

Differences in Neuroradiology Training Programs around the World

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ABSTRACT

BACKGROUND AND PURPOSE: No previous study compares neuroradiology training programs and teaching schedules across the globe, to our knowledge. This study was conducted to better understand international program requisites.

MATERIALS AND METHODS: Data from 43 countries were collected by an e-mail-based questionnaire (response rate, 84.0%). Radiologists across the world were surveyed regarding the neuroradiology training schemes in their institutions. Answers were verified by officers of the national neuroradiology societies.

RESULTS: While many countries do not provide fellowship training in neuroradiology ($n = 16$), others have formal postresidency curricula ($n = 27$). Many programs have few fellows and didactic sessions, but the 1- or 2-year duration of fellowship training is relatively consistent ($n = 23/27$, 85%).

CONCLUSIONS: There is a wide variety of fellowship offerings, lessons provided, and ratios of teachers to learners in neuroradiology training programs globally.

ABBREVIATIONS: ACGME = Accreditation Council for Graduate Medical Education; DNR = diagnostic neuroradiology; ESNR = European Society of Neuroradiology; INR = interventional neuroradiology; NR = neuroradiology

The United States considers itself a leader in medical education and training among nations.¹ Generally speaking, American medical school, residency, and fellowship programs are considered globally as being well-structured, highly competitive, and outstanding in the quality of education and instruction. As of the 2013–2014 academic year, 185 radiology residency programs and 85 neuroradiology (NR) fellowship programs in the United States are voluntarily supervised by the Accreditation Council for Graduate Medical Education (ACGME). This private, nonprofit organization sets educational standards and periodically reviews their implementation within the respective graduate medical educa-

tion programs.² In addition, completion of programs accredited by the ACGME is a prerequisite to becoming board-certified in diagnostic radiology and subspecialty certified in neuroradiology. Examinations are offered by the American Board of Radiology annually through the American Board of Medical Specialties. It oversees specialty and subspecialty certification in radiology and 23 other medical specialties in the United States.

The educational path for an aspiring American neuroradiologist typically begins by matching in a first-postgraduate-year prerequisite clinical year (internship year) and an ACGME-accredited postgraduate year 2- to 5-year diagnostic radiology residency program.³ The first 3 years of residency focus on diagnostic radiology (postgraduate years 2–4) and include 9 core rotations in abdominal radiology, breast imaging, cardi thoracic radiology, musculoskeletal radiology, neuroradiology, nuclear radiology, pediatric radiology, sonography, and vascular and interventional radiology. In postgraduate year 5, residents may participate in subspecialty rotations of their choice.⁴ The trainees' diagnostic experience in the different imaging modalities is assessed through a case/procedure log system, which is annually reviewed by the faculty of the program and the ACGME.⁵


After finishing residency, graduating radiologists have the opportunity to start additional fellowship training within their discipline of choice if they desire subspecialty expertise.⁶ Contributing factors that

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promote the implementation of fellowship programs in radiology are the rapid development of new imaging techniques, the need for appropriate interpretation skills and expertise to compete in the job market, and the trend toward endovascular and percutaneous therapies.¹

The first NR fellowship positions were offered in Stockholm and London in the 1950s and approximately 10 years later in New York (1960).⁷ Regarding neuroradiology, 2 fellowships are offered in the United States currently: diagnostic neuroradiology (DNR) and interventional neuroradiology (INR), with the latter, by ACGME regulations, requiring a previous DNR year. However, very few of the offered neurointerventional programs are currently ACGME-accredited, so this requirement is often not completed.

Because there is a trend toward greater subspecialization in radiology globally, we conducted a survey to investigate differences in radiology training programs across the world with regard to the general curriculum, focusing on neuroradiology fellowships in particular. Therefore, departments in countries on all continents were asked to complete a standardized questionnaire about their training programs. Hence, differences in international educational structures could be revealed.

MATERIALS AND METHODS

The parameters of radiology residency and fellowship training at institutions across the globe (both university hospitals and community teaching hospitals) were analyzed. From December 2013 through February 2014, a 16-item questionnaire was sent via e-mail to members of 50 non-US neuroradiology societies, neuroradiologists, neuroradiology fellows, and residents (On-line Table 1). To check the accuracy of information submitted, in a second step, we contacted representatives of national radiology and neuroradiology societies, who validated the responses.

The items were related to 3 topics: general information about the structure of medical education, features of general radiology residency, and neuroradiology fellowship programs. Responders were further contacted by e-mail to clarify specific issues if necessary.

