Is hybridic positron emission tomography/computerized tomography the only option? The future of nuclear medicine and molecular imaging

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Abstract

As we all know, Nuclear Medicine is the medical science using nuclear radiation for diagnosis, treatment and research. Nuclear Medicine, in contrast to Radiology, makes use of unsealed sources of radiation. Nuclear Medicine a few years ago has partly offered Nuclear Cardiology, the most lucrative of all Nuclear Medicine "children" at that time, to Cardiology. Radiology, has succeeded in being recognized by the European Union Authorities as Clinical Radiology. The word "clinical" offers greater independence to Clinical Radiology and makes it difficult for such a specialty to relinquish any of its equipment i.e. the diagnostic CT scan or the newly developed fast angiography CT, to other specialties. Contrary to Clinical Radiology, Nuclear Medicine being a laboratory specialty in most countries, seems to have no right to deny offering, after some period of "proper certified education", its PET camera to Clinical Radiologists. Nuclear Medicine by vitrue of its unique diagnostic techniques and treatments, is and should be recognized as a "Clinical Specialty" The interference of other specialties in the fields of Nuclear Medicine is also indicated by the fact that in vitro techniques of Nuclear Medicine are often used by Endocrinologists and Oncologists in their own laboratories. Also in some hospitals the Director of the Radiology Department acts as the Director of Nuclear Medicine Laboratory. Finally at present, Radiologists wish after "proper certified education", to be on equal terms in charge of the new hybridic equipment, the PET/CT scanner. If that is allowed to happen, Nuclear Medicine will be in a difficult position losing at least part of PET and consequently should ask for help from its "Overlords and Protectors" i.e. the National and the European Societies of Nuclear Medicine and the Society of Nuclear Medicine of the United States of America. Radiology as a specialty participating on equal terms with the PET camera, will then include the study of: a) "open sources of radiation" b) nuclear radiation and c) molecular nuclear medicine. The "European Journal of Nuclear Medicine and Molecular Imaging" shall have to erase the three last words of its title and be renamed. As Professor Abass Alavi et al (2007), have mentioned: "Is PET/CT the only option?" In favor of PET/CT are the following: Attenuation correction (AC) and better anatomical localization of lesions visualized by PET. Also PET/CT can be used as a diagnostic CT scanner (dCT). Against using the PET/CT scanners are the following arguments: a) This equipment is not necessary because we can always ask the Radiologists for a dCT scan. Many patients have already done a dCT scan at the time they are referred for a PET scan to the Nuclear Medicine Department. b) The absolute clinical indications for PET/CT with the use of a contrast agent, are under investigation. c) Although there is at present a list of indications suggested for the PET/CT scanner, there are studies disputing some of these indications, as for example in metastatic colon cancer where a high diagnostic accuracy for PET study alone, has been reported. d) The option of AC performed by the PET/CT scanner has also been questioned. Artifacts may be up to 84%. e) The PET/CT is expensive, time consuming, space occupying, and needs additional medical and technical personnel. f) Not to mention the extra radiation dose to the patients. g) Shall we inform those young medical students who wish to become nuclear medicine physicians, to hold their decision till the content of future Nuclear Medicine is clarified? *We may suggest* that: Our specialty could be renamed as: "Clinical Nuclear Medicine" and include additional "proper certified education" on the PET/CT equipment. The PET/CT scanner should remain in the Nuclear Medicine Department where Radiologists could act as advisors.

Keywords: – Separate PET studies – Separate CT studies – Advantages of PET/CT – Another option – Disadvantages of PET/CT

As we all know, Nuclear Medicine is the medical science using nuclear radiation for diagnosis, treatment and research. Nuclear Medicine, in contrast to Radiology, uses unsealed sources of radiation. The discipline of Nuclear Medicine appeared as a new and very promising medical specialty about 60 years ago. Recently Nuclear Medicine is facing substantial problems some still unsolved, that may weaken its diagnostic and therapeutic content and minimize its position in the field of Medicine. The present situation of Nuclear Medicine seems to resemble that of a family with many well standing children; in this family the mother Nuclear Medicine is asked by other specialties, to offer her own children i.e., methods and techniques that belong to Nuclear Medicine, for partial or for complete adoption.

