Standards for Accreditation of Residency Educational Programs in Medical Physics

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Preamble

Medical Physics is a branch of physics that applies the concepts and principles of physics to the diagnosis and treatment of human diseases. Medical Physics encompasses four fields: Imaging Physics, Nuclear Medicine Physics, Radiation Oncology Physics and Medical Health Physics. This document focuses on the essential educational and experience requirements needed to engage in medical physics research and development, and to enter a residency program in preparation for clinical practice of one of the first three fields.

Terms such as “shall”, “must”, “require”, “should”, “may” and “recommend” are frequently used in these standards. The terms “shall”, “must”, and “require” denote items or activities that CAMPEP believes are mandatory components of an educational program. That is, they are required components. The terms “should”, “may” and “recommend” are considered desirable but not essential components of an educational program.

Contents

1. Program Goal and Objectives 2
2. Program Structure and Governance 2
3. Program Director 3
4. Program Staff 4
5. Institutional Support 4
6. Educational Environment 4
7. Scholarly Activities 5
8. Residency Curriculum 5

1. Program Goal and Objectives

The objective of a residency educational program in medical physics is to instill into its graduates a level of competency sufficient to engage in independent clinical practice in a specified field of medical physics. The knowledge and skills that the resident should attain during residency education include:

1.1. The technical knowledge and skills related to the sophisticated technologies used in the practice of medical physics;
1.2. A critical awareness and evaluation of research and scholarship in the field;
1.3. An understanding of the protocols and practices essential to the deployment of technologies to detect, diagnose and treat various illnesses and injuries;
1.4. The ability to use analytical and research methods to solve problems arising in the clinical environment;
1.5. The professional attributes and the ethical conduct and actions that are required of medical physicists;
1.6. The communication and interpersonal skills that are necessary to function in a collaborative environment;
1.7. An awareness of the complexity of knowledge in the field and a receptiveness to other interpretations, new knowledge, and different approaches to solving problems;
1.8. An awareness of the need for confidentiality of patient information and familiarity with relevant regulations;
1.9. An appreciation of the clinical purpose and applications of sophisticated technologies;
1.10. The acknowledgement of the role of medical physicists in a clinical environment in which physicians, nurses, technologists and others work in cooperation;
1.11. The sensitivity to potential hazards that residents may encounter and appropriate measures to take to prevent risks to themselves and equipment;
1.12. The recognition and correction of suboptimal application or unsafe use of technologies;
1.13. The commitment to continued education so that practice knowledge and skills remain current.

2. Program Structure and Governance

2.1. The clinical facilities offering this training must be accredited by the appropriate healthcare accreditation organization.
2.2. The clinical training must be located in an appropriately structured clinical environment.
2.3. Admission requirements shall be consistent with CAMPEP policy as described in the CAMPEP Policy and Procedures Manual.
2.4. If applicants with deficiencies in their academic background are admitted conditionally into a residency program, the provision for remedial education shall be rigorous and well-defined.
2.5. Resident education shall be supervised and monitored by an appropriate steering committee, which meets at least twice per year. Committee membership shall include but not be limited to the program director and relevant staff involved in residency education. A physician

member is recommended. The process for appointment of the members of the steering committee shall be documented. A pathway for expression of resident concerns to the committee shall be available. Minutes of meetings shall be maintained.

2.6. The steering committee shall review the residency educational program in its entirety at least annually, and initiate appropriate remedial action and improvement where needed through the process of Continuous Quality Improvement. Minutes of the program review, including actions to be taken, shall be maintained.

2.7. A procedure shall be in place to appropriately counsel, censure and, after due process, dismiss residents who fail to demonstrate appropriate learning ability, competence, or ethical behavior.

2.8. All courses and clinical practica should use well-defined and consistently applied metrics for evaluating student progress and performance.

2.9. A program may consist of a single institution or multiple affiliated institutions (hub-and-spoke). Programs consisting of affiliated institutions must meet the requirements for affiliated programs described in the CAMPEP Policies and Procedures.

2.10. A program must publicly describe the program and the achievements of its residents, preferably through a publicly-accessible website. This information must be updated no less often than annually and must include the numbers of applicants to the program, applicants offered admission, residents entering the program, and graduates. Information on the destinations of graduates shall also be provided, i.e., numbers in academics, clinical practice, industry positions, etc.

2.11. A medical physics residency shall require at least 2 years, with progressively increasing responsibilities under the supervision of qualified medical physicists. Part of the educational experience may take place at one or more affiliated institutions.

3. Program Director

3.1. A single program director shall be responsible and accountable for ensuring that the residency program satisfies CAMPEP standards, and shall ensure that quality education occurs at all training sites and for all residents.

3.2. The program director must be certified by the American Board of Radiology, the Canadian College of Physicists in Medicine, or other appropriate certifying agency in the field of the residency program.

