includes state of the art imaging and ultrasound/CT image guided interventional techniques.

In addition to the extensive clinical activities of the division, there is a large research program with both basic and clinical investigations. There is dedicated research space with dedicated equipment. The research group has multiple federally funded grants and patents. Major areas of ultrasound research include many novel applications including evaluation of new contrast agents and contrast modes, unique techniques to enhance treatment of tumors and infections, new techniques to detect blood flow and pressure, evaluation of new musculoskeletal treatments, and characterization of tumors and vascular diseases.

A comprehensive ultrasound educational program provides intensive training for fellows and residents, technologists and physicians. The Jefferson sonography program is recognized as among the best schools for technologists in the nation. Physicians and technologists from the US and throughout the world come to the Educational area for CME courses and for visiting fellowships that may last days to a year.

HOUSING

Thomas Jefferson University Hospital and Jefferson Medical College are situated on a large upscale section of center city Philadelphia. The campus is surrounded by several of Philadelphia's legitimate stage theaters and fine restaurants. The Kimmel Center for the Performing Arts and the Academy of Music (home of the world-renowned Philadelphia Orchestra), the beautiful new Pennsylvania Convention Center, and historic Independence Hall are all within five blocks of Jefferson. The University owns two modern apartment buildings on its campus, for medical students, residents and fellows. In addition, many apartments are available at reasonable rentals in the surrounding area, known as Society Hill (one of the Philadelphia's finest neighborhoods). Some residents and fellows prefer to commute from the Philadelphia suburbs, which are 30 minutes from the hospital by mass transit or car. The major suburban rail lines within a 5-minute walk of the campus.

LIBRARY FACILITIES

The Department of Radiology Library contains numerous radiology textbooks. There is also computer access to all major Radiology and other medical journals, 24 hours a day, 7 days a week. There is an extensive teaching file of over 1,600 representative radiographs with a written description of their radiographic findings and clinical presentations, including the entire American College of Radiology Teaching File on CD.

The Sidney Kimmel Medical College Library (known as Scott Memorial Library), is located across the street from the hospital (between 10th and 11th on Walnut). It maintains a comprehensive general medical library of all major journals and textbooks including those for radiology.

HISTORY OF THOMAS JEFFERSON UNIVERSITY

Dr. George McClellan, who believed that medical students should actively participate in the diagnosis and care of patients, founded Jefferson Medical College in 1824. The medical college has always been located in Philadelphia, first in Dr. McClellan's office, then in the former Tivoli Theater, at 418-20 Prune Street (now Locust) near Washington Square, and finally since 1828 at its present site.

Jefferson Medical College was renamed Sidney Kimmel Medical College (SKMC) on June 17, 2014. It has awarded more than 31,000 medical degrees and has more living graduates than any other private medical school in the nation. It offers both undergrad medical education programs and innovative joint degree programs to more than 1,000 students each year.

The Sidney Kimmel Medical College is recognized for its balanced approach to medical education, and approximately one out of four to one out of five applicants throughout the U.S. apply to Jefferson.

From its inception, Sidney Kimmel Medical College's faculty and alumni have made significant contributions to medical science. A few highlights of these contributions are as follows:

Samuel David Gross, M.D. (JMC Class of 1828) is recognized as the outstanding surgeon of the 19th century and is immortalized in the famous painting "The Gross Clinic" painted by his anatomy student and devoted friend, Thomas Eakins.

Marion Simms, M.D. (JMC Class of 1835) is known as the Father of Modern Gynecology.

Silas Weir Mitchell, M.D. (JMC Class of 1850) and **William W. Perry Keen, M.D.** (JMC Class of 1862) combined their specialties to form the modern study of neurology and neurosurgery.

Carlos Finley, M.D. (JMC Class of 1855) discovered the carrier of yellow fever.

John H. Gibbon, Jr., M.D. (JMC Class of 1927) used the first heart-lung machine successfully on a patient during open-heart surgery in 1953.

James M. Hunter, M.D. (JMC Class of 1953), Director of Jefferson's Hand Rehabilitation Center since 1973, developed the first artificial tendon.

Allen J. Erslev, M.D., Director of the Division of Hematology since 1963, was the first to demonstrate the existence of the hormone erythropoietin which controls red blood cell production.

In 1969, Jefferson Medical College became Thomas Jefferson University, a modern academic health sciences university comprised of four divisions: Jefferson Medical College (now renamed Sidney Kimmel Medical College), Thomas Jefferson University Hospital, the College of Graduate Studies and the College of Health Professions. In 1978, Jefferson opened its new hospital facility, the Gibbon Building, and implemented a number of innovative health care concepts and programs that have helped to keep it at the forefront of modern care nationally. Jefferson's 650-bed hospital is one of the largest on the East Coast of the United States. It has a number of referral centers, attracting patients from a wide geographic area.