ACPSEM
Australasian College of Physical Scientists & Engineers in Medicine

Expert Working Group Framework for Education 2030 Project

Topic 3: Theranostics and Advanced Molecular Imaging for Medical Physicists

This document provides a framework and guidance for the Expert Working Group on Theranostics and Advanced Molecular Imaging, with a specific focus on the roles and responsibilities of medical physicists in advancing the field of theranostics and molecular imaging. The goal is to identify research needs, gaps in professional education, university foundation knowledge, and CPD (Continuing Professional Development) requirements, ensuring that medical physicists are equipped to contribute to the evolving field of theranostics and advanced molecular imaging in clinical practice.

:: 3.1 Fundamentals of Theranostics ::

POTENTIAL KEY AREAS TO EXPLORE
- **Diagnostic vs Therapeutic Isotopes**:
  - What are the differences between diagnostic and therapeutic isotopes, and what role do medical physicists play in the selection, administration, and safety of these isotopes in theranostics?
  - How do radiation physics principles influence the effectiveness and safety of diagnostic and therapeutic isotopes in both imaging and treatment?
- **PET/MRI and SPECT/CT Fusion Technologies:**
  - How do PET/MRI and SPECT/CT fusion technologies integrate diagnostic and therapeutic capabilities? What challenges exist in their implementation, and what role do medical physicists play in optimising these systems for clinical use?
- **Target Selection and Delivery Mechanisms:**
  - What are the methodologies for selecting targets in theranostics (e.g., tumour markers, molecular receptors)? How do medical physicists contribute to the design and validation of targeted therapies and delivery mechanisms?
  - What are the implications of these technologies for personalised medicine and treatment precision?

POTENTIAL EVALUATION QUESTIONS AND APPROACHES
- **Research Needs:** What are the current research gaps in theranostic-isotopes, fusion technologies, and target selection? How can medical physicists contribute to advancing these technologies?
- **Future Education Courses:** Should medical physics education programs incorporate more specialised training in theranostics, including the use of PET/MRI and SPECT/CT systems? How can students be better prepared for the challenges of integrating diagnostic and therapeutic techniques?
- **University Foundation Knowledge:** What core knowledge in nuclear medicine, radiation physics, and molecular biology should be embedded in medical physics programs to prepare students for work in theranostics and molecular imaging?
- **CPD Requirements:** What specific CPD modules should be designed to help practicing medical physicists stay up to date on theranostic technologies, fusion imaging, and targeted therapies?

:: 3.2 Radiation Protection in Theranostics ::

POTENTIAL KEY AREAS TO EXPLORE
- **Dose Limits for Caregivers and Staff:**
  - What are the radiation dose limits for healthcare staff working with theranostics, and how can medical physicists help ensure that these limits are adhered to in clinical settings?
  - How do medical physicists contribute to the design of safe workspaces and radiation shielding in environments where theranostic procedures are performed?
- **Waste Handling Protocols and Design Considerations:**
  - What are the key waste handling protocols specific to theranostics, especially in handling radioactive materials and disposing of radiopharmaceutical waste?
  - How do medical physicists contribute to the design considerations of radiation facilities to safely manage waste, particularly in environments utilising theranostic technologies?
- **Risk Communication to Patients and Public:**
  - How do medical physicists help with risk communication to patients and the public regarding radiation safety in theranostic procedures?
  - What are the best practices for explaining potential risks and benefits of theranostic treatments to patients, while ensuring informed consent is obtained?

POTENTIAL EVALUATION QUESTIONS AND APPROACHES
- **Research Needs:** What further research is needed in radiation protection protocols for theranostic treatments, particularly regarding staff exposure and waste management?
- **Future Education Courses:** Should medical physics education programs offer more in-depth training on radiation protection specific to theranostics? How can students be better prepared for the regulatory and safety challenges of working in theranostic environments?
- **University Foundation Knowledge:** What core knowledge in radiation protection, waste handling, and regulatory standards should be incorporated into medical physics curricula?
- **CPD Requirements:** What CPD courses are necessary to help practicing medical physicists stay current with radiation protection, waste management, and patient risk communication in the context of theranostic treatments?

