The development of interventional neuroradiology (INR) has increased rapidly during the past few years. A majority of cerebral aneurysms today are treated using more and more sophisticated endovascular techniques dedicated to the different types of aneurysms (fusiform/saccular, large and giant/small, wide neck/small neck, ruptured/unruptured). Also, endovascular techniques for the treatment of acute ischemic stroke are increasingly being used with highly effective results, particularly in the management of large-vessel occlusions, whereas angioplasty and stenting have a significant place in the prevention of stroke by treating cervical and intracranial stenoses. INR is the principal technique for the treatment of intracranial and spinal dural arteriovenous fistulas and also plays a significant role in the management of brain and spinal arteriovenous malformations, as well as in the presurgical embolization of cranial and spinal hypervascular tumors and in the devascularization of patients with, for example, epistaxis.

Although the creation and development of INR were initiated by neuroradiologists, other medical specialists have become progressively more involved with the techniques, particularly neurosurgeons and, to a lesser extent, neurologists. Because it was a new medical practice, no specific training was initially available but, over time, several scientific societies began to propose guidelines for the training and practice of INR.1,2 Until now, training in INR has been a matter between trainee and teacher and, thus, the result has often been less-than-optimal training with a long learning curve, with patients paying a high price.

The Union Européenne des Médecins Spécialistes (UEMS)/European Union of Medical Specialists) is the officially recognized and permanent consulting nongovernmental organization for European medical institutions; today it represents 35 national organizations and ≈1.6 million medical specialists. The UEMS is involved in professional issues important to European specialists and has a significant influence on how these issues are formulated in the directives and laws introduced in the European Parliament. It is also the one and only representative of medical specialists to the European Commission and Parliament. This means that most decisions regarding medical specialists are prepared in cooperation with the UEMS. The full membership of the UEMS comprises the European national medical associations, whereas each specialty is represented by either a section or a division.

The authors of the present report all either have official positions within the UEMS or have written mandates as representatives of their section or division toward the creation of these training guidelines. In addition, the scientific European societies of neurosurgery, neurology and neuroradiology were kept continuously informed of the progress of this project. Officers of the European Society of Radiology participated in the joint committee meetings at which these guidelines were discussed and approved. Furthermore, these guidelines were approved by the UEMS Council, which also made a strong recommendation that these guidelines should be included in each European Union country’s national body of regulations.

After its creation in 2009, the first task of the UEMS Division of Neuroradiology was to devise a training charter for both diagnostic and interventional neuroradiology. For INR training, a task force was created and directed by the Division of Neuroradiology. The task force had to answer 3 important questions: (1) Who is to be trained in INR?; (2) What are the contents and duration of training?; and (3) How are interventional neuroradiologists to practice after their training? Answers to these questions are proposed in the UEMS Training Charter and are here compared with the United States Accreditation Council for Graduate Medical Education (ACGME) program requirements for endovascular surgical neuroradiology.

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Who Is to Be Trained in INR?

It has been a not-so-uncommon opinion among European neuroradiologists that, because INR was originally conceived and developed by neuroradiologists, it therefore forever belongs to the field of neuroradiology. It was deemed inappropriate for other specialists to enter into its domain of practice and especially inappropriate for neuroradiologists to train non-neuroradiologists in INR. Turf battles therefore have ensued, which are all too common in medicine, and the patients are never winners in such situations. From the patient’s point of view, the most important issue is genuine competence. Whoever has the best ability to perform a specific procedure should be the one performing it. However, there is nothing to say that a physician who is a neuroradiologist, neurosurgeon, or neurologist by training will necessarily be a better interventional neuroradiologist. Every specialist has to be trained, albeit with education tailored to the needs of the trainee based on previous experience, knowledge, and skills.

In Europe, it may be possible to limit the practice of INR on national levels to only certain groups such as neuroradiologists, thereby making permission to practice INR a matter of professional prestige or regional or local health politics, rather than a matter of competence and qualification. However, any such attempt to limit the practice of INR to neuroradiologists would, on a European level, lead to untenable consequences and would be unacceptable to other concerned specialties and the relevant national authorities. Such a limitation could eventually lead to a situation in which no rules at all regarding training and qualification would be recognized by those wishing to practice INR. It would open the field too wide, allowing anyone to practice INR, whatever their training or competence might be. In fact, this might even be a tempting possibility to administrators and physicians, because it would be a positive response to the rapidly increasing demands for interventional treatments in cases of stroke.

