

I. INTRODUCTION

Following medical school and initial post-graduate education, I completed a two-year nuclear medicine fellowship at Johns Hopkins (1989-1991). Board certified in nuclear medicine, I returned to London to help create the Clinical PET Center at Guys and St. Thomas' Hospitals—the first such facility in the UK. In 1994 I came to Dartmouth as a resident in radiology, became chief resident and was board certified in radiology in 1997. I was promoted to Assistant Professor of Radiology and OB/GYN in 1998 and to Associate Professor in 2003.

II. AS CLINICIAN

Clinical Overview In common with most of my colleagues, clinical practice constitutes the largest single part of my professional role. The delivery of quality care and striving for improved patient outcomes therefore constitutes my highest priority. As a clinician, I believe I have earned the respect of my peers, and hope that I have earned the confidence of my patients. Although we lack a formal mechanism for evaluating patient satisfaction, anecdotal feedback from patients—in consultations and through a significant volume of personal letters—has been consistently positive.

My areas of clinical expertise include breast imaging (mammography, MRI and breast biopsies), ultrasound, nuclear medicine and chest imaging. I also rotate through CT and radiography. I read all routine clinical studies in these imaging sections, teach residents, provide consultation with clinical colleagues at DHMC and regional affiliates, and take part in the regular on call schedule. I have a secondary appointment in OBGYN through my performance, and interpretation of high risk obstetrical ultrasound studies. I take part in both the general and ultrasound call schedules in the department. Through the early years of my professional career, my clinical and research focus was in nuclear medicine. While I remain active in this subspecialty, my clinical interests have shifted to breast imaging, in large part to accommodate the changing needs of the department. As a key member of the DHMC Breast Imaging Division, I participate in the full range of its clinical activities, with an emphasis on breast MRI and interventional procedures. This year I will perform roughly 250 image-guided biopsies—utilizing mammography, ultrasound, and, increasingly, MRI—and regularly receive personal referrals from regional breast surgeons and primary care practitioners to perform difficult breast biopsies and second opinions.

Breast MRI program Five years ago, I helped develop and subsequently directed a new program in breast MRI. The program—now directed by Dr.X— which makes available the enhanced malignancy-detecting capabilities of MRI for cancer screening of high-risk patients, preoperative evaluation of patients with newly diagnosed breast cancer for cancer staging, and diagnostic exams. We receive referrals from a large catchment area in northern New England. I developed the auditing and tracking system that we use still for all patients who undergo breast MRI, which is crucial for maintaining interpretative quality and feedback, as well as obtaining national certification through the American College of Radiology.

Clinical research At Johns Hopkins and at London's Clinical PET Center, I was active in nuclear medicine research, especially in the area of brain SPECT imaging, co-authoring 17 published studies, including several which made significant contributions to the field: Mayberg, Lewis, et al (*J. Nucl. Med.*, 1994) examined paralimbic hypoperfusion in unipolar depression, cited 238 times; Jeffery, Monsein, et al (*Radiology*, 1991) compared SPECT with traditional angiography in pre-surgical intra-arterial sodium amobarbital (Wada) tests; Lewis, Griffin, et al (*Lancet*, 1994) evaluated the use of whole-body ¹⁸F-FDG PET in lung cancer, cited 158 times;

and published the first case reports on ¹⁸F-FDG PET in sarcoidosis (Lewis and Salama, *J. Nucl. Med.* 1994), cited 173 times. For several years following my arrival at DHMC I continued active involvement in nuclear medicine research and participated as an investigator and author in a variety of studies on ictal and interictal SPECT, and functional imaging for localizing seizure activity. More recently, my clinical research priorities have shifted to breast MRI. In 2006, I received a pilot grant from the Prouty Fund to establish and analyze a database (still active) related to breast MRI studies, which led to publication of "Role of breast MRI in the preoperative evaluation of patients with newly diagnosed breast cancer" (Schnell, Rosenkranz and Lewis, *Am J Roentgenol*, 2009). This latter paper has helped found our and others guidelines for the management of pre-operative breast cancer patients.

