that some expensive imaging modalities may actually save money in the longer-term, when applied properly. Indeed, this stands to reason when it is understood that the cost of an appropriate therapeutic intervention is always high, and so the use of a diagnostic modality to select patients who are going to benefit from a particular intervention will be cost effective.

Preliminary studies have demonstrated this principle in oncology and cardiology, and, moreover, have shown that, moving forward, it should be possible to confirm these principles for the other major fields which benefit from the effective application of diagnostic nuclear medicine: oncology, neurology, cardiology, orthopaedics and infectious diseases.

It must also be stressed that the appropriate use and timing of radionuclide studies is of paramount importance if their cost effectiveness is to be maintained. For instance, nuclear medicine procedures are never applied within screening programmes, as they are very expensive for the healthcare providers; nor are they employed during the last months of a cancer patient’s life, as this is a particularly expensive timeframe. Again, the appropriate use and timing of radionuclides studies is of paramount importance for them to remain cost effective.

With regard to the radiation burden of all imaging modalities, this is a significant concern for both healthcare systems and patients. However, new procedures that are now being applied in diagnostic nuclear medicine and radiology have the potential to significantly reduce the general population’s radiation burden. This is in addition to the many initiatives now in place – driven by both industry and scientific societies alike – to reduce the absorbed dose of radiations without compromising the diagnostic quality.
A further important field of nuclear medicine concerns the therapeutic use of radiopharmaceuticals, within which the same rules must be applied: radiopharmaceuticals must be used when they can be effective and when they can have an impact on patient survival, otherwise they will not be cost effective.

The availability of the necessary human and technological resources for these radiopharmaceuticals to be used remains an issue, however, due to the fact that rules regarding waste management must be implemented and adhered to in order to ensure that the lowest possible environmental impact is made following the administration of these drugs. Nevertheless, radiopharmaceuticals are generally less expensive than many new anti-angiogenic drugs, meaning that there are benefits to be had.

In addition to these diverse issues, problems also exist concerning the approval and reimbursement of radiopharmaceuticals for both diagnosis and therapy. That is, once the European Medicines Agency (EMA) has approved them, radiopharmaceuticals must then be approved by the different national pharmaceutical agencies for clinical use, the only exception being those radiopharmaceuticals that are produced in a hospital's own pharmacy.

These regulatory procedures are both expensive and time consuming and, in many instances, are an obstacle in the way of the increased availability of radiopharmaceuticals throughout Europe.

And the hurdles do not end here, as, after approval, another issue emerges in the form of reimbursement: in many countries, reimbursement does not cover the entire cost of the procedure (the use of radiopharmaceuticals, the technical procedure, the subsequent reporting) and thus makes it difficult for patients to access these diagnostic and/or therapeutic elements. Furthermore, new radiopharmaceuticals are currently encountering increasing difficulties regarding approval for full reimbursement due to budget limitations imposed by the financial crisis. Nevertheless, several scientific societies and pharmacological industries have developed actions aimed towards healthcare payers in order to tackle this issue.

What do you feel needs to be done, from a policy perspective, to ensure the sustainable supply of radioisotopes in the interest of public health? Indeed, what are your views on European policy with regard to nuclear medicine more generally?

The supply of radioisotopes must be guaranteed to ensure the availability of radiopharmaceuticals through Europe. It is well known that the 99m-technetium supply chain passed through a crisis just a few years ago and that another possible crisis has been forecasted to occur within the next few years. This is due to this radionuclide's production system, which relays on old reactors originally designed for research purposes. The problem is affecting the global supply of technetium and will therefore impact on the
availability of technetium-labelled radiopharmaceuticals, which are applied to millions of procedures using single photon emission procedures, such as bone scan or myocardial perfusion studies – known as scintigraphy or SPECT (Single Photon Emission Computed Tomography).

Efforts have already been made to insert new reactors into the supply chain, due to the fact that some of the older ones will soon be decommissioned, but the problem remains that these reactors are very expensive to design, produce and install, and, indeed, it can take many years before they can even begin operating.

The reduced availability of highly enriched uranium is another important issue, and is one which forced reactors to produce radionuclides from low enriched uranium (which has a lower than 20% concentration of $^{235}$U), a procedure that requires investments before being tuned and is much less effective.

Alternative ways of technetium production, using cyclotrons instead of reactors, have been embraced by some governments and have the advantage of being less demanding in terms of investments, but the technological development still needs to be completed.

The real alternative to the technetium shortage is to increase the use of PET radiopharmaceuticals. Most, if not all, nuclear medicine procedures currently being performed with technetium-labelled radiopharmaceuticals can be also be performed with PET.

