Who Should Read and Interpret ^{18}F-FDG PET Studies?

Currently, PET is one of the most exciting imaging modalities in clinical practice. Although PET is a new addition to the imaging facilities of many institutions, it is not a new technique. In fact, the first images with positron-emitting radiopharmaceuticals were obtained decades before the advent of CT, MRI, or ultrasound. Why then is PET only now becoming a routine diagnostic procedure? Several factors have contributed to this lengthy maturation process. The first of these is that the high cost and complexity of the cyclotron facilities required for production of PET radiopharmaceuticals prevented implementation of the technology at all but the largest academic medical centers. Second, regulatory issues prevented approval of PET radiopharmaceuticals for clinical application. A third factor is that, because of limitations in computer technology, early PET systems had small fields of view and were restricted to imaging of the central nervous system. Finally, third-party reimbursement was not available for PET studies.

Clinical PET was born in neurology and provided many important insights about the function of the central nervous system. As imaging systems with larger fields of view were developed, PET expanded into cardiology and made important contributions to our understanding of cardiac physiology and pathophysiology. However, the realization of the importance of PET in oncology, particularly with ^{18}F-FDG, a tracer of glucose metabolism, was the key development in modern implementation of the technology. The relatively long physical half-life of ^{18}F (~110 min.) allowed for the development of regional radiopharmaceutical distribution facilities that eliminated the need for each PET center to have its own cyclotron facility, and in 1997, the restrictive Food and Drug Administration regulations governing the manufacture of PET radiopharmaceuticals were relaxed. Also, advances in detector and computer technologies provided PET instruments that are suitable for whole-body imaging. Perhaps of greatest importance, over the past several years PET studies for numerous applications in oncology have been approved for third-party reimbursement. Because of these developments, in 2001, the 2 major instrument manufacturers installed more PET imaging systems than the total number that had been in service until that point.

In the early years of PET, the technique was not even on the radar screen of radiologists or oncologists and many nuclear medicine physicians scoffed at PET, calling it impractical, too expensive, and overly complex. In this context, we owe a great debt to a small group of true believers in PET technology who kept the lights burning through years of adversity and uncertainty. The technical, regulatory, and financial hurdles related to the widespread implementation of clinical PET have been resolved. However, one key issue remains—"turf." Which medical specialty will read and interpret clinical PET studies in oncology? Will it be nuclear medicine physicians, radiologists, or oncologists? Because PET studies currently have the highest reimbursement rate for any diagnostic imaging procedure, this is a particularly important issue for physician groups, which own the imaging facilities and thus bill for the technical component of the study. Because PET incorporates radionuclides, a case can definitely be made for nuclear medicine physicians to be the primary readers of PET studies. This case is reinforced by the fact that these individuals are the physician group most familiar with the principles of tracer kinetics. However, the anatomic resolution of ^{18}F-FDG PET, although significantly greater than that of any other procedure in nuclear medicine, is still less than perfect and study interpretation often requires detailed comparisons with imaging studies with greater anatomic fidelity (CT, MRI, and ultrasound). Because proficiency with these techniques is not usually within the scope of expertise of nuclear medicine physicians, they have a disadvantage.

In the case of radiologists, the issues are different. These physicians are well versed in the intricacies of anatomic imaging, but their limited training in nuclear medicine leaves most radiologists relatively weak in their knowledge of tracer kinetics and mechanisms of localization. Although oncologists are the physicians most well versed on the clinical issues directly related to cancer patients, as a group they have not assumed the role of primary interpreter of the CT or MRI studies of their patients, and unfortunately, this is unlikely to change with PET.

Thus, it comes down to whether nuclear medicine physicians or radiologists will interpret the studies. This issue has become further complicated by the recent introduction of hybrid PET/CT imaging systems. With these devices, PET and CT images are acquired sequentially in a common gantry and are in close anatomic registration. For interpretation of a PET study,

Received Mar. 20, 2003; revision accepted Mar. 27, 2003.

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the images are usually displayed on a workstation in 2 formats—as rotating maximum-intensity-projection images and in transaxial, coronal, and sagittal projections or multiplanar reformations. By a mouse-click at the site of a suspected lesion on one of these projections, the position of the lesion on the other projections is displayed. With PET/CT, the anatomic position of the lesion is also displayed on the corresponding CT projections. Thus, when the study is reviewed by a nuclear medicine physician, the observer is directed from the PET study to the CT locus. Clearly, this reduces the level of CT interpretation expertise that is required. In contrast, when a radiologist is interpreting the CT study of a cancer patient, clicking on a CT lesion will display the corresponding locus on a PET study. Although, in many situations, this approach will certainly aid interpretation of the CT study, should the radiologist also interpret the PET study? The answer is probably not, since in numerous cases ^{18}F-FDG–avid lesions do not have clear anatomic correlates. Also, a second level of turf issues can occur in radiology departments that are subspecialized by organ system. In this situation, if a chest radiologist is interpreting a chest CT study and an abdominal radiologist is interpreting an abdominal/pelvic CT study, and both physicians access the PET data, which subspecialist will interpret the PET study? Unlike CT and MRI, for which images of specific anatomic regions constitute individual studies and are reported and billed separately, for PET only a single billing is allowed. Also, how will PET lesions in regions of the body for which anatomic imaging studies were not obtained be evaluated? Will chest and abdominal radiologists ignore lesions in the head and neck region and extremities?