Clinical scholarship In 2009 I was recruited by Oxford University Press to co-edit (with my DHMC colleague Dr. X) a student and intern radiology textbook for their popular *Handbook* series, with anticipated publication in early 2012. In addition, I will be writing three of the chapters: chest imaging, breast imaging, and imaging algorithms. (The more significant portion of my scholarship activities in recent years has been directed toward the development of a variety instruction and assessment vehicles, described more fully below.)

Institutional contributions With others in the Breast Imaging Division, I helped establish the Comprehensive Breast Care Program, an integrated approach to breast-cancer patient management which coordinates care from the departments of radiology, surgery, oncology, pathology, and radiation oncology. Interactions with collaborating members of this multidisciplinary team are a routine part of my clinical duties. For 12 years I served as the department's representative on the Lymphoma Tumor Board, with weekly case previews, patient-management reviews and consultation at the weekly conferences. As part of my service commitment to the institution, I have been a member of several search committees, including the Chair of Anesthesia search committee (2007-8), as well as the Board of Governors Nomination Committee (2010).

American Board of Radiology Leading from my clinical expertise in nuclear medicine and educational experience, in 2006 I was appointed to the ABR's Maintenance of Certification Committee (Nuclear Radiology), charged with developing the first MOC exams in nuclear medicine. I have been a highly active member of this committee, as developer of the template used in question-writing, as author of over 300 of the 1100 questions now in place, co-editor of all questions and as co-developer and administrator of three examination cycles. I am also Vice Chair of the ABR Certifying Exam Committee (Nuclear Radiology), charged with developing the new certifying exam for residents, a member of the Category Steering Committee for Nuclear Radiology, which oversees all aspects of nuclear medicine evaluation at boards level, and have served as an Oral Boards Examiner in Nuclear Radiology.

Other national leadership roles leading from clinical expertise: I am a member of the Radiological Society of North America (the largest radiological society in North America) Scientific Committee (Nuclear Medicine) which reviews abstracts for the annual meeting and develops the section program. I have moderated Nuclear Medicine sessions for the last two RSNA meetings. I am also an instructor for the three-day Dartmouth-Hitchcock PET/CT course, sponsored by the American College Radiology, which involves intensive one-on-one mentoring. I am at present a regular reviewer for *Academic Radiology*, and have served in the past as a reviewer for a variety of nuclear medicine and general radiology journals and scientific meetings, including the *Society of Nuclear Medicine*, *Association of University Radiologists* and the *Radiological Society of North America*.

III. AS EDUCATOR

Leadership in DMS student education When I became director of medical student education for the department in 1998, it consisted of a relatively unremarkable, unstructured 4th-year elective based exclusively on physician ‘shadowing.’ Today, after twelve years of sustained effort, not only by myself but by the entire medical imaging faculty, radiology education has been transformed into a robust program that actively involves residents as teachers and mentors, and whose success can be measured in a number of quantifiable achievements.

The fourth-year elective, *Basic Clinical Radiology (RAD502)*, remains—as an expanded and significantly enhanced course—at the heart of the radiology student education program, and is now typically taken by well over half of all DMS students, and is by that measure the most popular of the school’s specialty electives. This response to the elective echoes the growth in radiology as a career choice among DMS students: the number of our graduates choosing radiology residencies has averaged over 8% of total class size during the past three years, significantly above the national average of just under 5%. Latest match results strongly confirm the trend, as more than 14% of the class of 2009 selected radiology residencies. To have played an instrumental role in developing this sustained interest in our program—and for radiology as a career goal—has been enormously gratifying. I take similar pride in the quality of preparation provided by the radiology program, and by DMS medical education in general: for more than ten years, every one of our students who has applied for a radiology residency has successfully matched.