Positron emitting radiopharmaceuticals have the advantage of being labelled with cyclotron-produced radionuclides, and so will be unaffected by the reactor shutdowns, and several scientific societies, including the European Association of Nuclear Medicine, have suggested that doctors use PET instead of technetium-based scintigraphy for many clinical and research studies.

For instance, in many Western European countries, where PET scanners are available, bone scans can easily be substituted with bone PET. In this scenario, it would also be possible for technetium to be used for very simple imaging modalities, like renal or thyroid scans. In countries where the availability of PET scanners is insufficient to increase the number of studies performed, an effort should be made to increase the number of PET scanners.

Of course, this transition must be made in agreement with governments and healthcare authorities, but it is important that we are prepared for and proactive in our approach to the next technetium shortage, otherwise non-radiouclides techniques, which are much less effective, will come to be proposed.

How do you think the standardising of PET measures of treatment responses can be achieved?

In recent years, imaging standardisation has come to be of paramount importance. With the increased use of imaging in the implementation of personalised treatments, the need for standardised imaging biomarkers has truly become an emergent issue.

PET radiopharmaceuticals are used to select patients who stand to benefit from a particular treatment or procedure and assess how they may respond to a particular therapy, and so it is easy to understand that there is a fundamental need for a robust standard which can be used to compare data from all the centers in which the technology is used.

The way to achieve a standardised PET has already been paved: programmes are in place, one driven by the EANM, to standardised image generation with $^{18}$F-FDG, a sugar analogue that is used in more than 90% of oncological PET procedures. There remains, however, a need to standardise how the images are actually read by specialists when they are evaluating responses in solid tumours, as a criteria only exists for lymphoma. Furthermore, quantitative evaluation also needs to be standardised for different tumour entities.

A strong standard for tumour response assessment must be developed, and this can be achieved by bringing together the many clinical and imaging societies to debate the issue. This model has been used for several clinical applications of PET and will, I have no doubt, work for response evaluation too.

There are countries where the subject of nuclear medicine is either not taught in medical schools or is taught as part of radiology or imaging or as an optional subject. How can the very real issue not only of education but of cross-border inequalities in nuclear medicine be addressed?

Education is one of EANM’s core priorities, and is a concept which spans from medical schools to the continuing medical education of experienced specialists. It is true that in some countries nuclear medicine is not recognised as a separate specialty or educational tract, however, and this is something that needs to be changed.

To effect this change, an effort should be made towards medical students in order to make them aware of the benefits that nuclear medicine can have for patients. This awareness would serve to place nuclear medicine in an increasingly positive light and thus improve its prospective take-up by future generations of doctors, irrespective of the specialty that they are going to choose.

In order for this step to be taken, it is imperative that advanced nuclear medicine departments are represented in every academic hospital in
given that the core of the discipline lies in the use of specific probes which are able to show different processes and gene expressions in the living body.

We do need highly sophisticated scanners to generate images, but they are useless without the right radiopharmaceutical. Multimodality imaging is already the standard in many nuclear medicine departments, and this will expand in the future; single imaging modality will only survive as an exception. Molecular radiation therapy will also benefit from the availability of new, more selective and effective radiopharmaceuticals.

The EANM has several priorities moving forward, including radiopharmaceutical availability; the demonstration of clinical evidence regarding diagnostic and therapeutic modalities; standardisation; and education. These priorities are managed through a strategic plan and will be put forward in partnership with industry, clinical societies and patients’ organisations.

Overall, the EANM will continue to play an important and proactive role in the evolution of nuclear medicine.

**How do you foresee the future of nuclear medicine developing, and what role will the EANM continue to play in its evolution?**

Nuclear medicine will develop thanks to the availability of new radiopharmaceuticals, on the other hand, however, it is not overly important for all imaging modalities to exist as a single track within a medical school. Imaging specialists work very closely together, and multimodality imaging has already become something of an everyday practice for many of them.

We do, however, need dedicated curricula and educational tracks for every imaging branch in postgraduate schools, since the spectrum of medical imaging is so broad that a single specialist would not be able to cover every element in any real depth.

The future will see the emergence of organ-based specialists who are able to take full advantage of every imaging modality, and nuclear medicine will play a prominent role both in this evolution and beyond. Of course, country specific differences will dictate the pace of this transformation.

**Professor Arturo Chiti**  
President-Elect  
European Association of Nuclear Medicine (EANM)

**[Browse](www.eanm.org)**