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AJNR Am J Neuroradiol 1991, 12 (4) 587-590
http://www.ajnr.org/content/12/4/587.citation

This information is current as of April 19, 2024.

Special Article

Development of the First Fellowship Training Program in Neuroradiology in North America

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Subspecialization in radiology was essentially nonexistent in the decade of the 1950s. The emphasis was on general radiology, and on the idea that all radiologists should perform and interpret all radiologic examinations. In the early 1950s, these consisted of chest films; upper and lower gastrointestinal examinations; excretory urograms; examinations of the skeletal system, gallbladder, paranasal sinuses, mastoids, and skull; and tomography. In many hospitals, myelograms were interpreted by the radiologists, but they rarely injected the contrast material. In a few institutions, pneumoencephalography also was performed and usually interpreted by the neurosurgeon or the neurologist, although the radiologist submitted a written report. The use of cerebral angiography was slowly increasing. However, in the few institutions where it was carried out, the injection and interpretation of findings invariably were performed by neurosurgeons, and sometimes by neurologists. Some radiologists were interested in learning something about the interpretation of angiograms and tried to generate intelligent reports. Nuclear medicine procedures were essentially unknown at that time.

If one considers the staffing situation in the 1950s, it becomes clearer why there was no consideration of subspecialization within radiology. For one thing, the number of radiologists was increasing slowly, and many more positions were available than there were trained radiologists to occupy them. Consequently, radiology residents in training were not exposed to the possibility of subspecializing in a given area. Although radiologists in some private hospitals received a percentage of the gross charges for radiology services, the majority were on a salary. In the teaching institutions, these salaries were usually low and resulted in a lack of interest in academic careers by young radiologists completing their American Board of Radiology (ABR) requirements.

In addition, most teaching hospitals were reluctant to commit additional funds for postresidency radiology training, even though these institutions usually received generous surpluses from the operation of the radiology departments, which at that time were considered "profit" centers.

Thus, the two most important ingredients in creating subspecialty training in radiology, role models to stimulate the young radiologists to seek subspecialty training and the existence of funds to support the trainees, were absent during the early 1950s.

In Europe, fellowship-equivalent positions were available, particularly in Sweden, where neuroradiology had received the interest and support of two chiefs-of-service, Eric Lysholm and later Eric Lindgren. In the 1950s a few Americans were accepted for postresidency training in neuroradiology in Dr. Lindgren's department at the Serafimer Hospital in Stockholm. These included Al Smith and Elliott Lasser, who were there for brief periods, and James Galloway, who spent an entire year. None of these individuals subsequently pursued a full-time career in neuroradiology. Others in the early 1960s trained in Gothenburg under Ingmar Wickbom. They include Fred Hodges and William Hanafee, both founding members of the American Society of Neuroradiology (ASNR). Vincent Hinck and Sidney Wallace received training in Lund. In addition, a few Americans were accepted for training under James

Received March 6, 1991; accepted without revision March 7, 1991.
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Bull at the Institute of Neurology at Queen's Square in London. These included Hans Newton and Eugene Leslie, both founding members of the ASNR. Dr. Bull himself had trained under Dr. Lysholm.

Development of the First Training Programs in the United States

The concept of subspecialization was alive at Columbia Presbyterian Medical Center in New York, the first true medical center in the United States organized almost entirely under one roof, with only the Neurological Institute and the Institute of Ophthalmology housed in separate buildings. In addition to these two institutes, the constituents of the medical center included the Babies Hospital, the Sloan Hospital for Women, the Squire Urological Clinic, the Medical and Surgical Services, and the Vanderbilt Clinic. The Neurological Institute began as an independent institution and later joined the medical center complex. In the early 1950s, two radiologic subspecialties were fostered at the Columbia-Presbyterian Medical Center: pediatric radiology under John Caffey and neuroradiology under Ernest Wood and, in 1952, under me.