RAD502: Basic Clinical Radiology This elective is the core of our student education program—and my personal focus as an educator during the past 12 years. The course has matured into a highly structured and effective four-week elective offered in any of four blocks during the 4th year, and now available to 3rd-year students. It includes an introduction to all areas of diagnostic and interventional radiology: the advantages and limitations of the key imaging modalities; the clinical basis for appropriate imaging requests; how images are obtained and procedures are performed with the goal of understanding patient selection and suitability; how to provide informed advice to patients; how imaging is incorporated into logical medical problem solving; and the basics of radiological interpretation as applied to routine and emergency medical practice. Lectures are supplemented with subspecialty rotations chosen by students on the basis of personal career interests, special workshops, and an extensive library of electronic and web-based resources (see below). Interactive activities, lively quiz sessions and learning games form an essential part of a curriculum designed to emphasize multiple teaching methods. For the duration of the elective, students are welcomed to participate in all academic and social activities of the department. [See Appendix 1 for curriculum.]

Other program innovations We have been able to successfully expand the curriculum beyond the basic elective. Fourth-year students may choose from several shadowing-type electives; subspecialty electives in neuroradiology, interventional radiology and women’s imaging; and a research elective which forms the basis for short or long-term research projects which students are encouraged to undertake. I also present a 3-hour interactive ‘Must Know’ session as part of the Advances in Medical Sciences course to the entire 4th year class. During the period 1998-2006, I organized and taught a 6-hour didactic lecture series for the 3rd year’s *Integrated Clinical Experience* course. Subsequently, as limitations in the sequencing of this material became increasingly apparent, I developed and introduced *CORE*—a web-based radiology curriculum (see below and appendix 3)—as a replacement for the lectures. In 2006 I developed and introduced a nine-hour course taught by various members of the department into the 2nd year’s *Scientific Basis of Medicine* course, organizing the course for its first three years, teaching one of the sessions myself.

Three years ago, I started the *Radiology Interest Group* for first and second year students. It has been well-received, with attendance of 15-20 students at each of the eight sessions offered each year. I teach four of

these, including an interactive ultrasound workshop which is extremely popular. In addition, I offer and organize a shadowing Spring Elective in Radiology to 1st and 2nd year students (8 per year).

Commitment to student mentoring In addition to supervisory and direct teaching responsibilities, I am active as a mentor for students considering radiology careers, and strive to be an effective role-model and to share my enthusiasm for imaging in all interactions with students throughout their medical school experience. An extensive mentoring series for students considering radiology careers usually begins in the spring of the third year, though I am informally available from the first year. Helping students with career choices and the match process is one of my priorities. I have written an extensive residency application guide that is available to all interested students. I encourage DMS students to participate in research or educational projects with me, and several of these have presented their projects nationally under my mentorship. I make a point of meeting regularly all students seriously considering radiology residencies, and frequently contact programs to advocate on behalf of our students. I conduct surveys of students interviewing in radiology about the institutions and programs they have visited, and distribute the results to 3rd/4th year students. And every year I invite interested 3rd and 4th year students to a "Meet the Experts" dinner at my home, an informal informational exchange session about radiology careers and the match process.

I participate in the Nathan Smith program, and regularly have undergraduate Dartmouth students shadowing me. In recognition for my involvement in medical student education, I was a member of the Medical Education Committee for DMS for 6 years, during which time we instituted a number of changes to the 3rd and 4th year curriculum, initiated competency-based evaluations, and successfully underwent LCME review. In 2006 I was honored by the 4th year students with being elected to AOA and as one of two elected DMS Faculty Scholars for that year.

Faculty mentoring I have for many years taken an interest in mentoring women members of the radiology staff: encouraging participation in national organizations such as AMSER, AUR and APDR; including them in projects (e.g., writing chapters for the student textbook project, or helping develop *Radiology ExamWeb*); involving them in student educational activities and guiding their teaching portfolio development. I have extensively mentored Nancy McNulty M.D., who is the current Alliance of Medical Student Educators in Radiology (AMSER) President. Nationally, I try to support junior faculty who are often given the responsibility of student radiology clerkships by donating educational resources and curricula and providing support and guidance. I get them involved in AMSER committees and programs. I am often contacted by faculty from other institutions who are developing new or revising old Radiology curricula. Recent contacts have been from the University of South California and University of Washington.

