Editorial

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Nuclear medicine maintains its dynamic growth, with new applications and technologies emerging. It is therefore opportune that the Journal reviews the main areas of clinical utility. Nuclear medicine encompasses diagnostic procedures, laboratory-based measurements (such as plasma volume, red cell mass, glomerular filtration rate) and therapeutic interventions.

Diagnostic procedures rely on a radiopharmaceutical which will target a specific site, allowing imaging devices to record the 3-D distribution of the tracer on the targeted site. Novel targets for imaging have emerged including labelled glucose for the imaging of cancer, labelled somatostatin tracers for the imaging of neuroendocrine disease and beta-labelled tropane homing on to the dopamine transporter for the investigation of niagrostriatal integrity in patients with movement disorders. Many novel targets are of great interest: progress is expected in the imaging of the Alzheimer plaque, atheroma plaque, angiogenesis and hypoxia – to name just a few.

All diagnostic procedures have benefited from major progress in instrumentation; in the last five years the emergence of multimodality imaging has become routine. Conventional gamma cameras have been linked to advanced computed tomography (CT) scanners (single-photon emission computed tomography (SPECT)/CT) and modern positron emission tomography (PET) scanners to the latest CT devices (PET/CT). The combination of anatomy and function has provided significant growth in the field.

The National Institute for Health and Clinical Excellence has now recognised the importance and utility of myocardial perfusion imaging via SPECT/CT. The Department of Health has announced an expansion programme for PET/CT to ensure rapid deployment of these services throughout England.

The major benefit to be gained from diagnostic nuclear medicine technologies is linked to unique picomolar sensitivity, linked to the specific targeting of radiolabelled ligands. In the next few years, new targets for imaging will enter the clinical arena – some are now in the experimental phase. These novel ligands target *inter alia* the study of angiogenesis, proliferation, hypoxia, apoptosis, the unstable plaque in atheroma, sigma, opiate, glutamate and 5-hydroxytryptamine-2 family of neuroreceptors.

PET/CT has changed the management of cancer. Even with non-specific downstream targeting of glucose, as occurs with PET/CT, there has been a major impact in the staging of cancer, especially in restaging and assessing a patient's early response to treatment. It is now accepted that an early metabolic response to therapy in cancer, as judged by serial PET/CT scanning with labelled glucose, is a good prognostic marker for the evolution of the disease. The technologies of sentinel lymph node (SLN) detection have changed the surgical management of patients presenting with early breast cancer – extensive axillary sampling in the context of a negative SLN result is now considered inappropriate.

In drug development, PET/CT is being used to document tissue penetration, proof of drug mechanisms and disease pattern activity.

SPECT/CT and myocardial perfusion imaging are powerful tools in the assessment of coronary artery disease, stratification of risk and avoidance of invasive coronary angiography. PET/CT applications in cardiovascular medicine are just emerging and a single assessment of risk scores (calcium), myocardial perfusion and metabolism, coupled with non-invasive assessment of the whole coronary tree, are now within grasp.

Nuclear medicine therapy has also seen significant growth beyond the established and well recognised treatment of benign and malignant disease of the thyroid. I-131 therapy is highly effective in the treatment of toxic thyroid nodules and Graves' disease, also in volume reduction of long-standing goiters. I-131 therapy is fundamental to the treatment of differentiated thyroid cancer. When linked to metaiodobenzylguanidine, I-131 is used in the treatment of neuroendocrine malignancies, especially phaeochromocytomas and neuroblastomas. Newer ligands targeting the SS2 receptor subtypes are emerging, labelled with Yt-90, Lu-177 and other radionuclides, in the expectation of better delivery of radiation to the target.

Pain palliation in advanced metastatic and skeletal prostate and breast disease is available and successful; broadly speaking, one-third of patients show excellent response to a variety of radionuclides (Sr-89 chloride, Re-186 as etidronate, Sm-153 as ethylenediaminetetramethylene phosphonate) with surprising little toxicity.

Nuclear medicine therapy has recently proven of great interest in the treatment of relapsed non-Hodgkin's lymphoma. A number of labelled antibodies have been entered in numerous clinical trials and some have now been approved as specific treatment options (Zevalin or Yt-90-labelled ibritumomab tiuxetan and Bexxar or I-131-labelled tositumomab). Again, the toxicity profile of these nuclear medicine therapies is most encouraging. Significant progress is expected in this area, with the ideal protocols and treatment regimens with combined chemotherapy and nuclear medicine therapy being investigated at multiple sites.

Nuclear medicine is alive and well – alas in the UK, in contrast to Europe, it continues to be a neglected Cinderella specialty.