At Massachusetts General Hospital, we have been applying a team approach to interpreting ^{18}F-FDG PET studies of cancer patients. In this model, each study is reviewed by a nuclear medicine physician and radiologists subspecialized in chest and abdominal/pelvic imaging. For specific issues of head and neck and muscular skeletal tumors, additional subspecialty radiologists are consulted. Each physician contributes expertise improving the interpretation and teaching each other in the process. Moreover, the organ system radiologists are proving to be an important interface for instructing clinicians about the utility of PET. Clearly, compared with general nuclear medicine physicians and general radiologists, subspecialty radiologists have a greater knowledge base on the diseases of their organ system of interest. Although this approach is ideal and can be applied at other large, subspecialty-organized radiology departments, it is not practical for smaller departments.

Thus far, we have concentrated on interpretation of ^{18}F-FDG studies. However, contrary to the opinion of most radiologists and many nuclear medicine physicians, PET is not spelled *F D G*. In fact, ^{18}F-FDG is only one of a vast and nearly limitless array of PET radiopharmaceuticals. For example, ^{18}F-fluoride was one of the earliest tracers applied for skeletal imaging and enjoyed limited application in the era of the rectilinear scanner. However, with the introduction of the Anger camera and ^{99m}Tc-labeled diphosphonates, superior-quality images could be obtained by single-photon imaging. With modern whole-body PET systems, the situation has reversed and skeletal images of much higher resolution can currently be obtained with PET. When hybrid PET/CT systems are used, greater anatomic differentiation of lesions is also possible. Because ^{18}F-fluoride is quite inexpensive to produce and imaging times can be significantly reduced by PET/CT, PET skeletal scintigraphy may become cost competitive with single-photon techniques. The issues relating to the interpretation of ^{18}F-fluoride bone images are the same as for ^{18}F-FDG studies in oncology. Will the images be interpreted by nuclear medicine physicians, skeletal radiologists, or general radiologists? ^{18}F-FDG and ^{18}F-fluoride are only tips of the vast iceberg of PET radiopharmaceuticals that can be substituted for single-photon agents to yield higher-resolution images with greater quantitative fidelity and anatomic definition. If, in an extreme case, all current single-photon nuclear medicine studies were replaced by PET procedures, who would read and interpret the data? If radiologists choose to compete in this area, they will have to become experts on the pharmacokinetics and imaging properties of numerous tracers and will effectively become nuclear medicine/radiology dual specialists. In contrast, for nuclear medicine physicians to remain significant players as PET evolves, their training must be expanded to include significant experience with the anatomic imaging modalities. In our opinion, it will be easier for nuclear medicine physicians to develop a working knowledge of anatomic imaging than for radiologists to become experts on the vast array of current and potential PET tracers.

Another important consideration in determining who will read PET studies is training; that is, how will it be determined whether an individual imaging specialist is competent to read and interpret PET studies? Because few radiologist or nuclear medicine physicians had significant exposure to PET studies with ^{18}F-FDG or other tracers during residency or fellowship training, what criteria and mechanisms will be used to establish proficiency? It would appear that anyone working in PET would benefit from more training.

Who will perform the advanced PET imaging studies that require multiple tracer injections, arterial blood sampling, analysis of plasma concentrations of tracer metabolites, and detailed kinetic modeling? Because neither radiologists nor the majority of nuclear medicine physicians currently interpreting ^{18}F-FDG PET studies has significant experience with these techniques and the procedures are not covered by third-party payers, it is highly unlikely that turf issues will arise in this area.

In summary, it appears that 3 practice models are evolving for the interpretation of PET studies. In large, in-

tegrated, subspecialty-structured radiology departments, the team approach that employs both nuclear medicine physicians and subspecialty radiologists will flourish and both groups will gain crossover experience. This approach clearly focuses the highest concentration of imaging talent on the clinical problem at hand. In hospitals where nuclear medicine sections are not well integrated into subspecialty radiology departments, it is likely that nuclear medicine physicians will be the primary readers of PET studies. In contrast, in community hospitals and private practice groups where radiologists who are not subspecialty trained in nuclear medicine interpret conventional single-photon studies, these activities will be expanded to include the interpretation of PET studies. Clearly, each of these models has advantages and disadvantages for the patient populations being served. Only time can determine the relative impact of each approach on clinical practice.

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