Nevertheless, it is untenable and illogical to limit the practice of INR to only 1 specialty. Also, the intention should be to make sure that those practicing INR do possess genuine competence to safely perform endovascular procedures. These physicians also should be able to work in teams dedicated to the endovascular treatment of brain and spinal diseases on equal terms and, in fact, should be equally respected as interventional neuroradiologists but with a different original background. An interventional neuroradiologist with a clinical background, such as a neurosurgeon or neurologist, also could bring new aspects to a team of interventional neuroradiologists and could provide a solid platform from which a healthy practice of INR could truly claim full responsibility for the patient, from establishing the diagnosis and setting indications and the therapeutic strategy to the actual procedure performance and postprocedural care and follow-up.

On the foundation of these basic principles, the UEMS Division of Neuroradiology and the UEMS Section of Neurosurgery invited all recognized specialties with even the slightest interest in INR to participate in the work of forming a training charter. The core of the task force was formed by representatives of the sections of neurology, neurosurgery, cardiology, radiology, and neuroradiology under the leadership of the President of the Division of Neuroradiology.

The most important achievement in this process was that the final document is a product of 5 specialties working together to achieve a common goal: a clear definition of the entity “interventional neuroradiology.” This is the first time that several specialties, represented by their UEMS divisions and sections, have come together to agree on a common Training Charter, which was made possible through mutual respect and recognition between specialties. The document therefore is the result of cooperation, compromises with mutual acceptance, and agreements among peers.

It is interesting to compare these European guidelines, presented from the various sections and divisions, and endorsed by the UEMS Council, with the guidelines established by the ACGME in the United States (Table). The eligibility criteria and duration of training are rather different. According to both the UEMS and ACGME rules, the trainee should have an established basis in a recognized specialty before commencing training in INR. By UEMS rules, the precise specialty is unimportant, but the training should comprise 4 years of full-time training. However, the ACGME-accredited program in the United States admits only neurosurgeons, radiologists, and neurologists. In fact, most of the specialists to be trained in INR will come from the specialties listed in the ACGME program, and it is certainly likely that the interest of dermatologists or nephrologists for INR will be limited. Some cardiologists are likely to be attracted to INR, especially in relation to stroke treatment. After 6 years of medical school and a minimum of 5 years of cardiology, they will need to study for 4 more years to become interventional neuroradiologists. After such a long period of training, representing a huge personal investment, there is no reason to believe that, as interventional neuroradiologists, they will not be as good as those coming from neurosurgery, neurology, or radiology; also, their clinical practice is likely to devote an important amount of resources to or is likely to be completely focused on INR.

What Are the Contents and Duration of Training?

Within the UEMS, it is possible to define a body of knowledge that is shared by several established medical specialties, such as intensive care medicine and INR. The basic principle is that specialist doctors with different specialties are welcome to train and become INR specialists or interventional neuroradiologists. To achieve this goal, however, it is necessary to define the complete shared body of knowledge, skills, and attitudes required for INR work, which would then be translated into a curriculum and an in-advance agreed-on plan for training that, when completed in full, would lead to recognition as an INR specialist. Those who do not wish to train fully and complete the full curriculum would not be recognized as INR specialists.

The text of the Training Charter in INR was finalized in December 2010 and was approved by the UEMS Division of Neuroradiology, Section of Cardiology, Radiology, Neurology, and Neurosurgery, and the document was officially sanctioned.
The full training to become an INR specialist is defined as 4 years of full-time training. For a resident with an early focus on INR, the respective training in neuroscience and neuroradiology could be part of a residency program. Thus, depending on any previous training and experience, the training time may be reduced, with credit given for previous training and clinical skills as evaluated by the director and codirectors of the training program.

The ACGME-accredited program in the United States is for all trainees and is based on only 1 year of graduate training in endovascular surgical neuroradiology (Table). However, in Europe, given the variety of clinical situations and endovascular techniques in INR, 1 year of training was considered too short a time in which to become completely autonomous and able to provide an acceptable level of safety to patients. The number of procedures with the trainee as first operator is higher in the ACGME program (100 vs 50 in the UEMS Training Charter). Although the case mix is not defined in the ACGME program, in the UEMS Training Charter, the trainee has to be competent at all procedures, including aneurysm treatment, arteriovenous malformation, and fistula treatments, and stroke treatment. The idea of having interventional neuroradiologists dealing with only 1 part of INR activity during their training was not considered an appropriate approach. By the end of the training period, an interventional neuroradiologist should be able to manage the wide spectrum of vascular (and, to a lesser extent, tumoral) diseases of the brain and spine. Only after beginning a professional practice can an interventional neuroradiologist then decide to practice only certain procedures.

In Europe, during the first year, the INR trainees rarely will be the first operators, and then only for a limited number of procedures, including external carotid embolization, coil treatment of small aneurysms with small necks and some stroke treatments. For complex aneurysm treatment (remodeling, stenting, flow diversion, flow disruption) and the treatment of brain and spinal arteriovenous malformations or dural fistulas, trainees will serve as the first operator only for a limited number of procedures, then decide to practice only certain procedures.