For example, Nuclear Medicine has partly relinquished only a few years ago Nuclear Cardiology, the most lucrative of all Nuclear Medicine's children at that time, to Cardiology. Cardiologists, in some countries, besides their clinical duties and after "some period of certified education", can now perform Nuclear Cardiology studies in addition to Cardiac Ultrasound,

Diagnostic and Therapeutic Angiography. Nuclear Medicine physicians can still do Nuclear Cardiology studies but of course these studies are now fewer in number. Some may say that this is to be expected i.e. that Nuclear Medicine is not a clinical entity and thus should remain in a strictly laboratory role, auxiliary to clinical specialties. At present though, this is not the case in some European countries where nuclear medicine physicians do practice Clinical Nuclear Medicine, attending the patients they treat with radio-nuclides and co-discuss the follow-up of these patients with the relevent primary clinicians. Contrary to what happens in Nuclear Medicine, Radiology, being related to Nuclear Medicine but dealing with different kinds of radiation, has been recognized by the European Union Authorities as Clinical Radiology. The word "clinical" offers independence to Clinical Radiology and seems to make it more difficult for such a specialty to offer its equipment i.e. part of the hybridic positron emission tomography/CT, (PET/CT) scanner or the newly developed fast angiography CT, to other related specialties. On the contrary, some may say that Nuclear Medicine has no right to deny offering its PET camera, after some "period of certified education", to Clinical Radiology. The question appears unbiased: Is Nuclear Medicine a "Clinical Nuclear Medicine" discipline? There is no doubt that the "functional, molecular, diagnostic and therapeutic role" of Nuclear Medicine is much more sophisticated and equally important to Clinical Medicine, as the overall diagnostic and therapeutic part of Clinical Radiology.

It is not only cardiac studies that Nuclear Medicine has offered to Cardiologists. Endocrinologists and Oncologists often use the in vitro Nuclear Medicine techniques in their own laboratories, mainly for thyroid or for malignant diseases.

Nuclear Medicine is considered "a closely related specialty to Radiology" in some hospitals and the Director of Radiology Department acts also as the Director of the Nuclear Medicine Laboratory, the last being considered rather as a subdivision of the Radiology Department. Please note the terms: Radiology Department, Clinical Radiology versus Nuclear Medicine Laboratory.

Few years ago, the question arose as to whether Mother Nuclear Medicine should give again, the best of her children for partial or for complete adoption, this time to Clinical Radiology. Now Radiologists wish after "proper certified education", to be on equal terms in charge of the new hybridic equipment, the PET/CT scanner. The next obvious step is that the PET/CT equipment will be removed into the Clinical Radiology Department, close or at some distance from the Laboratory of Nuclear Medicine, under the Directorship of the Radiology Department, having perhaps at the beginning a Nuclear Medicine physician as a consultant. If that happens, what shall remain for Nuclear Medicine? Mother Nuclear Medicine in view of losing again a major part of her family which is the PET camera, seems to be very sorry and asks for the help of her "Overlords and Protectors" i.e. the National and the European Societies of Nuclear Medicine and the Society of Nuclear Medicine of the United States of America. Is this appeal going to work? Or shall we fail again? In case PET camera in the form of the hybridic PET/CT equipment becomes eventually part of Radiology, Radiology as a specialty will then additionally include the study of: a) "unsealed sources of radiation" b) nuclear radiation and c) molecular nuclear medicine. The "European Journal of Nuclear Medicine and Molecular Imaging" shall have to erase the three last words of its title and be renamed as: "European Journal of Nuclear Medicine" or perhaps "European Journal of Nuclear Radiology". On the other hand, do we think that Clinical Radiologists will be happy to realize that they must add this large part of Nuclear Medicine education to their already very heavy diagnostic curriculum?

