Radiography (2010) **16**, 238–243

available at www.sciencedirect.com

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journal homepage: www.elsevier.com/locate/radi

REVIEW ARTICLE

Evaluating the fundamental qualities of a nuclear medicine radiographer for the provision of an optimal clinical service

Marc Griffiths [a,*], **Simon King** [b], **Rob Stewart** [c], **Gary Dawson** [d]

[a] *Radiography, Faculty of Health & Life Sciences, University of the West of England, Bristol, United Kingdom*
[b] *University Hospitals Bristol NHS Foundation Trust, Bristol, United Kingdom*
[c] *Diagnostic Imaging, Faculty of Health & Life Sciences, University of the West of England, Bristol, United Kingdom*
[d] *Nuclear Medicine, Salisbury District Hospital, Salisbury, United Kingdom*

Received 11 August 2009; revised 21 December 2009; accepted 22 December 2009
Available online 29 January 2010

KEYWORDS
Education;
Career development;
Clinical practice;
Nuclear medicine

Abstract The developing nature of nuclear medicine practice highlights the need for an evaluation of the fundamental qualities of a Radiographer working within this discipline. Existing guidelines appear to be in place for clinical technologists working within nuclear medicine. However, limited guidance has been provided for Radiographers practicing within this discipline. This article aims to discuss the fundamental qualities that are considered essential for optimal service delivery, following consultation with various stakeholders. Areas such as technical expertise and knowledge, appropriate use of imaging equipment and current models of safe working practice will be discussed. Patient care and ethical considerations will also be evaluated, along with some core recommendations for future advanced practice.
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Introduction

Nuclear Medicine practice continues to evolve with the advent of new technology such as SPECT/CT, advancing techniques and role development. Apart from the four-tier career structure[1] there does not appear to be a clearly defined professional development pathway for Radiographers specifically working within Nuclear Medicine practice. The Institute for Physics and Engineering in Medicine (IPEM) provides some guidance for Technologists and it is hoped that the Modernising Scientific Careers consultation document[2] will provide further career development. Given the potential cross fertilization of skills, knowledge and understanding in this developing field of clinical imaging; clear educational and training frameworks for Radiographers are clearly required.

The European Association of Nuclear Medicine (EANM) provides guidance for Nuclear Medicine Technologists at

* Corresponding author. Tel.: +44 (0) 117 3288488; fax: +44 (0) 117 3288437.
E-mail address: marc.griffiths@uwe.ac.uk (M. Griffiths).

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doi:10.1016/j.radi.2009.12.005

entry and advanced level.[3] The ''*entry level*'' guidelines were originally developed by the British Nuclear Medicine Technologist Group and although the core dimensions of academic knowledge, clinical and practical experience and general managerial skills are discussed, the publication, now over ten years old, fails to take into consideration the current technological and service provision advancements that are widespread across the National Health Service.

Suggested fundamental skills of a Nuclear Medicine Radiographer have been identified by the authors and are documented in Fig. 1. The formulation of these proposed skills were generated following the construction of an informal professional steering group, as part of the re-approval of the MSc Nuclear Medicine Programme at the University of the West of England, Bristol. This group consisted of clinical practitioners, post graduate students and members of the academic Nuclear Medicine community. The rationale of the group related to the developing nature of Nuclear Medicine practice and how this may impact upon the Radiographer. Appropriate themes were identified during the re-approval event and documented within this article.

For reference purposes, the professional qualities of a Radiographer working within Nuclear Medicine may also be related to a Technologist as many departments within the UK employ a mixture of both professional groups.

Although the Knowledge and Skills Framework (KSF)[4] exists to identify the core dimensions within Radiography as a profession, at present there are no clearly defined fundamental definitions for a post-holder working to an autonomous level in Nuclear Medicine. Further evaluation and establishment of the fundamental qualities identified in Fig. 1, is crucial to the on-going development of Nuclear Medicine practice. Now is the time for strategic involvement in order to formulise a clear and specific career pathway that provides guidance and opportunities for the profession.

The following article provides an overview of essential Nuclear Medicine practice necessary to provide a robust clinical service. Additional areas, such as role development have briefly been included in order to highlight potential future working practice.

