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CONTROVERSY

EANM–ESR white paper on multimodality imaging

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Abstract
Introduction The introduction of hybrid imaging modalities such as combined positron emission tomography and computed tomography (PET-CT) has altered image analysis and reporting as well as the expectations of the referring physicians. The training in multimodality imaging is unsatisfactory at the moment because no specialisation is adequate for full analysis of the resulting image data. In the recent "White paper of the European Association of Nuclear Medicine (EANM) and the European Society of Radiology (ESR) on multimodality imaging", ways to adjust training opportunities and, thus, to improve the situation were proposed. We think that action is urgently required in order to provide optimal training in multimodality imaging.
Opinion Training in both nuclear medicine and diagnostic radiology should be restructured to allow for optional integrated training in multimodality imaging while maintaining the depth and detail of the individual specialties.
Suggested action We propose criteria for the training in multimodality imaging that can be implemented locally and fast without precluding a yet to be defined regulatory framework.

Keywords PET–CT · Hybrid imaging · Multimodality imaging · Nuclear medicine · Diagnostic radiology

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Introduction

In the recent "White paper of the European Association of Nuclear Medicine (EANM) and the European Society of Radiology (ESR) on multimodality imaging" [1, 2], the implications of the recent introduction of hybrid imaging devices for the practice of nuclear medicine and clinical radiology are presented. The need to update the training curricula in both specialties in order to allow for training in multimodality imaging is recognized, and potential pathways for adequate training are explored. In parallel, imaging research will also have to be updated, according to the authors, in order to use the full potential of multimodality imaging and for Europe to remain competitive.

We think that action along the lines proposed in the white paper is urgently needed, and we would like to offer the view of medical practitioners and researchers who have encountered hybrid imaging, either earlier in their career or later, and have experienced the limitations of the current training and research opportunities.

Learning clinical multimodality imaging

The introduction of hybrid devices, most importantly the introduction of combined PET–CT devices in recent years, has already changed the practice of image interpretation and reporting in many ways.

After the PET–CT scan, both anatomical and molecular information are simultaneously available. Both types of information belong to the same patient, the same clinical question, the same pathophysiological process. There is no natural division between them. It is inherent in human nature to use all information available in the best way possible in order to solve a problem and help the patient. This also

implies that a person training in medical imaging strives to improve his skills and knowledge in all relevant areas.

The bias towards the molecular or morphoanatomical imaging component of a hybrid study comes only with a different background of the person looking at the data. If a person has years of training in one imaging modality but not in the other, a bias is inevitable. There is, of course, a difference in factual knowledge but also a huge difference in culture, attitude and approach to image data. Whereas diagnostic radiology has its foundations in X-ray imaging where morphoanatomical changes associated with disease are depicted, nuclear medicine imaging is mostly based on visualisation of biochemical changes and physiological processes. Even today, this difference characterises the specialisations to a large degree. It can often be observed that the approach of a person with a long experience in nuclear medicine towards PET–CT is to first interpret the molecular data and to refer to the correlated anatomical data thereafter. A radiologist would more likely look at the anatomy first and use the molecular data second. The question is not which of the two approaches is better but whether such a bias is a good thing at all.

For beginners in the field of multimodality imaging, the subdivision between the molecular and morphoanatomical components of hybrid imaging does not come naturally. Today, it can often be painful to reach the hard edges of one's specialty. A novice in either of the specialties, nuclear medicine or diagnostic radiology, is offered a way to become proficient and competent in one part of the examination by way of formal and recognised training but not in the other. Informal and on-the-job gathering of information is a poor substitute. One is always painfully aware that one is prevented from reaching one's own full potential in interpreting hybrid data. We think it is fair to say that in the current situation, a beginner in either nuclear medicine or diagnostic radiology is prevented from mastering hybrid and multimodality imaging. Oddly enough, young people specialising in a clinical speciality such as cardiology have a much better opportunity to do just that. Not everywhere but in many places and increasingly so. They may perform and interpret echocardiography, invasive angiology, nuclear cardiology, magnetic resonance imaging and also computed tomography. So, for true multimodality imaging, a young physician has to choose a clinical speciality.

