



The Role of the Clinical Scientist in Nuclear Medicine

1. Introduction to Nuclear Medicine

Nuclear Medicine is the field of healthcare that uses radioactive substances in the diagnosis and treatment of disease. Highly specialised equipment such as gamma camera, SPECT and PET scanners are used to obtain functional images of the human body. In addition to diagnosis, Nuclear Medicine also includes radionuclide therapy which involves the administration of radiopharmaceuticals for the treatment of benign and malignant conditions.

Clinical Scientists (CS) in nuclear medicine are responsible for the design, optimisation and delivery of diagnostic and therapeutic procedures. These procedures require high-level scientific and technical support for their safe and effective utilisation.

2. Scientists in Nuclear Medicine

Scientists specialising in Nuclear Medicine have a combination of scientific knowledge and practical skills required to support and develop the clinical service. They typically have a basic science degree and an MSc in Medical Physics, while some may also have a PhD in a relevant subject. They also have clinical training obtained either through a training scheme such as the NHS Scientist Training Program [1] or through work-based experience. To work independently in Nuclear Medicine they need to be registered as Clinical Scientists with the Health and Care Professions Council (HCPC) [2].

In their role Clinical Scientists work closely with nuclear medicine technologists and radiographers, radiopharmacists, nurses and ward personnel as well as nuclear medicine physicians and radiologists, often acting as a liaison between different professional disciplines. Examples of the main roles of the Clinical Scientist in Nuclear Medicine are outlined in the following sections.

2.1 Medical Physics Expert

The role of the Medical Physics Expert (MPE) in Nuclear Medicine is described in the Ionising Radiation Medical Exposures Regulations (IRMER) 2017 [3]. MPEs are actively involved in the delivery of diagnostic and therapeutic services and are also responsible for equipment quality assurance, optimising radiation exposures, and making dosimetry assessment. They support the investigation of suspected radiation incidents, and advise the employer on compliance with the IRMER regulations.

Historically the MPE qualification was provided with years of work experience post HCPC registration depending on local hospital needs, but more recently an MPE recognition scheme has been established to formalise the training requirements and recognition process for this complex role [4].

2.2 Diagnostic Nuclear Medicine

Specific to diagnostic nuclear medicine procedures, the Clinical Scientist is normally engaged in the design of diagnostic protocols. This can involve both the selection and optimisation of image acquisition parameters as well as the creation and validation of image processing and quantification tools. The Clinical Scientist frequently takes on troubleshooting and advisory roles during complex imaging procedures and may also undertake complex image processing when required.

Optimisation in diagnostic nuclear medicine presents a fine balance between image quality, radiation exposure and acquisition duration. This task requires specialist scientific and clinical skills and forms one of the key responsibilities of the MPE.

2.3 Radionuclide Therapy

Radionuclide therapy procedures are typically carried out by nuclear medicine teams often in collaboration with local oncology and radiotherapy teams. Clinical scientists play an essential and often patient facing role in radionuclide therapy procedures by supporting the delivery of individual patient administrations. They also work with the patient to provide individualised radiation risk assessments to protect them, their loved ones, and their colleagues from radiation hazards. To help understand the radiation dose delivered to the patient during their treatment and to help optimise any further treatments, Clinical Scientists perform dosimetry calculations for the target area(s) of the treatment, and organs at risk using quantitative gamma camera and SPECT imaging.

2.4 Quality Assurance

Clinical Scientists in Nuclear Medicine typically operate under a quality management system, which sometimes has ISO accreditation. A large part of their role is to design and oversee the quality assurance program of nuclear medicine equipment such as gamma camera, SPECT and PET scanners, radionuclide calibrators, gamma counters, intraoperative gamma probes, uptake counters and contamination monitors. Clinical scientists are involved in all stages of the equipment life cycle, from specification to acceptance testing and performance follow up with routine quality control procedures. Their role is to monitor equipment performance and advise on suitability for continuous clinical use in reference to national and international standards such as IPEM reports [5] and NEMA standards [6].

Clinical scientists are also frequently involved in the quality management of software tools used for patient data analysis, as well as in undertaking audits to evaluate clinical protocols and procedures.