3.3. The program director shall have at least five years of full-time experience beyond clinical certification.

3.4. The program director shall be responsible for coordinating the faculty, recruiting residents into the program, advising the residents, and evaluating and promoting the program.

3.5. The program director shall determine that each student offered entry into the residency program satisfies the CAMPEP prerequisites for residency education in medical physics or is offered rigorous remedial education to meet the prerequisites.

3.6. The program director shall ensure that all student statistics, annual reports, and other information required by CAMPEP are reported accurately and in a timely fashion.
3.7. The process for the appointment of the program director shall be documented.
3.8. The program director shall meet periodically with each resident to assess the resident's progress, and minutes of the meeting shall be maintained, with a copy provided to the resident.
3.9. The program director shall document any prior education from another institution (other than an accredited graduate or certificate program) that is used to satisfy educational prerequisites or requirements of the residency program.

4. Program Staff

4.1 Adequate qualified staff shall be available with sufficient time for resident education in the field in which the program specializes.
4.2 The process for the appointment of the program staff shall be documented.
4.3 Staff should be engaged in scholarly activities such as scientific presentations and publications, as well as participation in scientific societies and meetings and continuing education activities.
4.4 At least two certified physicists shall be engaged in the residency educational program, and the ratio of full-time staff to residents in the program shall be at least 1:1.

5. Institutional Support

5.1. The institution sponsoring the residency program shall provide administrative support, including clinical and educational resources, budget, resident office or cubicle space, access to computing resources, conference room(s), audiovisual facilities, and office support (e.g. copiers, internet access, email account, telephone).
5.2. The institution must express its commitment to long-term financial and administrative support of the residency program.
5.3. Financial support of residents, including benefits, shall be described clearly to prospective applicants prior to their entry into the residency program.
5.4. Entering residents shall be provided both a verbal and written orientation to their role in the program to ensure their efficient and safe integration into the program.
5.5. The program shall instruct its residents on the potential hazards that they might encounter and the appropriate measures for them to take to minimize risks to themselves and equipment.

6. Educational Environment

6.1. A residency program shall be situated in an environment that encourages open communication and facilitates the exchange of knowledge, experience and ideas. The

existence of other educational programs for physicians, technologists, etc. helps foster a productive educational environment.

6.2. Conferences, journal clubs, and teaching rounds shall include residents, and residents should be encouraged to present at appropriate institutional conferences. Teaching and other opportunities for presentations to non-medical physics audience should be encouraged.

6.3. Residents shall have access to a sufficient variety of journals, books, and resource materials appropriate to medical physics, as well as to the internet and a general medical library.

6.4. Residents shall have access to adequate clinical facilities appropriate for a medical physics residency program.

6.5. Residents shall be provided with a mechanism for feedback concerning the quality of their instruction and the diligence of their mentors. The residents shall be protected from repercussions if that mechanism is used. Feedback on the entire program should be sought from program graduates.

6.6. Issues and concerns identified by feedback from residents and graduates shall be evaluated by the steering committee, and remedial action taken where appropriate.

7. Scholarly Activities

7.1. Residents should be encouraged to engage in research projects and solving problems related to patient care challenges arising in the clinic.

7.2. Residents should be allowed to participate in the clinical commissioning of new technologies.

7.3. All clinical, educational and scholarly activities engaged in by the resident shall be recorded in an activities journal using any appropriate format maintained personally by each resident and examined periodically by the Program Director.

8. Residency Curriculum

8.1 The self-study document shall include written expectations of resident performance and behavior as well as the training schedule that is given to incoming residents. This training schedule shall include:

1. Duration of each clinical rotation
2. Clinical rotation objectives
3. Didactic educational expectations
4. Optional research opportunities which do not compromise clinical training

8.2 The elements of clinical training shall be consistent with the curriculum described below.

8.3 The self-study document shall include a summary of the elements of clinical training of each clinical rotation to include:

1. Documentation of specific training objectives;
2. Documentation of resident progress evaluation with resident name removed;
3. Documentation of any required remedial didactic education;
4. List of clinical conferences, seminars and/or journal reviews including their frequency that the resident is expected to attend.

5. An appropriate reading list.

8.4 The process for creating or modifying training objectives shall be described.

8.5 All facilities used by the residents including their location, availability, and capacity shall be listed.

8.6 Ethics and Professional Curriculum

These standards shall be fully addressed before completion of the resident educational programs.

