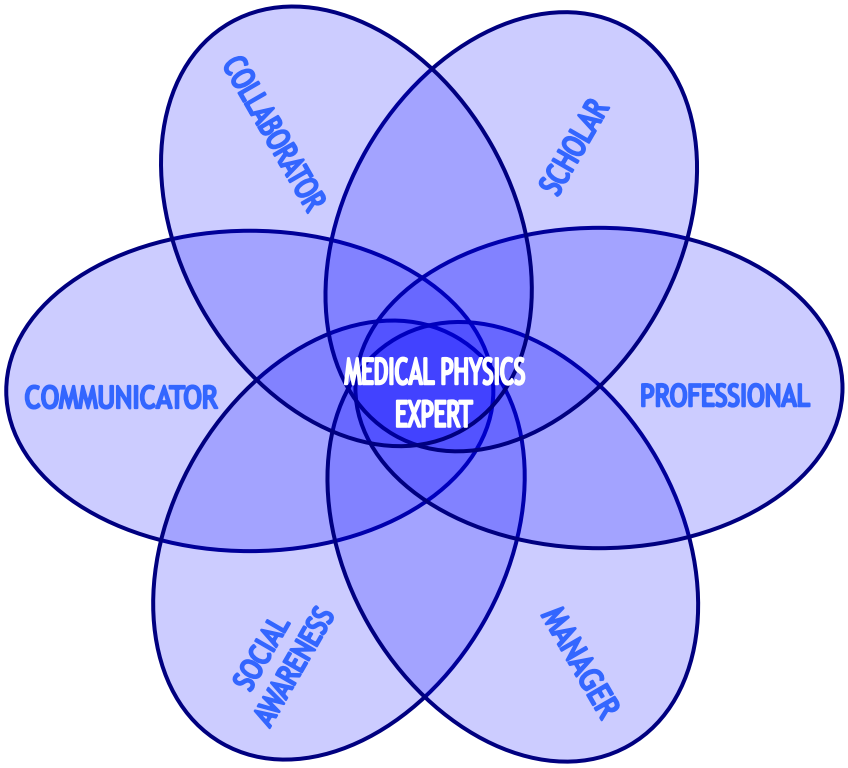
CORE CURRICULUM FOR MEDICAL PHYSICISTS

VOLUME 2 – GENERAL MEDICAL PHYSICS (AKF)



Introduction

The purpose of the medical physics curriculum is to provide the resident medical physicist with the necessary competences to operate succesfully as a medical physicist, as well as with the necessary minimum required knowledge and skills for this task. This is volume 2 of the curriculum for the field of expertise called 'general medical physics'. General competences are already described in volume 1 of the curriculum. During this second part, the specialised training, the resident should use and deepen the already aqcuired knowledge, skills and competences.

The second part of the curriculum, specific for general medical physics, describes the knowledge, skills and competences for the general medical physicist. The curriculum 'uses' the same items in the same order to describe what is expected from the resident medical physics in the last two years of the training. When entering the second part of the curriculum, the resident should have sufficient experience in the following five subjects to include this in his work, their training and their daily practice.

- Fundamentals of Human Anatomy, Physiology and Pathology
- Quality Assurance of Medical Instrumentation
- Health Technology Assessment (including Medical Statistics)
- Basics of Healthcare Law and Ethics
- Interaction with Patients and their Proxies

These subjects are therefore not specifically mentioned in this part of the curriculum, but the resident is expected to incorporate them in such a way that the resident's knowledge, skills and competences will continue to develop and grow.

The time to be spent on the topics of the second part of the curriculum (volume 2) is a total of 90 ECTS credits. Each subject requires a minimum amount of ECTS spent. Combined with the 90 ECTS spent on the general part of the Curriculum (volume 1) and the 60 ECTS on the research project, it adds up to a total of 240 ECTS credits spread over 4 years of residency.

TOPIC	**ECTS**
RESEARCH PROJECT	60
FUNDAMENTAL KNOWLEDGE, SKILLS AND COMPETENCES	90
KNOWLEDGE, SKILLS AND COMPETENCES SPECIFIC FOR GENERAL MEDICAL PHYSICS	90
	At least:
1. Basics of Physics and Engineering for Medical Devices	15
2. Principles of Medical Imaging and Image Handling	15
3. General Safety Principles and Risk Management in the Medical Environment	10
4. Quality Management of Medical Technology	10
5. Radiation Protection for Ionising Radiation	10
6. Information and Communication Technology	10

Development of the six general competences, as described in Volume 1, takes place parallel to gaining the necessary knowledge and skills to work as a medical physicist. This development covers the full length of the training, during which the complexity of the projects increases.
Volumes 1 and 2 of the Curriculum do not prescribe a minimum time to be spent on the development of the general competences, as it is typically integrated into the learning process. However, courses aimed at strengthening individual competences can be considered by residents. Time spent on this particular development should be allocated separately from the other topics listed above and in chapter 3 of volume 1.