Technical expertise and knowledge

Optimal image quality

Ensuring optimal imaging quality is one of the highest priorities for staff working within Nuclear Medicine departments. It is a fundamental requirement of the Radiographer to have an appreciation of how to assess image quality, and importantly to understand how various factors can affect it.[5] This is especially true when you consider that the usefulness of a clinical report is directly related to image quality.[6]

When assessing image quality, two key factors must always be considered; the quality of the raw data acquired by the camera and the quality of the final displayed image. Clearly if the image is poorly presented, this will potentially result in an underutilisation of the imaging modality. Secondly, image quality should be assessed in terms of its suitability for the purpose it was intended; as such it should not be assessed in isolation.

Being able to identify technical and physiological artefacts should be considered a fundamental attribute of a Radiographer working within Nuclear Medicine. For example, being able to distinguish pharmacological ''*clumping*'' from a patient specific artefact and identifying poor labelling of a radiopharmaceutical are crucial analytical and problem solving skills expected of a trained Nuclear Medicine Radiographer.

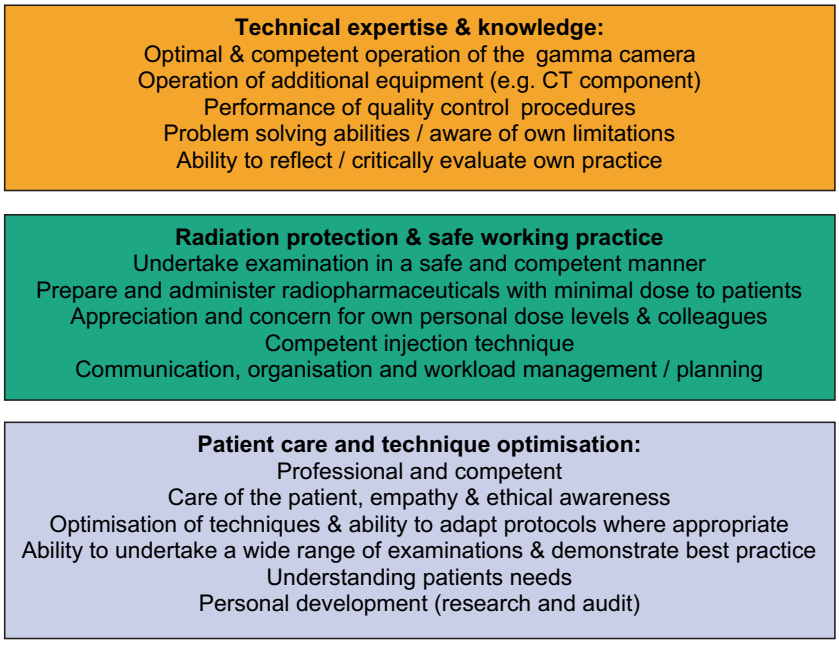

Figure 1 Suggested fundamendal qualities of Nuclear Medicine Radiographer.

Gamma camera hardware & techniques

In terms of gamma camera hardware and techniques, it is important to understand the intrinsic design of a modern gamma camera and how the appropriate use of collimators ensures the accurate representation of radioisotope uptake within the patient. The collimator is an integral part of the gamma camera system and it is the process of '*absorptive collimation*', which allows an image to be produced.

Without an understanding of the comparative performances and various uses of the different collimator types there are clearly implications for poor practice. The incorrect use of a collimation device can have a negative effect on image quality, which may in turn have a subsequent detrimental effect on patient management.[5]

The Nuclear Medicine Radiographer has to utilise their skills and be able to produce images of optimal quality in the shortest possible time period. Obviously factors such as the initial injected dose (especially paediatric doses), physiology of the patient and quality of the gamma camera system will play a part in the final acquisition. Modification of a default imaging protocol may be required to suit the individual patient and it is in these instances that the advancing nature of the Radiographers practice becomes apparent.

