UNION EUROPÉENNE DES MÉDECINS SPÉCIALISTES
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Syllabus for postgraduate specialization in Nuclear Medicine – 2011/2012 Update

Nuclear Medicine training in the European Union

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CHARTER on TRAINING of MEDICAL SPECIALISTS in the EUROPEAN COMMUNITY

Chapter 6 - Requirements for Specialty Training in Nuclear Medicine

Preamble

Nuclear Medicine is a branch of medicine that uses unsealed radioactive substances for diagnosis and therapy.

Nuclear Medicine (NM) became an independent medical specialty under the European Directives in 1988. The minimum duration of the postgraduate specialized training in the European Union is 4 years, but may be extended beyond this period according to the requirements for training in other clinical disciplines.

Candidates for specialized training should have a good general background in internal medicine. More detailed knowledge about those conditions which may need to be investigated or treated by NM techniques has to be acquired. Some complementary imaging and biological methods as far

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as they relate to NM procedures must be mastered. Training in basic sciences, such as pharmacokinetics, radiochemistry, instrumentation, image processing, dosimetry and quality control is required.

The quality of training has to be objectively assessed, using final examination on a national basis covering basic sciences and clinical skills, after satisfactory completion of a minimum number of courses and/or workshops and a formally organized and controlled practical training. Each training program should contain a standard against which the progress of the trainee can be assessed for each element of the syllabus. The assessment may take the form of an interview, a written paper, an essay, a set of multiple-choice questions, or an oral examination of displayed images of various NM techniques in clinical practice. Continuous assessment is an alternative. Each end of year or training program assessment should carry a score that indicates how the candidate has progressed against the set target. Successful trainees are awarded with a final certificate, degree or diploma that is recognized by the government, local health authority and hospital as an assurance of specialist competence in NM.

The clinical training of physicians specializing in NM should include: 1) a minimal theoretical foundation of the general principles of NM with active participation in clinical presentations, seminars and meetings and 2) *in vivo* diagnostic procedures performance. Personal responsibility (including indication, justification, performance and interpretation) must be taken for at least 3.000 *in vivo* NM diagnostic procedures, with a broad-spectrum of the most currently used procedures. The list of the procedures published in the syllabus will be subject to revision. It is recommended that a period of training be spent away from the main department in at least one other recognized centre, ideally accredited by the UEMS/EBNM. In addition, the training should cover the initial evaluation of patients for therapy with unsealed radioactive sources as well as their follow-up and re-evaluation. The trainee must have taken part in a sufficient number of various NM therapeutic procedures. The responsibilities of the NM specialists are listed in Table 1.

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Table 1. Responsibilities of the nuclear medicine specialist

- Define the patient's and clinician's rationale for the request or referral, i.e. **justify** all referrals.
- Inform the patient about the entire procedure and administration of radiopharmaceutical or therapeutic applications.
- Determine and organize the appropriate tests and protocols according to accepted guidelines.
- Adapt the protocols to the needs and condition of the patient.
- Prescribe radiopharmaceutical and appropriate activity.
- Prescribe appropriate medication needed for patient preparation (before or after) the examination or therapy.
- Organize or accomplish interventions (physiological, pharmacological or thyroid fine needle aspiration biopsy).
- Regulate the study analysis and interpretation according to the clinical information.
- Interpret the results and their clinical, biological and pathological implications.
- Consider follow-up consultations.
- Guarantee the safety of both the patient and staff.
- Provide training and education for junior doctors and technical staff.

I. Scope and limits of Nuclear Medicine as medical specialty

1. Definition (scope):

NM utilizes the nuclear properties of radionuclides to investigate disorders of metabolism and function, under physiological and physiopathological conditions, including molecular biology and anatomy to diagnose and treat disease with unsealed radioactive sources. The range of procedures that are implicit within this definition include *in vitro* procedures, *in vivo* imaging with radiopharmaceuticals, radionuclide-guided surgery, other correlative imaging modalities aiming to localize and quantify detected lesions and other techniques related to nuclear physics in medicine as well as the medical applications of radiobiology, dosimetry and radiation protection.

2. Clinical knowledge and experience:

A good general background in medicine (namely internal medicine, oncology, cardiology, endocrinology, surgery) is assumed. More detailed knowledge of those conditions which may need to be investigated or treated by NM techniques is required.

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3. NM specialists may also make use of complementary methods related to NM procedures.