In the mid 1950s, I received a few inquiries about the possibility of obtaining postresidency training in neuroradiology. My response was always negative because there were no funds to support postresidency training. What existed was a subspecialty rotating program for junior attending physicians initiated in 1950–1951 by Ross Golden at Columbia-Presbyterian in which junior attending radiologists were assigned to pediatric radiology, neuroradiology, general diagnostic radiology, and radiation therapy for 6-month rotations. I was fortunate enough to be the first junior staff member to be selected for this program. It opened my eyes to the need for subspecialization in radiology, since I could observe the superior knowledge and experience with newer techniques that existed among subspecialists compared with their colleagues in general radiology. This conviction and the need to do something about it has remained with me to this day.

In 1958–1959, the National Institute of Neurological Diseases and Blindness (NINDB) expanded the concept of fellowship training and agreed to support trainees not only in clinical neurology but also in other branches of the neurologic sciences, including neuropathology, neurophysiology, and neuroradiology. Organizing neuroradiology required some new thinking. The desire was to generate increased expertise in this area, which was considered poorly represented. A small meeting called by Elizabeth Hartman, who was then director of Training Grants and Awards at the NINDB, was held in New York. The meeting was attended by Mrs. Hartman; the director of the extramural program of the NINDB, Murray Goldstein; and two invited radiologists, Kurt Amplatz from the University of Minnesota and me.

I cannot recall who the neurologists and neurosurgeons were who were present at this meeting. Only generalities were discussed, but the need to have competent consultants in diagnostic radiology with interest and knowledge of the nervous system was emphasized strongly. The late H. Houston Merritt was very active at the NINDB in those years, and he put me in touch with Aura Severinghaus, a professor at Columbia College of Physicians and Surgeons, who was then chairman of the Training Grants Committee at NINDB. Dr. Severinghaus indicated that the climate was favorable for applying for a training grant in neuroradiology.

There were two types of training grants. In one, a sum of money was granted annually to support part of the training expenses of the institution, but most of the award went to support stipends for trainees. This type was the one used in clinical neurology at that time because these trainees were supported during their residency training period. The permissible stipends in this type of grant were rather low at the time. The second type of training grant consisted of a small amount of support to cover the training expenses of the institution but no support for trainees. The trainees would then apply for a special training fellowship upon recommendation of the training program director. In this case, each applicant, after being accepted by the program director, had to be accepted by the Training Grants Committee at the NINDB.

In discussion with Mrs. Hartman and others, I chose to apply for the second type because I thought it was important to accept only applicants who had completed their radiologic training and were eligible to take, or had already taken, the ABR examinations. I also thought it was necessary to have well-qualified applicants who were not apt to be distracted by other duties, and who were likely to have made a career choice in this subspecialty of radiology. The second review by the Training Grants Committee was useful for obtaining the best applicants and also for complying with the National Institutes of Health (NIH) policy by selecting individuals with research and teaching potential who, later, were likely to organize their own training programs. The latter would help fulfill the national requirements for trained neuroradiologists in the shortest time possible.

Another problem that had to be considered was the optimum length of the training period; my decision was a 2-year period after completion of general radiology training. The special training fellowships were renewable for up to 3 years through a simpler reapplication. Although I was the first to establish a training program approved and funded by the NINDB at the Neurological Institute of Columbia-Presbyterian Medical Center, the details of it were discussed with Mannie M. Schecter, who proceeded to organize a similar program at Bronx Municipal Hospital–Albert Einstein College of Medicine. This also was funded by the NINDB. Thus, two programs were available in New York early in 1960, and there was an almost immediate response from senior radiology residents interested in subspecializing in neuroradiology.

I have often wondered about the "sudden" interest. The only explanation I can offer, and for which I take credit, was the establishment in 1956 of an annual postgraduate course in neuroradiology at the Neurological Institute that was oversubscribed and continued to be so for the next 8 years. These 1-week courses exposed many to what neuroradiology was, and probably stimulated some to seek training. Harold Peterson of Minneapolis also organized excellent courses in neuroradiology, the first of which took place in 1939, and these

also contributed to arousing interest. The other factor was that the need for trained neuroradiologists was beginning to be recognized by other medical specialties, particularly neurosurgery.