In order to achieve optimal image quality, essential acquisition parameters need to be considered prior to the start of each clinical examination. These include the matrix size, number of counts and acquisition zoom. Consideration for the amount of specific injected activity (ARSAC limits), physical and biological half life of the isotope and day to day department organisation should also factor as part of a Radiographer's core knowledge base.

Prolonged scanning times may induce issues relating to image quality. Specific patients' tolerance of imaging procedures dramatically decreases the longer the scan lasts, often leading to patient movement which will itself degrade image quality.[7] With this in mind the Radiographer must therefore be able to constantly adapt and use professional judgment in order to assess whether the image is sufficient or whether lengthening the scanning time to acquire more counts may in fact be detrimental to the patient. This is especially true if paediatric examinations are being undertaken and the requirement for clear communication with parents/guardians and other health care professionals is to be expected.

One of the most important aspects of traditional Nuclear Medicine imaging is ensuring that the distance from the object to the camera is as small as possible, therefore optimising image resolution. Issues with claustrophobia are commonplace during imaging procedures and in such cases the Radiographer must appear confident, calming and empathetic toward the patient and their parents/guardians/care assistants where appropriate.

Appreciating the value of additional views is a fundamental factor of any Radiographer within clinical practice. Additional views may be undertaken (e.g. obliques/laterals) to confirm findings or rule out suspicious areas. This factor may have a positive significant effect on technical and clinical reporting. An example of this point is highlighted in Fig. 2.

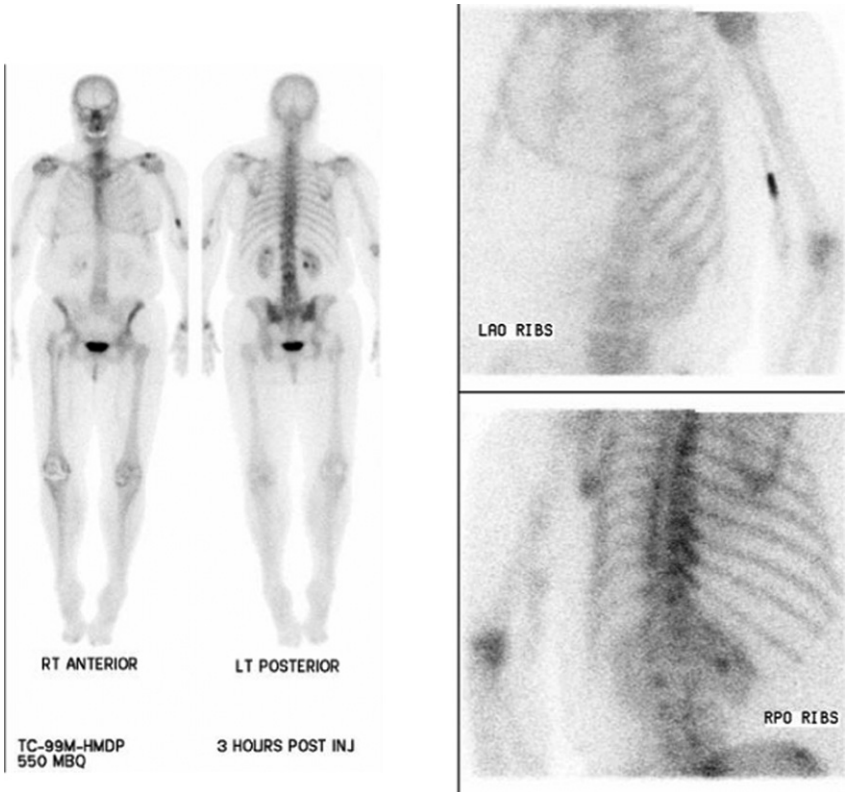

Figure 2 Value of additional views during a skeletal study, with a suggested solitary metastasis being rules out as an injection technique resulting in a collection of radiotracer activity.

An inappropriate choice of matrix size will also degrade image quality and therefore the Radiographer must fully understand the principles of modern acquisition parameters, in accordance with national (BNMS)[8] and international imaging recommendations (EANM).[9]

Within the Nuclear Medicine department quality assurance (QA) is vitally important to ensure the best possible patient service is provided, and should be an integral part of the daily routine of every department10. Following appropriate training, the Nuclear Medicine Radiographer needs to take direct responsibility for the effective performance of equipment. This includes the monitoring of gamma camera hardware, computer systems, dose calibrators and environmental radiation monitoring equipment. Fundamental quality control tests are identified in national (IPSM[11]) and international (EANM[3]) guidelines.