:: 3.3 Radiopharmaceutical Design & Production ::

POTENTIAL KEY AREAS TO EXPLORE
- **Targeting Vectors (Peptides, Antibodies):**
  - What are the key targeting vectors (e.g., peptides, antibodies) used in theranostic treatments? How do medical physicists contribute to selecting and optimising these vectors for personalised therapy?
  - How do medical physicists collaborate with chemists and clinicians in the design and application of radiolabeled molecules for theranostics?
- **Production Pathways: Cyclotron vs Generator:**
  - What are the differences between cyclotron-produced and generator-produced radiopharmaceuticals? How does the choice of production method impact the physicist's role in ensuring quality control and regulatory compliance?
  - How do medical physicists ensure the safe and effective production, handling, and application of radiopharmaceuticals in clinical practice?
- **Labelling Techniques (e.g., DOTA, NOTA Chemistry):**
  - What are the key labelling techniques (e.g., DOTA, NOTA) used in theranostic radiopharmaceuticals? How do medical physicists contribute to ensuring accurate labelling and effective delivery of radiopharmaceuticals?

POTENTIAL EVALUATION QUESTIONS AND APPROACHES
- **Research Needs:** What research is needed to improve the design and production of radiopharmaceuticals for theranostic applications? What role do medical physicists have in advancing these processes?
- **Future Education Courses:** Should medical physics education programs include more content on the design, production, and application of radiopharmaceuticals? How can students be better prepared to work with the evolving landscape of theranostic treatments?
- **University Foundation Knowledge:** What foundational knowledge in radiopharmaceutical chemistry, targeting vectors, and production methods should be included in medical physics curricula?
- **CPD Requirements:** What CPD courses should be developed to help practicing medical physicists stay current with the latest radiopharmaceutical design, production methods, and labelling techniques?

:: 3.4 Quantitative Dosimetry ::

POTENTIAL KEY AREAS TO EXPLORE
- **MIRD Schema and Voxel-Based Dosimetry:**
  - How does the MIRD schema (Medical Internal Radiation Dose) apply to quantitative dosimetry in theranostics? What role do medical physicists play in adapting this framework to modern therapeutic applications?
  - How do medical physicists use voxel-based dosimetry to calculate radiation dose distribution in patients receiving theranostic treatments?
- **Post-Therapy Imaging Protocols:**
  - How should post-therapy imaging protocols be developed to accurately assess the distribution of radiopharmaceuticals in patients after treatment?
  - What is the role of medical physicists in developing and optimising imaging protocols for quantitative dosimetry post-therapy?
- **Kinetic Modelling of Isotope Uptake and Clearance:**
  - How do kinetic models of isotope uptake and clearance contribute to personalised treatment planning in theranostics? What role do medical physicists play in validating and applying these models?

POTENTIAL EVALUATION QUESTIONS AND APPROACHES
- **Research Needs:** What research is required to improve the accuracy and applicability of quantitative dosimetry in theranostic treatments? How can medical physicists help advance these techniques?
- **Future Education Courses:** Should medical physics programs offer more specialised courses on dosimetry, particularly in radiopharmaceuticals and theranostics?
- **University Foundation Knowledge:** What core knowledge in quantitative dosimetry, kinetic modelling, and post-therapy imaging should be integrated into medical physics curricula?
- **CPD Requirements:** What CPD training is needed to ensure practicing medical physicists are proficient in kinetic modelling, dosimetry, and post-therapy imaging?

:: 3.5 Radiobiology for Internal Emitters ::

POTENTIAL KEY AREAS TO EXPLORE
- **Alpha vs Beta Emitter Effects:**
  - What are the biological effects of alpha and beta emitters in theranostic treatments? How do medical physicists contribute to assessing and managing the risks associated with these internal emitters?
  - How does radiobiology influence the decision-making process when choosing between alpha and beta emitters for targeted therapies?
- **Sub-Cellular Damage and Repair Pathways:**
  - How does sub-cellular damage caused by internal emitters impact treatment efficacy and patient safety? What are the repair pathways involved, and how can medical physicists assess and mitigate the risks of such damage?
- **Heterogeneity in Dose Deposition and Response:**
  - How does the heterogeneity of dose deposition affect therapeutic outcomes in theranostic treatments? What role do medical physicists play in assessing and optimising dose distribution for better treatment responses?

POTENTIAL EVALUATION QUESTIONS AND APPROACHES
- **Research Needs:** What research is required to better understand the radiobiology of internal emitters, particularly the effects of alpha and beta particles? How can medical physicists contribute to advancing these areas of study?
- **Future Education Courses:** Should medical physics education programs focus more on the radiobiology of internal emitters, dose deposition, and biological response?
- **University Foundation Knowledge:** What foundational knowledge in radiobiology, sub-cellular damage, and dose response should be included in medical physics curricula?
- **CPD Requirements:** What CPD programs should be developed to ensure practicing medical physicists are equipped with the necessary knowledge of radiobiology, internal emitters, and their effects on therapy?