To evaluate the structure of the trainee didactic and clinical education, we asked for the weekly number of neuroradiology teaching sessions in the programs. In addition, a ratio of the number of residents/fellows to the number of attending physicians was calculated for each department.

RESULTS

The response rate was 86.0% (43/50 countries). Members of national neuroradiology societies helped to verify 76.7% of the initial results ($n = 33/43$ countries). Representative information was obtained from the following 43 countries:

- North America: United States and Canada
- South America: Argentina, Brazil, Colombia, and Guatemala
- Europe: Albania, Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Lithuania, Norway, Portugal, Spain, Sweden, Switzerland, the Netherlands, Turkey, and United Kingdom
- Africa: Egypt, South Africa, and Tunisia

- Asia: China, India, Indonesia, Iran, Israel, Japan, Lebanon, Pakistan, Philippines, Saudi Arabia, South Korea, and Thailand
- Australia
- New Zealand.

As for general categorization of responses, the countries were divided into those who do not provide neuroradiology fellowship programs and those who do.

Countries That Do Not Provide Fellowship Training

On-line Table 2 provides information about the 16 countries reporting that they do not offer a fellowship program for either diagnostic or interventional neuroradiology ($n = 16/43$).

The duration of medical school, including an internship period before graduation, ranges from 4 years in Lebanon (an American system with a 3-year bachelor of science degree required) to up to 7 years in Iceland, Egypt, and Tunisia.

Internships as part of general radiology residency are mandatory in Albania, Denmark, Lebanon, New Zealand, Pakistan, and South Africa. The shortest radiology residency program (3 years) of all surveyed countries without neuroradiology fellowships was in Egypt. Only in Egypt (1:1), and New Zealand (1:1.5) are there official requirements for a resident/faculty ratio.

In Spain, no official fellowship programs are provided, and instead, candidates are obliged to get a 2- or 3-year grant for a specific project from the national government, a hospital, or the pharmaceutical industry. In Turkey, a few hospitals have formal approval to offer fellowships for interventional neuroradiology, but there are no public tenders for diagnostic neuroradiology fellowships.

None of the surveyed African nations (Egypt, South Africa, and Tunisia) offer neuroradiology fellowships. A unique feature of the Tunisian radiology residency program is that the residents rotate through different departments in various cities and hospitals across the country.

Pakistan offers 1-year fellowships in vascular and interventional radiology during which the fellows likely get some interventional neuroradiology exposure, but there is no dedicated program per se.

Countries with a Formal Neuroradiology Fellowship Program

On-line Tables 4 and 5 show information about the 27 countries that provide postresidency training in DNR and/or INR.

If one looks at the ratio of the number of residents/number of attending physicians, there is a large difference among the surveyed departments: on the one hand, countries such as Finland (ratio 0.2), Norway (0.3), the United States (0.3), and Canada (0.5) have a surplus of attendings (attendings exceed residents by far). On the other hand, Germany (ratio: 2.9), Brazil (3.2), Iran (3.2), and Indonesia (8.3–10.0) have a high number of residents compared with the number of attendings. National requirements regarding the number of faculty members are available only in a few countries (Austria, Australia, India, the Netherlands, and the United States).

Of those countries with a neuroradiology training program, almost every department offers regular neuroradiology lectures or at least the opportunity for residents to attend otolaryngology,

neurosurgery, or neurology case conferences. Case logs for tracking the residents' experience are used by most departments (63%).

Thirteen of 27 analyzed hospitals offer diagnostic and interventional neuroradiology fellowship programs; 9 departments provide only a diagnostic ($n = 8$) or a neurointerventional program ($n = 1$). The neuroradiology fellowships in Germany (2–3 years), India (3 years), Ireland (1 year), and South Korea (2 years) include both diagnostic and interventional NR in 1 curriculum (see "NR" in On-line Table 5).

The largest fellowship program is offered by the representative United States department (Johns Hopkins University) with 8 places for diagnostic NR and 2–3 places for interventional NR yearly. This program offers 1–2 teaching sessions daily (case presentations, journal clubs, grand rounds) given by neuroradiology, neurosurgery, neurology, and otolaryngology faculty or by the fellows themselves. There is a wide variety in terms of the number of scheduled lectures among other countries (only sporadic lectures in the Swedish, British, Chinese, Iranian, and Korean departments; 1–5 lectures per week in all other departments).

Ten of these 27 countries do not require a written or oral examination at the end of the neuroradiology fellowship.

Because of a lack of specialized interventional neuroradiologists, interventional neuroradiology procedures in Indonesia are performed by general interventional radiologists. A fellowship program for INR is currently in the planning phase.