Leadership in resident education I am also active in residency education, giving lectures (breast MRI, reporting skills), conducting board review sessions, and mentoring residents in clinical rotations at the workstation. In recent years I have taken a more direct role in program administration, serving on the Radiology Resident Education Committee and the Resident Promotion Committee. I developed a program for teaching and evaluating reporting skills that includes lectures, assessment of standardized reports, and monthly report evaluations. I am the Assistant Resident Program Director, with responsibilities that include: resident evaluation, promotion, and mentoring; helping manage the on-call schedule; applicant review (reading a major portion of the 400+ ERAS applications we receive) and interviewing as well as service on the ranking committees. Apart from radiology resident education, I am involved with resident programs for the institution at large. Each year, the department hosts roughly ten medical interns and residents for 2-4 week radiology electives. I organize these electives, providing a series of teaching resources, and spending considerable time in direct teaching at the workstation. In 2007 and again in 2009, the Department of Medicine honored me for this effort with *Excellence in Teaching* awards.

National leadership: AMSER My efforts at DMS to improve radiology education have led to national recognition and leadership. Since 1998 have been a member of the Alliance of Medical Student Educators in Radiology (AMSER)—the only national organization dedicated to student education in radiology—and served as AMSER president for 2006 and 2007, and program organizer in 2006. As president I instituted several

innovations, including the concept of shared national resources. As part of the Education Committee, I was one of the two editors of the AMSER National Student Curriculum, a 74-page document that also includes a variety of teaching resources, including a frequently cited “must-see” list, which is widely used by programs nationally and internationally. (see appendix 5). As Chair of the AMSER Electronics Committee for the last two years, I am responsible for the organization’s website, for the development of *Radiology ExamWeb* (see below) and for the AMSER *Resource Database*, a project which I directly implemented and continue to update. The *Resource Database* is hosted at Dartmouth (with the DMS role clearly noted on the website.) It includes a collection of teaching resources donated by AMSER members (curricula, presentations, quizzes, etc.) and a database of nearly 5000 images. These resources have been downloaded 1,400 times in the last two years. The Electronics Committee is also nearing completion on two new projects for students—the *Professionalism Module*, and the *AMSER Guide to Applying to Radiology Residency*.

National leadership: ACER The Alliance of Clinical Educators in Radiology (ACER) was established to support and educate those academic radiologists who teach, but are not necessarily student course directors. I have been in leadership positions in this organization since its inception and am on the Executive Committee, currently serving as Secretary Treasurer and Finance Chair. I will become ACER president in 2012. ACER, still a fledgling organization but has had educational programs at the AUR (see below) for the past two years, focused on developing our members’ teaching and evaluation skills and portfolios for promotion. I am the AAMC’s *MedEdPORTAL* Associate Editor for ACER. In this role, I direct peer reviews (identifying and recruiting reviewers, making final editorial decisions) of radiology resources and organize the online ACER collection for MedEdPORTAL.

National leadership: NBME My experience in exam writing, at AMSER, and in student education generally, helped prepare me for a current position on the National Board of Medical Examiners *Step 1 Exam Development Committee* (Anatomy and Embryology). I write and edit roughly 50 scenario-based exam items a year, and participate in the editing of hundreds of additional exam questions at the annual three-day meeting. I have been an active source of imaging resources for my NBME colleagues, and in return, my experience on the committee has improved my skills in exam development.

Other national leadership roles I have been a member-at-large for two years for the parent organization of AMSER/ACER, the Association of University Radiologists (AUR). I give presentations and conduct workshops every year for the association, and I am also a member of the AUR Electronic Communications Committee, responsible for website, social media, and similar web-based activities. As a member of the AUR Education Committee for three years I graded abstracts for the annual meeting (around 100/year), and as a member of the AUR Awards Committee I evaluate papers for various awards (around 16). I am also a member of the Association of Program Directors in Radiology (APDR), and have recently been appointed to its Education Committee, and to its Program Development Committee.