As Professor Abass Alavi and his colleagues have mentioned (2007) [1]: "Is there another option than PET/CT?" Are there enough reasonable clinical benefits for urgently introducing and using CT by the PET/CT hybridic equipment? The PET camera was introduced in 1970 and only in about 1998 its clinical indications were well described. The PET/CT scanner has been developed in 2001 and its indications are still discussed. The main benefits for PET/CT are: Attenuation correction (AC) and better localize anatomically (A) PET lesions: (the PET/CT, AC/A) scanner. Also, the PET/CT can be used as a PET/CT diagnostic CT (dCT) scanner. Against considering the use of the PET/CT scanner at present, are the following: a) One can always ask the Radiologists for a dCT scan. There are plenty of dCT scanners around Europe and the U.S. Greece has more dCT scanners than necessary. In practice, many patients have already done a dCT scan at the time they are referred to the Nuclear Medicine Department for a PET scan [1]. In "Evangelismos" hospital in Athens, 286 out of the first 300 patients referred for a PET scan, had already performed a dCT scan. The actual dose of a dCT scan is about 25 mSv while the dose of the AC/A CT scan is 3-5 mSv. b) The absolute clinical indications for the PET/dCT are also under investigation. c) The diagnostic value of the dCT scan without the use of a contrast agent, has a low sensitivity and specificity offering perhaps no more information than a PET study alone, while there is no general agreement as to what are the indications for the use of the contrast agents [1]. d) It is considered that the PET/CT scanner is diagnostic for the evaluation and follow up of metastatic disease, orthopedic infections, inflammatory disorders, some biopsies, radiation field and surgery planning, while is not indicated for cardiac, central nervous system disorders like Alzheimer's and Parkinson's disease, seizures, head injuries and inoperable brain tumors [1, 3-5]. There are recent studies disputing some of the above indications i.e. reporting that in colon cancer metastases, the PET study alone offered a very high diagnostic accuracy [6, 7]. e) The option of AC performed by the PET/CT scanner by using transmission X-rays has also been questioned because: (a) It gives up to 84% artifacts mainly at the diaphragmatic area and (b) Although saving some 25 min of the study time, does not add enough to the PET picture as compared to the previous AC performed by germanium-68 or cesium-127 [1, 2, 8, 9]. f) The PET/CT is a more complex piece of equipment than the PET camera, more expensive, time consuming,

space occupying, that needs additional medical and technical personnel. g) The use of the hybrid system gives rise to an extra radiation dose which in pediatrics may be considerable [1, 5, 10, 11]. h) In the near future matching the electronics of the PET and the dCT images performed alone, could be a good diagnostic procedure for the patients [1]. The actual case of having an extra PET/CT, dCT scanner besides the independent dCT scanner, reminds us of a husband who gets to know a second wife being afraid that his first wife would die. Eventually, his second wife dies first. Also, reminds us of someone carrying two umbrellas for better protection from the rain.

If PET is adopted by Clinical Radiology, routine Nuclear Medicine shall be left to deal, besides the therapeutic part, with the SPET scans, the functional studies and some auxiliary laboratory tests. Is that very pessimistic? If not, shall we inform those young medical students who wish to become nuclear medicine physicians, to hold their decision till the content and the future of Nuclear Medicine is clarified? Of course these medical students could always become Clinical Radiologists, or perhaps in the future Nuclear Radiologists. But will that solution help Diagnostic and Therapeutic Clinical Medicine? Following this pessimistic procedure, quite a few educational, research, diagnostic, therapeutic and of course financial medical issues will arise. As was mentioned before even the Clinical Radiologists may not like such an increase of their curriculum.

Nuclear physicians are more than any other physicians aware of human anatomy and in many countries, as is the case in Greece, all nuclear physicians have already studied for 6 months in a Radiology Department and have acquired enough additional experience of the anatomy of the tomographic CT images, in addition to the experience they already have as physicians by routinely reporting the SPET and PET tomographic images. *In conclusion.* Based on the above, we may suggest that: a) The PET/CT equipment should not without further discussion, replace the PET and the dCT used alone scanners. Matching the electronics of these separate tests is a good diagnostic procedure for the patients. b) We strongly believe that PET/CT equipment should remain for reasons of: better "knowhow", radiation protection, licensed area, personnel etc, at the premises of the Nuclear Medicine Department. If a dCT scan is suggested, the Radiologist shall be asked to act as an advisor, as is now the case with the Cardiologist. c) In the future, it would be reasonable to call our specialty "Clinical Nuclear Medicine", which will include "proper certified education" on the PET/CT scanners. Our National, European and the US Nuclear Medicine Societies could help on this matter. Of course, any Radiologist or any physician could eventually and officially become a Clinical Nuclear Medicine physician. The above could treat all possible problems mentioned above, save the independence of Nuclear Medicine as a specialty and offer better diagnostic facilities to the patients. "Better complete than destroy", as The Lord said.

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