The Tehran University of Medical Sciences is the only hospital in Iran that offers a fellowship for INR. The DNR postresidency program in Israel has been recently approved by the Israeli Medical Association and was reported to start in 2014.

Compared with the aforementioned countries, Portugal is an exception. After 6 years of medical school, the trainee must complete 18 months of an internship and can then start a 5-year neuroradiology fellowship program without doing a general radiology residency beforehand. Currently 7 teaching centers with 30 trainees offer a program solely focusing on diagnostic and interventional neuroradiology, including rotations in neurology, neurosurgery, and neuropediatrics. Fellows have a case log and must pass an oral examination at the end of the 5 years.

Taken together, nearly half of the European countries analyzed provide formal postresidency training in neuroradiology ($n = 11/20$). To obtain an official degree in neuroradiology in a country without a fellowship program, one can complete a special course program organized by the European Society of Neuroradiology (ESNR, On-line Table 3). The first-level course is held on a yearly basis as a 2-day course in varying European cities, reviewing the most common cerebral pathologies, and is designed for residents in their first, second, or third year. The second-level course is organized every 6 months and is designed for certified radiologists with a 2-year minimum of neuroradiology training. Each of the 4 modules (first course: embryology/anatomy/malformations/genetics; second course: tumors and tumorlike lesions; third course: vascular diseases; and fourth course: trauma/degenerative/metabolic/inflammatory) lasts 5 days. The location is selected by the ESNR executive committee. Eligible candidates for the final European Diploma in Neuroradiology are certified radiologists with a 2-year minimum training in neuroradiology, who

need to successfully pass the written examinations associated with the second-level course modules. The ESNR also organizes third-level courses (European Advanced Courses/European Diploma of Higher Qualification). The duration of these programs varies, but usually 1 course lasts several days and is offered in different cities. In doing so, the ESNR aims to achieve standardization of neuro-radiology education throughout Europe.⁸

Regarding training in general radiology in Europe, the European Society of Radiology recently published the revised version of the European Training Curriculum for Radiology. It aims to harmonize radiology training in Europe because it describes the objectives in knowledge, skills, and competences and attitudes for radiology residents. The curriculum does not include details about lecture hours, case log minimums, or the number of faculty members.⁹ Comparable with the European Society of Radiology work, the ESNR implemented the "European Charter for Education and Training in Clinical Neuroradiology (Diagnostic and Interventional)," attempting to standardize neuroradiology subspecialization training in Europe.¹⁰

DISCUSSION

In this study, data about neuroradiology training programs in various countries worldwide were collected, though it is virtually impossible to realistically compare their quality. Socioeconomic factors, local culture/preferences, historic precedents, and financial factors may explain differences in educational structures in these countries more than any other condition. However, this survey was primarily conducted to give an impression of the educational concepts in different countries and to show how their training schemes are organized.

Preresidency

Despite the varying structure of medical school curricula (eg, undergraduate/graduate education in the United States, Canada, or Australia versus direct-entry medical programs in Germany, Brazil, or Thailand; and inclusion of an internship within the medical school curriculum versus noninclusion), the duration of medical school is roughly equal in all countries studied (4–6 years). In almost all the analyzed countries, it is mandatory to complete an internship, which is either included in the medical school curriculum or has to be performed after graduation from medical school before a radiology residency. On the other hand, there is an ongoing debate in America as to whether the year of internship should be spent in other activities for future radiologists. Shortening the US radiology residency program to 3 years and potentially completing clinical months instead of a preresidency internship as part of subspecialty fellowship training after the residency has been suggested in editorials.^{1,11}

Residency

There was a wide variation in the duration of radiology residency, ranging from 3 years (Egypt, Brazil, Colombia, India, Thailand, and Japan; 6/43 = 14%) to 5 years ($n = 17/43$ departments = 39.5%). Iceland, with the lowest population density of all European countries, provides formal residency programs for general medicine and psychiatry, but not for radiology. All 3 neuroradi-

ologists working there obtained their training in mainland Scandinavia.

Because new imaging techniques are developing more rapidly, whether the shorter programs would be able to cover the same teaching modules as the longer programs has been questioned. However, the current trend is toward greater subspecialization. In this setting, it may be feasible for even a short general program to provide a sufficient basis for proceeding to more focused subspecialty expertise.