- Professionalism
  - Definition of a profession and professionalism
  - Elements of a profession
  - Definition of a professional
  - Elements of professionalism (altruism, honesty, integrity, excellence, humanism, duty, accountability, respect for others)
  - How is professionalism judged?
  - Do's and don't's of professionalism
  - Physician's charter and applicability to physicists
- Leadership
  - Qualities of leaders
  - Rules of leadership
  - Causes of leadership failure
- Ethics
  - Ethics of a profession
  - Ethics of an individual
  - Interactions with colleagues and co-workers
  - Interactions with patients and the public
  - Confidentiality
  - Peer review
  - Negotiation skills
  - Relationships with employers
  - Conflicts of interest (recognition and management)
  - Ethics in research (fabrication, fraudulence, plagiarism)
  - Use of animals in research
  - Use of humans in research
  - Relationships with vendors
  - Publication ethics

8.7 Imaging Physics Residency Curriculum

Minimum requirements are described below for completing a residency in imaging physics. For tests to be conducted, the number of systems to be tested to demonstrate competency

is left to the discretion of the program director and the supervising physicist, except for systems where accrediting agencies define the minimum number of systems that must be tested for an individual to be considered a qualified medical physicist. In these cases, the minimum number of systems to be tested shall be at least the number specified by the accrediting agency. For topics that define quantities that may be measured or computed, the resident should perform actual measurements or computations to demonstrate familiarity with the quantities and their uses.

- Conduct system performance evaluations and quality control, safety and compliance tests, including vendor recommendations, under supervision of a qualified physicist
    - Radiography
    - Computed radiography
    - Fluoroscopy
    - Interventional/angiography
    - Mammography
    - Stereotactic breast biopsy
    - Computed tomography (CT)
    - Magnetic resonance
    - Ultrasound
    - Image processors/printers
- Safety evaluations
    - Entrance exposure estimates
    - Organ dose estimates
    - Computed tomography dose index (CTDI) and dose-length product (DLP)
    - Mean glandular dose
    - Effective dose
    - Risk estimates
    - Personnel exposure estimates and reduction
    - Fetal dose
    - Contrast agents
    - Protocol optimization
    - MRI hazards
    - Organ/fetal doses with MIRD system
    - Radiopharmaceutical applications and risks
    - Site considerations and shielding design
    - Personnel shielding/monitoring
    - Calibration and survey instruments
    - Radiation surveys
    - Safety policies/procedures
    - Compliance audits

    - Dose limits
- Informatics
    - Picture archiving and communications systems (PACS) and radiology information systems (RIS) systems and their integration
    - Digital imaging and communication systems (DICOM) standards
    - Health Level 7 (HL7)
    - Information acquisition from PACS/images
    - Informatics variations among modalities
    - Dose reporting features
    - Use of Integrating the Healthcare Enterprise (IHE) radiology profiles
    - Open source software resources
    - Quality/maintenance of imaging workstations
    - Evaluation of viewing conditions
    - Image registration, fusion, segmentation, processing
    - Computer-aided detection (CAD) and computer-aided diagnosis (CADx) systems

8.8 Nuclear Medicine Physics Residency Curriculum

Minimum requirements are described below for completing a residency in nuclear medicine physics. For tests to be conducted, the number of systems to be tested to demonstrate competency is left to the discretion of the program director and the supervising physicist, except for systems where accrediting agencies define the minimum number of systems that must be tested for an individual to be considered a qualified medical physicist. In these cases, the minimum number of systems to be tested shall be at least the number specified by the accrediting agency. For topics that define quantities that may be measured or computed, the resident should perform actual measurements or computations to demonstrate familiarity with the quantities and their uses.

- Conduct system performance evaluations and quality control, safety and compliance tests, including National Electrical Manufacturers Association (NEMA) and vendor specifications, under supervision of a qualified physicist
    - Gamma camera, including intrinsic/extrinsic/SPECT performance
    - PET/CT, including ACR accreditation tests
    - Sufficient tests to achieve ACR qualified medical physicist status
    - Non-imaging equipment (e.g. dose calibrators, uptake probes, well counters)
    - Image processors/printers
    - Computer systems
- Safety evaluations
    - Organ/fetal doses with MIRD system
    - CTDI and DLP
    - Effective dose
    - Risk estimates

  - Personnel exposure estimates and reduction
  - Radiopharmaceutical applications and risks
  - Site considerations and shielding design
  - Personnel shielding/monitoring
  - Unsealed source management (storage, inventory, packaging, transportation, personnel protection)
  - Calibration and survey instruments
  - Radiation and contamination surveys
  - Radiopharmacy considerations
  - Radionuclide therapy/personnel safety/patient release criteria/public safety
  - Safety policies/procedures
  - Compliance audits
  - Occupational and public dose limits
  - National and state regulations
  - Radiation exposure to the public
  - Waste handling and disposal
  - Radioactive spills
  - Radiation signage
  - Medical events (definition and reporting requirements)
- Informatics
  - PACS and RIS systems and their integration
  - HL7
  - DICOM standards
  - Information acquisition from PACS/images
  - Informatics variations among modalities
  - Dose reporting features
  - Use of IHE radiology profiles
  - Open source software resources
  - Quality/maintenance of imaging workstations
  - Evaluation of viewing conditions
  - Image registration, fusion, segmentation, processing
  - Quantitative analysis
  - Kinetic modeling/computer analysis

8.9 Radiation Oncology Physics Residency Curriculum

Minimum requirements are described below for completing a residency in radiation oncology physics. For tests to be conducted, the number of systems to be tested to demonstrate competency is left to the discretion of the program director and the supervising physicist, except for systems where accrediting agencies define the minimum number of systems that must be tested for an individual to be considered a qualified

medical physicist. In these cases, the minimum number of systems to be tested shall be at least the number specified by the accrediting agency. For topics that define quantities that may be measured or computed, the resident should perform actual measurements or computations to demonstrate familiarity with the quantities and their uses.