Competitive environment

The advent of hybrid imaging has not only changed the work of the involved imaging specialists but, probably equally important, has also changed the perception and expectations of referring physicians.

One of the main advantages of hybrid imaging is its potential to yield a final assessment in the report incorporating all available information from molecular and morphoanatomical imaging modalities for every patient immediately and comprehensively. In contrast, the results of a single-modality imaging session often remain both incomplete and vague with respect to the interpretation. Results have to be carried over by the clinician to a second imaging modality for retrospective correlation (often followed later by a discussion in a joint conference). In modern fast-track medicine, where a patient usually stays in hospital for a minimal time, speed is important not only for financial considerations but especially for optimal patient care. If imaging results only become fully available after the patient has left the hospital, they are less likely to contribute adequately to patient management.

So, what might be a luxurious option today, namely the comprehensive report shortly after the examination, will soon become a requirement. In many cases, already today, the referring physician calls the person "responsible for the PET–CT scan" and expects an answer, or the PET-CT images are read after the examination to detect pathological changes that require immediate action. It is not feasible to always have a pair of experts from two specialties at hand to perform these tasks. That would also be too expensive in the long run.

The question is: who delivers? It can only be a person with a sound knowledge in both the molecular and morphoanatomical imaging modalities. That can be a person from the imaging specialities with formal education in both PET and CT, or it can be a clinician with a knowledge and experience in both modalities.

A situation is to be prevented in which multimodality imaging is performed by a person with inadequate training just because this is faster, more convenient and less expensive than having two specialists assessing all image data. Considering the increasing pressure for hospitals to operate economically efficiently, we believe that this danger is real.

We think that the disciplines nuclear medicine and diagnostic radiology can work together in order to define and organise a sound basis for training, as outlined below, that allows us to deliver quality and efficiency in multimodality imaging at the same time.

Research

The same that is true for clinical imaging is also valid for imaging research. The combination of molecular and morphoanatomical information is one of the great opportunities of our time. We are discovering more and more about the relationship of pathophysiological changes on a

molecular and genetic level and how this relates to morphological and functional changes. As was already pointed out in the aforementioned white paper, we cannot afford not to use this opportunity as efficiently as possible. Just as a person in clinical research has to learn about new developments in molecular medicine and the connections to morphoanatomical medicine, the same applies to imaging research. Only a sound understanding of multimodality imaging and the opportunity to deepen knowledge and experience where it is required can lead to optimal results. A researcher who is literally blind in one eye will not see the multidimensional nature of a problem; it does not help if he has a colleague who is blind in the other eye because neuronal connections between two people only go so far. We believe that only institutions that offer their researchers access to all available imaging methodologies can be competitive in the imaging sciences in the future.

Will the difference between nuclear medicine and diagnostic radiology disappear?

We think that the difference between nuclear medicine and diagnostic radiology will not and should not disappear. Not only diagnostic imaging but also radionuclide therapy and interventional radiology are rapidly evolving areas of medicine that promise to be even more important in the future. For nuclear medicine physicians and radiologists the objective should be to bring these methods to their full potential.

This includes the effective application of available routine methods in clinical imaging but also extends to the research, development and application of novel and specialist applications. To achieve this aim, we think that not only are there areas where tighter integration of nuclear and radiological imaging methods in training and application are required but also areas where the complementary tradition, focus and specialist knowledge of the individual specialisations should be maintained for optimal results. The proposed integrated training of nuclear and radiological imaging modalities such as hybrid PET–CT or PET–MRI for clinical routine imaging is an example of the former areas; however, there are also many examples of the latter areas:

- It is clear that radionuclide therapy and interventional radiology require very different skill sets and knowledge. For example, hardly anybody would disagree that an expert in interventional radiology should perform as many interventions as possible in order to improve and maintain his skills and to lower complication rates. This experience cannot be replaced by any number of radionuclide therapies. On the other hand, radionuclide therapies draw on the knowledge of radionuclide production, biodistribution, dosimetry and a large number of other factors that are part of the nuclear medicine expertise. This also cannot be replaced by mastering of catheter techniques.
- Advanced radionuclide and molecular imaging also require the aforementioned skill set pertinent to nuclear medicine, whereas there are also many specialist applications in diagnostic radiology where the specific knowledge and approach of the latter specialisation is needed to give the best results.