A striking difference was observed for the ratio of the number of residents to faculty members, which was lowest in the US department (0.3 residents/1 attending) and highest in Germany (2.9 residents/1 attending), Brazil (3.2 residents/1 attending), Iran (3.2 residents/1 attending), and Indonesia (8.3–10 residents/1 attending). A high number of attending physicians are suggested as the basis for maintaining a high standard of teaching, educating young radiologists, and conducting high-quality research. Consequently, in the United States, the ACGME requires at least 1 full-time equivalent physician faculty in each of the 9 core subspecialties for US radiology residency programs (see the first paragraph).⁴

Furthermore, a unique feature of US general radiology programs is that they must offer a minimum of 5 hours of lectures, case conferences, and journal clubs per week (mandated by the ACGME). As required by the ACGME, residents are not responsible for covering clinical service during that time.^{3,4} No other country mandates such extensive protected teaching/learning time.

Most neuroradiology lectures during residency are included in the general diagnostic radiology conference schedule, but ambitious residents may have the opportunity to plan extra rotations in neuroradiology. An additional focused lecture series in neuroradiology (4 weeks) for residents is provided once a year in some US and Turkish departments.

Fellowship

Regarding specialized training in neuroradiology, a wide spectrum of programs was observed, ranging from solely DNR (7 countries) or INR training (1 country) versus both DNR and INR fellowships (13 countries including the United States plus 4 countries with a joint DNR/INR [both diagnostic and interventional NR in 1 curriculum fellowship]) to a program that does not require completion of residency in general radiology but rather provides exclusive DNR/INR neuroradiology training for 5 years (Portugal).

The departments of 5/27 countries (18.5%) that provide neuroradiology fellowship training do not provide regularly scheduled didactic sessions. In contrast, daily teaching is strongly encouraged in some countries, where fellowship lectures are also provided by the clinical services (ie, neurosurgeons, neurologists, and otolaryngologists). The Philippine, Australian, and the Saudi Arabian departments also offer daily teaching. To encourage education and self-improvement of fellows (and residents), the didactic curriculum may also include a variety of formats (case series, journal clubs, noon conferences, grand rounds, and morbidity and mortality conferences).

To maintain the highest standards of neuroradiology educa-

tion and ensure competent guidance of the US trainees, a faculty-to-fellow ratio exceeding 1:1 is suggested by the ACGME. Except for the Chinese hospital (6 DNR fellows to 4 faculty members), each non-US department analyzed met this requirement (26/27 = 96.3%).¹²

The limitations of this survey are based on sampling bias for those respondents that replied to the survey and the results provided particularly for that institution. Because national regulations are not widely disseminated across each country, one could not tell whether the results from 1 institution truly represent the whole nation. We aimed to cross-check the validity of the answers (regarding general information) submitted by interviewing national representatives of neuroradiology and radiology societies, but not all officials responded. However, the information we obtained was provided by radiology residents, neuroradiology fellows, or radiology faculty members. Because the comparison with the representative American program was also based on a single large university hospital (Johns Hopkins), we used the ACGME regulations to provide the requirements of all American programs.

CONCLUSIONS

Several differences were observed with regard to the organization of neuroradiology training in the nations examined. The spectrum ranges from the complete absence of neuroradiology fellowships to highly specialized and elaborate programs in several countries. These variations across the globe may be primarily related to financial and economic factors; historical precedents, politics, and turf battles among medical specialties; the volume of candidates available; the job market; and the teaching expertise available.

ACGME-approved radiology residency programs in the United States are structured educational experiences, because they are based on concrete enforceable guidelines.^{4,5,12} These include scheduled rotations with specified goals and objectives, requirements for qualification of personnel, the necessity of a case log as an accurate trainee experiential record, teaching standards with scheduled conferences and lectures relating to a core didactic curriculum, periodic review of the resident, and the implementation of objective national certifying examinations.⁴ As well, ACGME-accredited neuroradiology fellowship training is offered in the United States and also provides analogous guidelines requiring faculty-to-fellow ratios that exceed 1:1. Non-ACGME-approved fellowships in neuroradiology are also offered. However, because they may not lead to US subspecialty certification and may not be recognized for state licensure, those programs remain less desirable.

The ESNR has recently endeavored to coordinate training courses in neuroradiology, implement standardized European examinations, and create a “European Charter for Education and Training in Clinical Neuroradiology”.¹⁰ Primarily, it aims to harmonize subspecialization training in neuroradiology throughout Europe and to create common standards of knowledge.

In summary, many different philosophies and methods for training radiologists and neuroradiologists can be found across the globe. While the duration of diagnostic neuroradiology train-

ing varies only minimally, the structure of that training and the regulations and oversight vary widely.

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