Innovation in learning systems and tools I have developed and promoted a number of educational resources for students and residents, several of which are now widely utilized throughout the national student education community. Some of these have been published in peer-reviewed publications such as *MedEdPORTAL* (the educational resource database published by the Association of American Medical Colleges). With support from a Dartmouth College *Venture Fund* grant, I conceived, developed, and continue to improve the medical student teaching system, *Case Orientated Radiology Education* (CORE). This series of 14 cases provide approximately 75% of the Radiology curriculum in a case-based on-line format (see Appendix 3). Students currently take appropriate cases during clinical clerkships in the 3rd and 4th year, which permits imaging to be taught in parallel to the clinical clerkships. For example, students do the Women’s Imaging cases during OB/GYN. These continually updated cases have been developed with other radiology faculty and DMS IV students applying to radiology residencies. Student response to this case-based approach has been very positive. This project has been peer-reviewed and presented nationally, and I had a paper on this initiative accepted by the *Journal of the American College of Radiology*. I am exploring making these cases available to other institutions.

Radiology ExamWeb My interest in developing shared resources and item writing led to the conception and development of *Radiology ExamWeb* with DMS colleague Nancy McNulty M.D. (see Appendix 3 for more details, screenshots and access). This was conceived as a way of providing a web-based exam tool and database for medical students taking Radiology clerkships anywhere in the country. By providing a centralized database, question item quality can be maintained, allowing consistent testing. Faculty who have limited time and computer skills do not need to ‘reinvent the wheel’. Radiology clerkship directors can develop their own exams or use preexisting exams and students take the exams on-line. This effort has been supported by grants from the Hudson Foundation and a prestigious RSNA Education Grant (total grants \$74,700). The exam database contains >800 items currently, both image and non-image based. Further projects involving this tool will include the development of ‘shelf’ type exams based on the AMSER curriculum. To date 30 institutions have signed up to use this resource and 435 students have taken exams.

Other learning tools Additional electronic education resources for students which I have developed include: *Image Jeopardy* (see CV for MedEdPORTAL link), *Must See Radiology* (see CV for MedEdPORTAL link), *Lines and Tubes* and other Powerpoint-based modules; an extensive *Blackboard* site with multiple links and further resources; and a comprehensive “Goals and Objectives” page on our website providing medical students and residents detailed program descriptions and linked learning resources (see appendix 1 for link) The *Goal and Objectives* site, incidentally, has achieved a following even outside DMS, and receives frequent visitors from other institutions. I have continued to utilize my training and expertise in exam development by creating the formal competency assessment process for first year radiology residents for evaluation of competency prior to them starting independent call. Each (of 3) exam includes 50 cases in a Powerpoint based, hyperlinked format. I have given the exam annually for the last 3 years. It is assessed in a similar way to the American Board of Radiology board examination, and residents who fail retake a similar exam 6 weeks later after directed learning. (See CV for MedEdPORTAL link). These various published electronic modules on MedEdPORTAL have been downloaded and used by users in ten countries as well as the USA since early 2010.

SUMMARY

Since joining the faculty in 2003, I have worked steadily to develop radiology education at DMS throughout the four year curriculum, as well as radiology education for medical students nationwide. Not in a small part to my efforts DMS now has a radiology course at or above the level of those offered at top national institutions such as Harvard, Johns Hopkins and Yale. I have a significant national profile in radiology education as evidenced by my presence on multiple national education committees and boards. The teaching resources that I have developed have been peer reviewed, published and utilized by institutions both within and outside the USA. I write exams for both American Board of Radiology and the National Board of Medical Examiners and an examiner for the oral component of the ABR certification. I have continued to publish and have received over \$90K in grants in this period. My clinical skills are respected by my colleagues and the regional community, particularly in the field of breast imaging. Finally, I have been involved with ‘service’ for DMS/DHMC, including several search committees, Board of Governors nomination committee, tumor boards, departmental committees and residency training program responsibilities.