2.5 Radiation Protection

Clinical Scientists in Nuclear Medicine sometimes act as Radiation Protection Advisers (RPAs), providing their employer with advice to help comply with the Ionising Radiation Regulations 2017 with the aim of protecting employees and the public from the harmful effects of ionising radiation [7]. This includes the use of open radioactive sources for diagnosis and therapy, sealed sources used for brachytherapy applications and equipment testing, as well as X-ray sources which form part of Hybrid SPECT/CT and PET/CT systems. The RPA is also involved in the critical examination of radiological installations and the implementation of controlled and supervised radiation areas; advises on monitoring of environmental and staff doses and compliance with radiation dose limits; and investigates any radiation incidents.

Clinical Scientists in Nuclear Medicine can also act as Radioactive Waste Advisers (RWAs) and advise their employer on compliance with the Environmental Permitting Regulations 2000 [8]. Specifically, they advise on the management of radioactive waste produced in their employers' premises, aiming to optimise the radiation protection of the population and environment. RPAs and RWAs are certified by the RPA 2000 certification scheme [9].

3. Training and Education

Clinical scientists in nuclear medicine support both academic and vocational clinical training and education and are experienced in addressing a broad range of audiences.

In the hospital environment they are regularly involved in the training and supervision of junior scientists working towards Clinical Scientist or Healthcare Practitioner qualifications. They also support the training of technologists and radiographers in new techniques or best practice and are frequently involved with radiation protection training for multiple staff groups such as laboratory or ward personnel.

Clinical scientists can be involved in lecturing at university courses in physics and engineering, and may also supervise students in their BSc, MSc or PhD dissertations. For medical doctors, Clinical Scientists support the training of specialist registrars for their Fellow of Royal College of Radiology qualification, through lecturing and hands on technical workshops.

Clinical Scientists are also often involved in outreach activities such as talking in career days at schools encouraging young people to do science subjects, running hospital open days and giving open lectures to engage with the public and promote the role of science in healthcare. Many of these activities are co-ordinated through IPEM Volunteers [10] and the Science, Technology, Engineering and Mathematics (STEM) Ambassadors Scheme [11].

4. Scientific Leadership

The Leaders in Healthcare Science are known as Consultant Clinical Scientists. In Nuclear Medicine, a Consultant Clinical Scientist typically works as the Head or Lead of Nuclear Medicine Physics, and has the advanced clinical, scientific and managerial skills required to support and develop a complex healthcare service. There is a formal pathway to Consultant level, through the Higher Specialist Scientific Training (HSST) scheme [12], as well as an equivalence route for scientists already working at consultant level [13].

The Consultant Clinical Scientist role goes beyond the managerial responsibilities of the Head of Group, to driving healthcare research and innovation as outlined in Section 5. Additionally, Consultant Clinical Scientists are often members of national and international scientific committees such as the IPEM Special Interest Groups (SIGs) [14], the Administration of Radioactive Substances Advisory Committee (ARSAC) [15], or the European Association for Nuclear Medicine (EANM) Physics Committee [16]. In this capacity they develop clinical guidelines to support evidence-based practice, advise regulators on the requirements and impact of new legislation and standards, and also plan and deliver scientific meetings.

5. Research and Innovation

A core component of the Clinical Scientist's role in nuclear medicine is to drive healthcare service development through research and innovation. Examples of service development include: (a) the introduction of new functional imaging techniques or the adaptation of existing protocols, (b) the introduction of new equipment including hybrid imaging systems to clinical service, (c) the development of new image quantification methods to improve accuracy and objectivity of diagnosis, (d) the design and introduction of new radionuclide therapy services. Service development requires a combination of scientific and project management skills and the ability to co-ordinate a multidisciplinary team of professionals.

Clinical Scientists in the NHS also support Clinical Trials for both diagnostic and therapeutic applications. This includes contributing to the design and writing of trial protocols, undertaking equipment and phantom measurements for the purpose of harmonisation in multicentre clinical trials, and providing MPE assessments for the Radiation Assurance component of a research application as required by the Health Research Authority [17].

Finally, Clinical Scientists are often involved in translational research through collaborations with Academic and Industrial Partners, such as for the development of new instrumentation, or evaluation of new therapeutic applications.

6. Conclusion

Clinical Scientists in Nuclear Medicine have complex, continuously evolving roles. They are operators, advisers, educators, leaders and innovators. Ultimately, they are healthcare workers, integral members of clinical teams who use their scientific skills to improve quality and safety in patient diagnosis and treatment.

7. References

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