These include:

- Ultrasound
- ECG (including dynamic + pharmacological stress testing) and management of emergencies in cardiac NM
- Correlative imaging methods, such as CT (for attenuation correction and anatomic localization), MRI and MRS.
- Non-radioactive laboratory assays
- Bone densitometry
- Other available techniques complementary to NM procedures, such as optical imaging.

4. NM specialists may cooperate in the assessment, prevention and treatment of physical or medical accidental contamination or incorporation of radionuclides.

II. Formative objectives

1. Theoretical formative objectives:

- Basic knowledge in physics, statistics, mathematics and computer science
- Basic knowledge in biology (including molecular biology), physiology and pathophysiology
- Radiation physics
- Radiobiology
- Radiochemistry
- Radiopharmacy
- Clinical radiopharmacology
- Tracer kinetic modeling

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- Applications of radiopharmaceuticals and injectable or implantable medical devices: indications, procedures and results, methodology and dosimetry
- Radiation protection and radiopathology
- Instrumentation
- Statistics of radioactive counting and its analysis
- Data acquisition and image processing techniques, including SPECT and SPECT-CT, PET and PET-CT.
- Quantitative techniques in NM and their standardization.
- Quality control.

2. Integrative objectives:

- Integration and evaluation of the diagnostic results with the clinical data and the results of other procedures.
- Radionuclide labelling of cells, sub-cellular structures and biological molecules.
- Diagnostic imaging methodology *in vivo* for different organs and systems.
- Methodology for targeted imaging and treatment.
- Prescription and administration of diagnostic and therapeutic radiopharmaceuticals, as well as, administrable or implantable medical devices.
- Principles of other diagnostic imaging techniques (including ultrasound, CT, MRI, MRS)
- Basic principles of scientific research methodology including clinical trial design.
- Comprehensive knowledge of the diagnostic algorithms in clinical fields with a high added value of NM examinations.
- Organization and management of a NM service
- Regulations related to the transportation, storage, disposal and use of radioactive material

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- Principles and applications of radioimmunological and immunoradiometric techniques *in vitro* (Optional)

III. Basic sciences training (Syllabus)

The period of training should be a minimum of four and preferably five calendar years.

(a) Scientific principles:

- Basic knowledge in physics, statistics, mathematics and computer science
- Basic knowledge in biology (including molecular biology), physiology and physiopathology
- Radiation physics
- Radiobiology
- Radiochemistry
- Radiopharmacy
- Clinical radiopharmacology
- Tracer kinetic modeling
- Applications of radiopharmaceuticals and administrable or implantable medical devices: indications, justification, procedures/protocols and results, methodology and dosimetry
- Radiation protection: justification and optimization [ALARA (as low as reasonably achievable), ALARP (as low as reasonably practicable) and limitation of doses (only for medical workers)] and radiation hazards
- Radiobiology
- Instrumentation
- Quantitative techniques in NM and their standardization.

- Principles of radiology modalities including dual energy X ray absorption (DEXA), ultrasound, CT, MRI and MRS
- Data acquisition and image processing techniques, including SPECT and SPECT-CT, PET and PET-CT.
- Statistics of radioactive counting
- Quality control.

(b) Clinical NM:

- **Diagnostic imaging:**
  - Patterns of radiopharmaceutical uptake; normal and abnormal appearances of images, normal variants and common artifacts in bone, heart, lung, kidney, brain, thyroid, tumor and infection images.
  - Learning of cross-sectional anatomy.
  - Comprehensive knowledge of imaging diagnostic thinking (e.g., advantages and limitations of PET- contrast enhanced CT versus PET- low dose CT).
  - Correlative imaging of NM images and those from other imaging techniques.
  - Special diagnostic investigations in cardiology, lung disease, gastroenterology, hepatobiliary dysfunction, nephro-urology, neurology and psychiatry, endocrinology, hematology, oncology and infection.
  - Radionuclide-guided surgery techniques
  - Radiotherapy treatment planning using NM techniques.
- **Therapeutic applications:**
  - Diagnosis and treatment of thyroid diseases including radionuclide therapy of hyperthyroidism and thyroid cancers
  - Hematological disorders (e.g. lymphoma, polycythemia, etc.)

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- Metastatic bone pain.
- Radiosynoviorthesis.
- Endocrine tumours.
- On-site liver metastases.

(c) Further practice and experience of techniques should also be learned in this training period:

- Ethics.
- Legal and regulatory requirements including telemedicine when relevant.
- Clinical Audit including Quality Control and Quality Assurance.
- Departmental and hospital management.
- Research techniques and evaluation.
- Teaching and training.