Definition of knowledge, skills and competences

- ✓ Knowledge: facts, information, and skills acquired through experience or education; the theoretical or practical understanding of a subject
- ✓ Skills: expertise, the ability to do something
- ✓ Competence: the ability to do something successfully or efficiently

1 Basics of Physics and Engineering for Medical Devices (minimum of 15 ECTS)

1.1 Short description

The general medical physicist may be asked to advise healthcare workers on which type of equipment should (or should not) be used. In order to function as an expert and to effectively communicate and operate within a multi-disciplinary team, a thorough understanding of the physics and engineering of medical devices is required. Also, a medical physicist must be able to compose a set of requirements regarding design and functionality of medical devices, and to communicate necessary or desired adjustments to vendors and/or manufacturors. The knowledge of devices and their working principles enables improved functioning of the medical physicist in the evaluation of devices and their safe use in clinical practice.

1.2 Knowledge, Skills and Competences

- Understand the physics and engineering of medical devices and awareness of possibilities and pitfalls in the clinical application of medical devices
- Able to participate in a multidisciplinary team with respect to communication and exchange of knowledge
- Able to teach the working mechanism and the safe use of a medical device or a group of medical devices to
  - medical specialists
  - residents
  - nurses
  - technicians
  - researchers

1.3 Core curriculum items:

- Basics (physics principles and working mechanism) and safety aspects of at least:
  - ventilator devices
  - monitoring devices
  - infusion pumps
  - electro surgery
- Signal analysis algorithms used typically in these devices
- Typical parameters settings of these devices
- Current state-of-the-art and future developments of medical technology in several medical specialties

1.4 Deliverables

During the training period, a resident general medical physicist is required to deliver at least the following items:

- For a minimum of three devices or groups of devices, a resident general medical physics should
  - either compose a complete business case or compose a request for proposal
  - and compose, set-up and perform an acceptance test
  - give a training to physicians or nurses or technicians for at least one type of medical equipment

  The resident general medical physicist should perform these tasks for at least one device in a “leading” role
- The above mentioned three devices should minimally include one device from each of
  - radiology or nuclear medicine
  - operating room or intensive care unit
  - function monitoring (e.g., cardiology, audiology)

2 Principles of Medical Imaging and Image Handling (minimum of 15 ECTS)

2.1 Short description

The general medical physicist is often reponsible for the safe and effective operation of imaging equipment. This requires that he is capable of optimizing image quality in relation to radiation dose, acquisition time or acquisiton parameters, has knowledge about state-of-the-art techniques, and is proactive in giving advice about new posibilities to the imaging department. All lifecycle phases of an imaging modality should be fully understood: selection, room design, acceptance, calibration, safety & quality assurance, optimization, and decommissioning. Furthermore, the medical physicist is capable of initiating and supporting training, education and research.

2.2 Knowledge, Skills and Competences

- Understand and apply the physics and principles of the whole 'imaging chain' for all modalities; this includes acquisition, reconstruction, processing, displaying and post-processing
- Understand the hardware and software design of the imaging equipment
- Understand principles of planar or projection imaging
- Understand principles of tomographic imaging
- Understand the role and responsibilities of the medical physicist in relation to doctors, radiographers, technicians and manufacturers in achieving optimal image quality
- Understand the role the medical physicist plays when a pregnant patient has had a radiologic exam at the Radiology department or Nuclear Medicine department and be able to give relevant advice to clinicians
- Able to understand and have technical discussions with engineers (e.g., concerning recalibration or replacement of parts)
- Able to perform the following aspects during the introduction of new imaging equipment:
  - advise in a business case
  - advise in a tender, write a request for proposal
  - specify, justify and rank the criteria for specifying and selecting new imaging devices
  - negotiate with vendors
  - design the room for an imaging modality, taking into account shielding and technical considerations incl. power supply, safety and climate control demands
- Able to perform a risk analysis for use and operation of equipment
- Able to perform and/or set up acceptance testing, commissioning and quality control of imaging equipment
- Able to operate imaging equipment safely
- Able to optimize image quality and the tradeoff between image quality and radiation dose
- Able to judge the proper use of dose reporting systems (radiation exposure monitoring) for patient dose
- Able to understand and discuss the engineering maintenance of the imaging equipment
- Able to recognize and interpret artifacts in images, and advise on the clinical impact and risks
- Able to support clinical research and multicenter trials