Appreciating the individual quality control requirements of a specific Nuclear Medicine department will impact on overall service provision. Optimising a daily QA programme will enhance image quality, whilst minimising potential service ''down time''.

Radiation protection and safe working practice

Clear awareness of published guidelines and policies for best practice can produce and maintain an environment where the levels of ionising radiation pose a minimal acceptable risk for human beings. Time, distance and appropriate shielding are the cornerstones of practical radiation protection in nuclear medicine and should be embedded within any training programme. Radiographers should always be vigilant in the nuclear medicine workplace and monitor themselves and the environment in accordance with local protocols and national recommendations.[12]

Time spent in the vicinity of radioactive sources must be minimised, so an awareness of surroundings is crucial. The Nuclear Medicine Radiographer must also perfect skills in the handling of radioactive materials in order to reduce the time spent on procedures. It must also be remembered that patients themselves are included as a radioactive source once they have been injected, therefore all interviews, documentation and examinations should be carried out prior to the administration of radioactivity.

In a clinical environment it is clearly not always possible to keep your distance from a patient who may have special needs; therefore discretion and critical thinking skills should be used when maintaining distance, without causing concern or alarm for patients or their carers. Hybrid imaging environments, such as SPECT/CT, are beginning to redefining the practical distance parameters and systems of work for Radiographers.

The emergence of X-ray based transmission units attached to modern gamma cameras will undoubtedly have an impact upon current and future clinical examinations. Training programmes should encompass emerging aspects of clinical practice and clearly identify appropriate use of technology. Role development should also accompany the use of emerging techniques and procedures in Nuclear Medicine, especially where core service areas are being developed (e.g. Sentinel node imaging and treatment).

The use of appropriate shielding when handling or storing radioactive sources is also a fundamental factor associated within the Nuclear Medicine Radiographers' skill base. Tungsten syringe shields are used when injecting radiopharmaceuticals and in order to safely administer radioactive material, new skills need to be developed. Appropriate cannulation training and frequent auditing of technique must take place within the workplace to monitor personal dose levels and levels of effective radiopharmaceutical administration.[12] Clearly it is fundamental for safe working practice that a Radiographer should have the ability to assess their own technique and be able to act on this self assessment to improve service provision.

With an ever-increasing workload it would be unethical to have only a fraction of Nuclear Medicine staff able to perform intravenous cannulations of radioactive material. All staff should be trained in this competency and be expected to perform this task on a rotational basis in order to limit the radiation burden acquired by a small number of staff. It is now classified as a statement of need that those working in the Nuclear Medicine department are competent in intravenous administration. A draft document '*The certificate of administration of intravenous radiopharmaceuticals*' by the BNMS Technologist Group[13] outlines the necessary steps in order to achieve recognised competency in this area.

At present, intravenous administration of radiopharmaceuticals is still seen as an advanced competency due to the lack of undergraduate education, however educators appear to have recognised the importance of this competency and it is slowly being introduced into the undergraduate curriculum.[14]

At all times the exposure of a patient to ionising radiation should follow the ALARA 'as low as reasonably achievable' principle and the Radiographer should be responsible for the justification of each individual medical exposure. Justification should be based on the Radiographer's knowledge of the potential risks associated with the exposure and the clinical information supplied by the Referrer.

Even in well organised departments accidents can occur. In the event of an accident involving an unsealed radioactive material, the principal requirement is to ensure the safety of the individuals and avoid the spread of radioactivity. The seriousness of any spill will be determined by the activity released and whether personnel or equipment have been contaminated.[10]

The Radiographer must be aware of and able to execute the general procedure for dealing with such an incident in a calm and controlled manner. Departmental guidelines should be in place to inform the process of decontamination, however the Radiographer must be organised in their actions in order to minimise the effects of any spillage and utilise the appropriate personal protective equipment (PPE) effectively. Clear communication with other health care professionals is also crucial in the event of any radioactive spillage and mock scenarios help provide essential experience for junior members of staff within the Nuclear Medicine department.