The quality of the basic science training has to be objectively assessed, using the following methods:

1. Final examination (covering basic science and clinical knowledge) on national basis and/or
2. Satisfactory completion of accredited, regional or national (international) courses or workshops in different fields (physics etc.): at least 120 hours recommended.

Radiation protection and regulatory issues have to obey local/national requirements.

IV. Clinical training in NM

Clinical training has to be added to the courses and formally supervised. Clinical training of physicians specializing in NM should include theoretical and practical training within the NM Department and outside. Minimum standards are indicated below.

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Formal and detailed description of all NM procedures performed by the trainee is required. Active participation in clinical presentations, seminars and interdisciplinary meetings is recommended. These should also be described.

1. Practical training in NM

Postgraduate trainees are obliged to play an active in-service role in the practice of NM in order to familiarize themselves with all the techniques and their details required from a NM practitioner, such as:

- Protocols of *in vivo* and therapeutic procedures;
- Data acquisition and processing with various types of equipment, quality control of instruments and labeled agents;
- Interventional procedures, including physiological, pharmacological and mental stress related to diagnostic applications, and also all therapeutic interventions;
- *In vitro* protocols and procedures (optional).

2. In vivo diagnostic procedures

At the end of the training program, postgraduate trainees must be able to plan, perform, process, analyse report and archive any type of diagnostic procedure *in vivo* related to the following clinical areas:

- Central nervous system
- Bone and joints
- Cardiovascular system
- Respiratory system
- Gastrointestinal system

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- Urinary and genital system
- Endocrine system
- Haematopoietic and lymphatic system
- Neoplastic processes
- Inflammatory and degenerative processes

The trainee must complete a minimum of 3,000 documented diagnostic procedures. The minimum recommended number for each procedure is as follows:

a)	Oncology	800 (80% at least PET or PET/CT)
b)	Bone and joint	600 (50% at least SPECT or SPECT/CT)
c)	Cardiovascular	400
d)	Endocrinology	300
e)	Neurology	200
f)	Respiratory system (50% combined V/Q)	100
g)	Urinary and GI track	100
h)	Others or additional from the above	500

It is recommended that at least 150 procedures have been performed in pediatric patients. Some flexibility may be accepted, but a broad-spectrum of most currently used procedures has to be covered. This list will be subject to periodic revision. It is strongly recommended that a period of training is spent away from the main department in at least one other recognized training centre (this must always be emphasized).

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3. Therapy

Training should include initial evaluation for indication, justification, administration, and therapeutic applications of radiopharmaceuticals and administrable or implantable medical devices, dosimetry, radiation protection and follow-up after therapy.

The trainee must take part in at least 100 therapeutic procedures.

4. Clinical training in addition to NM

The advisable duration of total NM training is 5 years. In some countries total duration of the specialized training is 4 years (which corresponds to the minimum duration under the EC Directives).

Training in other specialties is required during NM training, for example oncology (medical and radiation), cardiology, endocrinology, neurology, radiology, etc.

The proportion of the total training period devoted to clinical training in other specialties may vary according to several factors, amongst them the total length of the training.

In countries where part of the requested training is provided during rotation in other departments it must be assured that all requirements of the syllabus are always fulfilled.

5. In vitro procedures (optional)

Training can also cover *in vitro* procedures including analysis with radio-immunological methods, quality control and interpretation, with a recommended minimum duration of 3 months.

6. Clinical audit

The trainee should have received education in NM Clinical Audit (including Quality Control and Quality Assurance), in the management of NM services and cost-effectiveness of the NM procedures.

7. Legal responsibility

The trainee must acquire regulatory expertise in health care problems related to unsealed radionuclide sources.

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V. Assessment of training in Nuclear Medicine

Since trainees, after successful completion of training, will take over the responsibilities of NM physicians, they must pass qualification tests that cover both theoretical knowledge and practical abilities in the day-to-day practice of NM. A board or similar form of academic or national authority will award a certificate.

Appendix

The aim of the syllabus is to set standards about duration and content (qualitative and quantitative, practical and theoretical) of training in nuclear medicine. These essential requirements can be adapted for local practice and necessities in order to fulfil the specific situation of each country. The content of the syllabus also represents a basis for the Nuclear Medicine Board Examination and may serve as the standard for accreditation of training centres, especially in view of international certification and mutual recognition.

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