2.3 Core curriculum Items

- Principles of interaction between ionizing and non-ionizing radiation/waves and matter/tissue
- Operating image acquisition systems
- Operation of X-ray tubes
- Operation of photon detectors used in medical imaging
- Signal processing and data acquisition techniques (hard and software)
- Image reconstruction algorithms

- Effect of imaging parameters on image quality, dose and acquisition time
- Organization of a quality control system, including protocols and phantoms

2.4 Deliverables

During the training period, a resident general medical physicist is required to deliver at least the following items:

- Participate in the building design process for new imaging equipment
- Participate in artifact solving
- Participate in image protocol optimization, for at least one type of imaging equipment
- Perform image quality measurements, for at least two types of imaging equipment; a leading role is required in at least one of these projects

3 General Safety Principles and Risk Management in the Medical Environment (minimum of 10 ECTS)

3.1 Short description

A general medical physicist has to be able to assess the impact of many ionizing and non-ionizing radiation, electrical, chemical, mechanical and biological hazards to patients and hospital staff; therefore, potential hazards and necessary precautions have to be understood. A general medical physicist is able to design and implement a policy based on safety and risk analysis. He is capable of appreciating different methods in this field and assessing which one fits best for the local situation. This includes both prospective and retrospective analyses.

3.2 Knowledge, Skills and Competences:

- Knowledge of pharmaceutical and medical device safety regulations and standards
- Understand the different types of prospective and retrospective of risk analysis methods
- Understand SAR (specific absorption ration) limits for non-ionizing radiations, e.g., in relation to MRI
- Understand the principles of ultrasound safety (thermal index, mechanical index)
- Understand the principles of laser safety and recognize unsafe practices
- Understand the principles of radiation safety
- Understand the principles of electrical safety
- Understand the role of the medical physicist in a multidisciplinary risk analysis team
- Understand the principles of medical gas safety
- Able to conduct a patient-related incident analysis on different levels
- Contribute effectively to a multidisciplinary risk analysis covering the physics aspects

3.3 Core curriculum Items

- Safety and risk analyses and their application on physical agentia
- Human physiology and anatomy with respect to interaction with physical agentia

3.4 Deliverables

During the training period, a resident general medical physicist is required to deliver at least the following items:

- Perform a prospective analysis
- Perform a retrospective analysis
- Implement or analyze at least one laser safety system, including teaching laser safety to staff and personnel
- Perform a minimum of two patient-related, equipment-related incident analyses
- Participate in a local (department) incident analysis team
- Participate in the hospital-wide patient-related incident analysis team
- Participate in the electrical safety testing of at least one device
- Participate in the installation of a new room and new devices, with a focus not only on the safety test of the medical devices but also on the design and regulations for the room in which the device is used (e.g., emergency power supply, room ventilation and electrical safety requirements)

4 Quality Management of Medical Technology (minimum of 10 ECTS)

4.1 Short description

Quality management requires an organizational structure wherein responsibilities, procedures, processes and resources are clearly defined. Regarding medical technology and medical equipment, each hospital needs to have a quality management system in place in order to guarantee a safe use of this technology. Safe use means a safe product in the hands of a trained user in an environment that warrants safe use. A general medical physicist needs to be not only fully aware of all the necessary conditions to warrant safe use as laid out in the agreement on medical technology ('Convenant Veilige Toepassing Medische Technologie in Ziekenhuizen'), but also able to participate in the process to implement these conditions and the underlying organizational processes. Moreover, a general medical physicist needs to be prepared to act as the key person on safe use of medical technology in a hospital organization.

4.2 Knowledge, Skills and Competences

- Understand the life cycle of medical technology
- Understand all aspects of national legislation and agreements on medical technology, including 'Convenant Veilige Toepassing Medische Technologie in Ziekenhuizen'
- Understand maintenance protocols
- Understand cleaning, disinfection and sterilization of medical devices
- Understand recall procedures
- Able to introduce all aspects of national legislation and agreements on medical technology
- Able to perform audits to monitor compliance with national legislation and agreements on medical technology
- Able to assess changes in the national legislation on medical technology and its use, and analyze the implications for the hospital organization and its quality management system
- Able to set up a maintenance scheme
- Able (as a change agent) to increase quality, implement new technology and systems and able to (re-)act on organizational changes and dynamics

4.3 Core curriculum items

- Life cycle of medical technology
- Medical equipment management systems
- Investment procedure
- Prospective risk analysis
- Preventive maintenance model
- Planning of preventive maintenance
- Sterilization of medical equipment
- Recall of medical equipment