All in all, we think that having two specialties with separate deep specialist knowledge in combination with a common set of basic and routine skills for efficient multimodality imaging is the optimal solution. This is the only way to cope with the simultaneous requirement of a general knowledge in routine multimodality imaging and the maintenance of specialist knowledge in a focused field of imaging. Adequacy of knowledge in all areas of imaging is hardly conceivable any more.

What can be done?

At the moment, the only feasible solution to train for integrated multimodality imaging is a sequential specialisation in nuclear medicine and diagnostic radiology, or vice versa. Is that an ideal solution? We think that it is not. First, the physician does not grow up with multimodality imaging but instead with either a focus on morphology and anatomy or with a focus on biochemistry and physiology. During the second specialisation, competency in the primary specialisation degrades. Second, it is a great waste of time. Instead of pursuing a single road, becoming more and more proficient in what one does, time is spent on formal education in areas that will not be relevant in the future. Another important point is that sequential education most often requires a change of institution and, therefore, an interruption of research endeavours, career development and so forth.

We think that the relevant national and European societies of nuclear medicine and diagnostic radiology should strive to find ways to obtain high-quality training in multimodality training in a time-effective manner. In the long run, regulatory frameworks that require a formal discussion and definition are a solution. In addition, we suggest preliminary measures that can take effect immediately. All in all, a roadmap could look as follows:

Immediately:

- All trainings in the field of hybrid imaging (e.g. PET–CT or PET–MRI) where anatomical imaging is intended for diagnostic evaluation and not only for attenuation correction and coarse anatomical correla-

tion should satisfy the standards from both specialisations. That means that one trainee reads both the molecular and the morphoanatomical images, discusses the findings with the respective specialist and writes the report. This may require a term of CT or MRI training for nuclear medicine trainees or of molecular imaging training for diagnostic radiology trainees prior to training in hybrid imaging.

- All studies performed during the training period should be documented and counted, irrespective of the current training program. As an example, a CT study read by a nuclear medicine trainee should contribute towards the required number of studies for a specialisation in diagnostic radiology or one of the yet to be defined programs of multimodality imaging. The same should be true for a radiology trainee reading a PET study.
- All trainees in the field of multimodality imaging should visit relevant lectures and seminars provided by either department.

Prospectively:

- Requirements and programs for complementary training in hybrid imaging for people who have already specialised in either nuclear medicine or diagnostic radiology should be defined and implemented.
- A common trunk of basic training where the trainee is acquainted with the basic knowledge of both molecular and morphoanatomical imaging, learns to operate the respective equipment and becomes confident in performing and interpreting the common indications should be agreed. Interventional radiology, radioisotope therapies, specialist imaging applications and so forth should be left for a second specialisation phase in either diagnostic radiology or nuclear medicine.

We are aware that training in multimodality imaging can extend the time of training; however, this increase in total training time should be kept to a minimum. The advanced training in multimodality imaging should remain optional. It should be possible for trainees in either nuclear medicine or diagnostic radiology to specialise in areas different from multimodality imaging where a simpler set of knowledge in multimodality imaging, as is already part of most training curricula, is sufficient.

Conclusion

Training in nuclear medicine and diagnostic radiology should provide the option for multimodality imaging. The task is to define the necessary common skills for efficient routine multimodality imaging while maintaining and strengthening the depth and focus the individual specialties. Pending a defined training curriculum, every trainee working with hybrid imaging modalities should have the opportunity for adequate and recognised training in both components of hybrid imaging.

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