CT indicates computed tomography; DSA, digital subtraction angiography; INR, interventional neuroradiology; MRI, magnetic resonance imaging; US, ultrasound.

<table>
<thead>
<tr>
<th>Subspecialties* (with access to INR)</th>
<th>Accreditation Council for Graduate Medical Education</th>
<th>Union Européenne des Médecins Spécialistes</th>
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<tbody>
<tr>
<td>Neuroradiology</td>
<td>Radiology (neuroradiology)</td>
<td>All specialties</td>
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<td>Neurological surgery</td>
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<td>Program director (subspecialty)</td>
<td>Radiology</td>
<td>Interventional neuroradiology</td>
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<td>Neurological surgery</td>
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<tr>
<td></td>
<td>Psychiatry and neurology (all with expertise in endovascular surgical neuroradiology)</td>
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by the UEMS Council on October 8, 2011. Thus, the Training Charter in INR has the official status of a UEMS recommendation and is now part of the European Union legislative apparatus through European Directive 2005/36/CE.3

The full training to become an INR specialist is defined as 4 years of full-time training. Two of these years are to be spent in core INR and 1 year each is to be spent in diagnostic neuroradiology and clinical neuroscience. A neuroradiologist entering this program can obtain credit for the year in neuroradiology, whereas a neurosurgeon or neurologist can similarly obtain credit for the year of neuroscience. A radiologist, however, would have to complete the full 4 years of training. For a resident with an early focus on INR, the respective training in neuroscience and neuroradiology could be part of a residency program. Thus, depending on any previous training and experience, the training time may be reduced, with credit given for previous training and clinical skills as evaluated by the director and codirectors of the training program.

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In the United States, in addition to the 1-year training in INR, a preliminary year in neuroradiology is necessary for everyone entering the ACGME program, although the year may be part of a basic residency program in neurosurgery, but not a residency in radiology. The radiologist entering the program has to first complete the 1-year fellowship in neuroradiology and 6 months of neuroscience, with the latter as a possible component of a residency in radiology, before completing the year in endovascular surgical neuroradiology. Finally, a neurologist entering the program should have completed a 1-year vascular/stroke neurology fellowship, 3 months of neurosurgical care, and 1 preparatory year of neuroradiology. This means that a neurosurgeon with the right components of residency can, as a minimum, train for 1 year; similarly, a radiologist could train for only 2 years, whereas a neurologist would have to train for a minimum of 3 years and 3 months to obtain a subspecialty in endovascular surgical neuroradiology.
The European Training Curriculum was designed to provide a diversified and balanced mix of theoretical and practical education in INR. A specialist physician with a particular qualification in INR should have: (1) acquired knowledge in basic and clinical neurosciences, imaging technology, and radiation, clinical neuroradiology, therapeutic management, and attitude and ethics in INR and research; (2) acquired the skills needed to consult and communicate with referring physicians, as well as with patients and their relatives; (3) acquired the skill and knowledge to independently perform, conduct, and interpret common INR procedures; (4) the ability to advise other clinicians and have the main responsibility for how the diagnostic and therapeutic methods are used within the field of INR; and (5) mastered the diagnostic and therapeutic methods used within the domain of INR and should be aware of their associated development, strengths, weaknesses, and risks.

The INR training program is organized as a network of institutions/departments in which the INR unit constitutes the core unit around which the clinical and diagnostic units in neuroscience are based. The INR core should fulfill several conditions, including having a significant case load of endovascular interventions (at least 150 per year) and a case mix including stroke, aneurysms, arteriovenous malformations, dural fistulas, and spinal vascular malformations. These conditions are, in principle, similar to those of the United States program.

How Are Interventional Neuroradiologists to Practice After Their Training?
The Training Charter insists that INR ideally should be practiced by INR teams, thereby allowing an exchange of experience, knowledge, and research; therefore, it follows that a solitary practice is not recommended.

Any European specialist starting training in INR from now on is strongly advised to follow the Charter, and all European specialists currently in INR training should make every attempt, whenever appropriate, to supplement their training according to the Charter. Furthermore, it is reasonable to assume that any European specialist claiming expertise in INR, but with no practice of INR before October 2011, who becomes involved in a malpractice lawsuit may have to face the risk of being accused of not being properly trained in INR if not trained according to the new Training Charter. However, the Charter has no retroactive effect, and it is recognized that a number of specialists in Europe today are already performing all or some of the INR activities detailed in this Training Charter. Nevertheless, these specialists will have the acquired right to continue their practice.

Disclosures
None.

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Key Words: interventional neuroradiology ■ training
Training of Future Interventional Neuroradiologists: The European Approach
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