4.4 Deliverables

During the training period, a resident general medical physicist is required to deliver at least the following items:

- Write (or rewrite), implement and follow-up (Plan-Do-Check-Act) at least one local guideline on quality management or closely related item
- Perform or participate in at least one audit or safety check of a department in which a lot of medical equipment is used.
- Co-work with a technician on the maintenance of at least one medical device

5 Radiation Protection for Ionizing Radiation (minimum of 10 ECTS)

5.1 Short description

A general medical physicist must be able to act as the radiation protection officer of the department and/or of the hospital. He may have the full responsibility for the broad field of radiation protection and in that role will have to address the needs of protecting the patient, personnel and the general public. His competence to act is recognized by the competent authorities. A thorough knowledge of the physical and biological effects of radiation for exposed individuals, the relevant regulations, methods of compliance and record keeping, is required. Furthermore, the medical physicist has to have a thorough knowledge of national and international regulations and the capability to implement them in the local situation.
In addition, the medical physicist may need to take responsibility for dosimetry, including physical measurements related to the evaluation of the dose delivered to the patient.

5.2 Knowledge, Skills and Competences

- Understand all aspects of the local regulations of radiation protection, knowledge and Able on how to implement them
- Able to optimize radiation protection of patients and other individuals submitted to medical exposure, including the establishment and the use of diagnostic reference levels
- Able to design and implement a surveillance system of the medical installations with regard to radiation protection
- Able to effectively maintain compliance to radiation safety regulations
- Able to select equipment required to perform radiation protection measurements
- Able to train practitioners and other staff in relevant aspects of radiation protection
- Able to perform a risk analysis with regard to radiation protection compliant with national legislation
- Able to give advice to a practitioner or patient after an incident related to ionizing radiation
- Calculate the patient dose after unwanted exposure of a patient to ionizing radiation by medical radiological equipment
- Calculate the uterus dose after unwanted exposure of a pregnant patient to ionizing radiation by medical radiological equipment
- Able to give advice to a physician or a patient about the risks of exposure to ionizing radiation
- Able to give a travel advice to a patient after nuclear medicine therapy
- Able to report to the relevant authorities on radiation protection
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5.3 Core curriculum items

- Radiation physics
- Radiation legislation

5.4 Deliverables

During the training period, a resident general medical physicist is required to deliver at least the following items:

- Perform or participate in three procurement trajectories (including procurement, installation and implementation) of new medical radiological equipment or a radiopharmaceutical laboratory device)
- Set up at least one training program in medical radiological equipment to users
- Perform calculations regarding shielding (for at least one radiological used room)
- Compose a request for proposal regarding the radiation protection aspects
- Participate in a team to carry out all relevant legal work with the local authorities

6 Information and Communication Technology (minimum of 10 ECTS)

Information technology is an important part of day-to-day clinical practice. Sharing information hospital wide acquired from medical equipment (e.g., imaging modalities and patient monitoring en support devices) has become the standard. A general medical physicist needs to be able to participate in workgroups covering connectivity between mentioned devices and an electronic patient record (EPR). The medical physicist must be able to understand the needs of the user of devices and systems, have knowledge of IT systems and be able to communicate with IT professionals. In situations where connectivity between systems fails or data is represented wrong the medical physicist has sufficient knowledge to assist in finding the erroneous systems and perform validation of data transmissions.
A medical physicist should be able to advise not only on medical equipment but also on its use within the hospital IT system. The use of applications like a Patient Data Monitoring System (PDMS), a Picture Archiving and Communication System (PACS) or the use of a patient monitoring system are fields a general medical physicist typically advises on, often in close collaboration with the ICT department.

6.1 Knowledge, Skills and Competences

- Knowledge of the main IT applications in a hospital
- Knowledge of connection of devices to IT systems and the used standards
- Knowledge of basic IHE terminology like domains, technical framework, integration profiles, actors and transactions.
- Specific knowledge of integration profiles for Radiology domain. Knowledge where IHE standard workflow fits in between communication standards like DICOM and HL7.
- Understand the life cycle of IT systems
- Understand legislation on (medical) data safety
- Able to interact with the IT department
- Able to communicate with medical professionals on medical IT
- Able to assess needs for medical equipment with respect to connection requirements.

6.2 Core curriculum items

- IHE framework: actors, transactions etc.
- (basics) of information security requirements and privacy regulations
- Software applications such as EPR, PDMS and PACS
- Graphical user interfaces (GUI's) and their influence on healthcare
- Change management of medical IT systems

6.3 Deliverables

During the training period, a resident general medical physicist is required to deliver at least the following items:

- Realise the integration of a medical device to an IT system
- Test and accept software that is part of or connected with a medical device