Neurosurgeons had become aware of these needs because the diagnostic procedures were consuming an increasing amount of their time. Cerebral angiography gradually gained in importance following the introduction of better techniques and equipment and safer contrast media to replace Diodrast and Thorotrast. Some neurosurgeons, during visits to their colleagues in Europe, saw how satisfied they were to depend on neuroradiologists for the performance and interpretation of diagnostic procedures. Torgny Greitz, then at the Serafimer Hospital in Stockholm, was invited to Washington University's Mallinckrodt Institute of Radiology in St. Louis to spend a sabbatical year, in the late 1950s. In addition to his local activities, which were very well received and appreciated, he made a number of presentations at neurosurgical meetings in the United States that stimulated some neurosurgeons to ask the chiefs of radiology at their respective institutions to consider providing expert assistance in neuroradiology.

One important problem to be resolved in establishing the new training programs was how to ensure that trainees would get sufficient experience in performing angiography, pneumoencephalography, and myelography. Angiography had been performed by neurosurgical residents and to a lesser extent by neurology residents. Pneumoencephalography was most often carried out by neurology residents. Arrangements were made and changes began to take place slowly.

The neurology and neurosurgical residents were to carry out the procedures on their own patients (patients in the ward service). A few of the staff physicians agreed to have the procedures that were performed on their patients carried out under the supervision of the neuroradiologists. This gave them responsibility for a certain number of procedures, particularly angiography, but for the first 3–6 months the number of procedures assigned to the fellows was low. In those days, the complication rate for angiography was high relative to that in the modern era. Over a period of 12–18 months, it became apparent that the complication rate for cerebral angiography when procedures were carried out by the radiologists was noticeably lower than when procedures were carried out by others. This led more neurosurgeons and neurologists to request that angiographic procedures in their own patients be carried out by the radiologists. In addition, the staff neuroradiologists and fellows were always available, whereas the neurosurgical and neurology residents were often assigned to duties that made it difficult for them to carry out the studies at the time scheduled in the radiology department. In addition, whenever a neurology or neurosurgery resident got into difficulties with a specific procedure, usually angiography, the neuroradiologist was asked for assistance. Before then, they had called on one of their senior residents and often had to wait until that individual, normally assigned to other duties, could arrive on the scene. The combination of these three factors worked to increase the number of procedures available to neuroradiology fellows, and within a period of 2–3 years the performance of angiography by neurological and neurosurgical residents was virtually eliminated.

Trainees

Trainees in the first 3–5 years of the Neurological Institute program included Norman Chase, who came as a junior attending in 1958–1959 but wanted to devote himself to neuroradiology. He later became professor and chairman of radiology at New York University. Norman Leeds was the first special fellow accepted by the NINDB. He had finished his residency at Columbia-Presbyterian; sometime later he became professor of radiology at Albert Einstein College of Medicine.

Other early trainees included Irvin Kricheff, later professor of radiology at New York University; Herbert Goldberg, later professor of radiology at the University of Pennsylvania; Ralph Heinz, later professor and chairman of radiology at the University of Pittsburgh; Gig Svare; Freddie Gargano, later professor of radiology at the University of Miami; Joseph Flynn, later director of radiology at St. Joseph Hospital in Phoenix; David O. Davis, later professor and chairman of radiology at George Washington University; and Calvin Rumbaugh, later professor of radiology at Harvard Medical School.

J. Rodriquez-Carbajal was a trainee not supported by NINDB because he was not an American citizen. He later became director of radiology at the Institute of Neurology and Neurosurgery in Mexico City, professor of radiology at the University of Mexico, and also developed a training program for Latin American trainees. At the same time, William Marshall from Stanford University was a clinical fellow not supported by the NINDB. He later became head of neuroradiology at Stanford. Many other trainees in subsequent years achieved equally high academic positions.