Patient care and ethics

Radiographers must adhere to frameworks for service delivery set out under the banner of clinical governance. The National Institute of Clinical Excellence (NICE) is a national

body which assists with clinical governance by producing guidelines and protocols promoting best clinical practice.[15] Clinical governance provides a framework where each trust is accountable for the continued improvement of clinical service, while maintaining high standards of care (NHS Clinical Governance Support Group).[16] Clinical audit programmes help promote best practice and identify potential areas for improvement and enhanced service delivery.

As the role of the Radiographer expands in clinical practice, so does the potential for their involvement in legal claims.[17] The primary role of the Nuclear Medicine Radiographer is to provide and maintain the best care and management to patients whilst performing diagnostic and/or therapeutic procedures, in line with the Health Professions Council (HPC) Standards of Proficiency.[18]

As a Radiographer, an individual must not only become sensitised to ethical issues but must learn to exercise professional judgment on a daily basis. Frameworks for ethical guidance from professional bodies such as the College of Radiographers (CoR)[19] help in decision making processes such as informed consent. Consent can be implied (e.g. a patient holding out an arm for an injection), verbal or written. However to obtain valid consent the patient needs to be given sufficient information to understand the risks, benefits, likely consequences and alternatives of any investigation. Once given this information, there must then be an opportunity for the patient to ask questions and digest the information.[20]

Beyond the fundamentals?

Allied health professionals are continuing to expand their responsibilities (Department of Health)[21] within clinical areas outside their traditional boundaries, and many of these new responsibilities are found within the medical domain. These advanced responsibilities often have associated higher demands placed on the Radiographer, in terms of clinical updating, competence to practice and legal liability.[17]

Professional bodies should support the development of Nuclear Medicine Radiographers and strengthen their contribution to healthcare teams, by promoting role extension and facilitating greater empowerment.[21] There is a growing body of evidence discussing the scope of Nuclear Medicine practice and with it a realisation that role development benefits quality of care for the patient.[22]

A key area of role extension which has been given recent interest is non-medical Nuclear Medicine reporting. Various studies have been carried out evaluating the reporting skills of experienced Radiographers[23–25] and results suggest that Radiographers can report Nuclear Medicine studies with a similar degree of accuracy to medical practitioners.[26]

The BNMS[27] have published guidelines for the issue of reports by non-medical staff. These guidelines conclude that non-medical reporting is acceptable, provided the individual can demonstrate the correct level of competence. The guidelines state that the reporting non-medic must always realise their limitations and work as part of a multi-disciplinary team, under local Trust guidelines.

The CoR state that clinical reporting will become a core competence for Radiographers by 2010[28] and the skills acquired will help to form a clear career pathway to advance practice. This is considered appropriate for Nuclear Medicine practice and future service provision.

Conclusion

Although core competencies for the European Nuclear Medicine Technologist[3] exist, this information and guidance is dated. Given the recent publication of the Darzi report[21] and various modernisation strategies (i.e. The NHS Plan[29]), a new career pathway is required for Radiographers working within this field.

The generic title of ''*Nuclear Medicine Practitioner*'' should be discussed at appropriate strategic levels in order to help clearly define the role of an ''*entry/mid-level*'' practitioner working within this evolving area of clinical practice. A similar model already exists in the USA, whereby a career framework has been developed[30] which encompasses advanced areas of clinical practice.

Increased effort is required to formulate a clear career pathway that provides guidance to existing and newly appointed practitioners within Nuclear Medicine. Evolving technology and clinical techniques requires the skill development of Nuclear Medicine practitioners in order to maintain and further develop holistic patient pathways.

The authors of this article recognise the core competencies outlined in Fig. 1 are the opinions of a regional level group, which were discussed during a programme re-validation event. The core competencies are therefore suggestive and reflect regional considerations.

Conflict of interest statement

The authors confirm that there are no conflicts of interest to declare.

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