- Conduct system calibrations, performance evaluations and quality control, safety and compliance tests, including vendor specifications, under supervision of a qualified physicist
    - Megavoltage photons
    - Electron beams
    - Small field systems (SRS, SBRT)
    - Gamma knife (if available)
    - ^{60}Co (if available)
    - Brachytherapy implants (temporary/permanent)
    - Brachytherapy applicators, LDR, HDR
    - CT simulators
    - SPECT (if available)
    - PET/CT (if available)
    - MRI/CT (if available)
    - Protons (if available)
    - Dose scanning systems
    - In vivo dosimetry systems (e.g. diodes, thermoluminescence dosimeters (TLD), optically stimulated luminescence dosimeters (OSLD)
    - External beam dose measuring systems
    - 3D external beam treatment planning workstations
    - Immobilization devices
    - Organ motion-correction methods
    - Inhomogeneity correction algorithms
    - Image-guided radiation therapy equipment/techniques [e.g., planar MV and kV imagers, cone beam CT, non-radiographic localization (e.g., ultrasound (US), surface camera, radiofrequency (RF) beacon tracking)]
    - US in therapy
    - MRI
    - Total body photon irradiation (TBI)
    - Total skin electron therapy (TSET)
    - Optional: Conduct evaluations and tests of other therapy items (e.g. fluoro simulation, SPECT, PET/CT, MRI/PET, proton accelerators if in clinical use at the educational institution
- Treatment planning and delivery
    - Treatment simulation techniques (e.g. patient positioning, immobilization)
    - Beam properties (photons, electrons)

  - Beam modifiers [e.g., bolus, compensators, wedges (i.e., physical, dynamic, universal)]
  - Step-and-shoot and sliding window IMRT
  - Treatment planning algorithms
  - Monitor unit calculations/influencing factors
  - Monitor unit calculations/configurations (e.g. SSD setup, SAD setup, extended distance setup, off axis calculations, and rotational beams)
  - Tumor localization and International Commission on Radiation Units and Measurements (ICRU) target definitions [e.g. gross tumor volume (GTV), clinical target volume (CTV), planning target volume (PTV)]
  - Normal tissue anatomical contouring
  - 2D and 3D treatment planning
  - IMRT/VMAT planning/optimization/QA
  - Small field planning/optimization/QA
  - Site specific treatment planning – multiple applications
  - Plan evaluation [e.g., dose volume histogram (DVH), conformity index, homogeneity index, biological evaluators]
  - Treatment records
  - Dose limits to sensitive structures
  - Brachytherapy treatment plans and QA
  - Clinical applications of various radiation treatments
- Safety
  - Failure mode effects analysis (FMEA) principles/applications
  - Root cause analysis (RCA) principles/applications
  - Sealed source storage/safety/protection
  - Sealed source inventory/check in/out procedures
  - Sealed source packaging/transportation (e.g., Title 19 CFR)
  - Calibration of sealed sources
  - Exposure and contamination surveys
  - Radiation signage
  - Definition and reporting requirements for medical events
  - Radiation safety of personnel during radionuclide therapy
  - Patient release criteria following radionuclide therapy and radiation safety for the public
  - Safety policies/procedures
  - Compliance audits
  - Occupational and public dose limits
  - National and state regulations
  - Radiation exposure to the public
  - Site design and shielding (primary and secondary barrier computations)

    - Neutron shielding
    - Facility radiation surveys
    - Personnel dosimetry
- Informatics
    - Beam data acquisition/management
    - Beam modeling
    - Validation of imported images
    - PACS systems and their integration
    - HL7
    - DICOM standards
    - DICOM in radiation therapy (DICOM-RT)
    - Information acquisition from PACS/images
    - Quality/maintenance of imaging workstations
    - Evaluation of viewing conditions
    - Image registration, fusion, segmentation, processing
    - Quantitative analysis
    - Record and verify systems
    - Treatment record design/maintenance
    - IHE – Radiation Oncology (IHE-RO)
    - Network integration/management, and roles of physics and information technology staff
- Therapeutic radiopharmaceutical training should be included in the curriculum of radiation oncology physics residents