As soon as the first graduating fellows completed their training they were offered positions in a number of institutions, and usually, it was a matter of selecting the most attractive offers. The early graduates of the program performed so well at their chosen institutions that the demand for trained neuroradiologists rapidly expanded and no one wanted to wait too long to obtain these services. I vividly remember a sequence of events that was a great source of pride and satisfaction to me. Joseph Ransohoff, who had been at the Neurological Institute for a number of years, was appointed chairman of neurosurgery at New York University in the early 1960s. He told me that he was hoping to recruit one of my associates (at that time, Norman Chase and Gordon Potts) to go to New York University. He said that he had given much thought as to why the Neurological Institute had had, for a number of years, the best reputation in neurological surgery, and had concluded that the only real difference was the backup provided by neuroradiology, which had existed there since the time of Dyke, and that this support was absent in other institutions. Dr. Chase accepted the position and Dr. Ransohoff proceeded to provide exemplary support from neurosurgery, which greatly assisted in the development of neuroradiology at that institution and probably influenced others.

The NINDB invited both Mannie Schechter and me to become members of the two training grant committees of the NINDB. This was helpful in seeing that the applicants for special training fellowships received the proper attention and

consideration, in assisting in the development of other training programs, and in becoming acquainted with research trends and opportunities. The 4-year appointment provided invaluable training and experience in matters involving research and research training. After this, we were both invited to become members for an additional 4 years of the two committees dealing with research grant applications. The increased demand for competent services pointed to the need to develop more training opportunities.

Soon, a number of training programs were organized and were supported by the NINDB. These included the University of Minnesota under Harold Peterson; New York University under Norman Chase; Washington University, Mallinckrodt Institute of Radiology, under me; New York Hospital–Cornell University under Gordon Potts; University of California, Los Angeles, under William Hanafee; University of California, San Francisco, under Thomas H. Newton; University of Pittsburgh under Ralph Heinz; University of Miami under Freddie Gargano; Johns Hopkins University under Fred Hodges; Montefiore Hospital under Norman Leeds; and Massachusetts General Hospital under me, after becoming chairman there.

The training grants were later (about 1967–1968) converted to the type in which the stipends were included in the grant budget, which facilitated the appointment of new fellows. The stipend was lower than that of the special training fellowships but could be supplemented by the institution, if necessary. The training grants were continued by the NINDS (the institute changed its name to the National Institute of Neurological Disorders and Stroke after the creation of the National Eye Institute) until about 1976, at which time they were discontinued, along with other fellowship programs emphasizing clinical training. The emphasis was then placed on research training, and any approved training program had to emphasize research with the clinical portion of the training supported entirely by the institution. By then, however, there were a number of programs not supported by the NINDS, and those that were converted to support of the trainees from institutional or professional funds.

Although the original purpose was to train clinical neuroradiologists, the traditional research emphasis of the NIH was also emphasized. The trainees were so heavily involved in clinical duties during training that little time was available for research, and the majority of trainees received little exposure to it. Few neuroradiologists went on to apply for research grants from the NIH, although many became involved in research projects with other investigators, usually in neurology or neurosurgery. The lack of direct application to the NINDS (later NINCDS when communicative disorders were added) by neuroradiologists led to an *AJNR* editorial [1] by Murray Goldstein, director of the NINCDS, entitled "Where are you? You are needed!" in which he encouraged neuroradiologists to apply for research training support [1, 2].

As I think back to the late 1950s, I ask myself: Could we have developed neuroradiology without the assistance of the NIH? My response is that it would have been impossible. The institutions were not willing to support additional training, and at that time no professional funds were available because all (or practically all) radiologists in teaching institutions were on a strict salary. Therefore, I believe that the NINDB can be credited with the early development of neuroradiology in the United States. To me this is a wonderful example of what Abraham Lincoln referred to when he said: "Government should do for the people what the people are not able to do for themselves."

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2. Taveras JM. Neuroradiology: past, present, future. *Radiology* **1990**; 175:593–602

The reader's attention is directed to the commentary on this article, which appears on the following pages.