Q&A: Perspective on Pediatric Nuclear Medicine

Michael J. Gelfand, MD, is chief of the Section of Nuclear Medicine at Cincinnati Children's Hospital Medical Center (OH) and a past president of SNM. He co-edited the 1994 text Pediatric Nuclear Imaging *and has published more than 100 articles and 30 book chapters. Newsline spoke with Gelfand about the current status and future of pediatric nuclear medicine in the United States.*

Newsline: What do you personally consider to be the biggest "stories" in contemporary pediatric nuclear medicine? What innovations are the most promising?

Gelfand: The number 1 innovation on my list is ^{18}F-FDG PET. Almost every non–central nervous system solid tumor that we see in children and adolescents has high avidity for FDG. ^{18}F-FDG PET imaging is ready to move into a major role in pediatric oncologic imaging. This is already occurring with both Hodgkins' and non-Hodgkins' lymphoma. The challenge will be to extend ^{18}F-FDG PET imaging to less common pediatric solid tumors and to include ^{18}F-FDG PET imaging as a mainline diagnostic imaging technique in as many as possible of the multicenter cancer treatment protocols for solid tumors.

A few other areas of innovation are notable. PET/CT is taking over from PET, just as in adult nuclear medicine. PET radiopharmaceuticals other than ^{18}F-FDG are of considerable interest. ^{18}F-fluoride has been used for bone scans in children at Boston Children's Hospital. ^{11}C-methionine has been used for brain tumor imaging in children in Turku, Finland. In body imaging, we have not yet found another general purpose radiopharmaceutical that is as good as ^{18}F-FDG for tumor imaging, but we should keep looking. In the brain, we should be able to improve on ^{18}F-FDG. We will find other radiopharmaceuticals that are potentially useful in children; the challenge will be to study these radiopharmaceuticals and establish clinical roles for them.

Then there is the whole question of molecular imaging—finding ways to use PET imaging in children that take advantage of the vast amount of knowledge that has been gained about the control of normal and abnormal processes in the body. Accomplishing this goal should allow us to use PET imaging to answer many more diagnostic, therapeutic, and research questions.

A final area of innovation is in cancer therapy. ^{131}I-metaiodobenzylguanidine is gaining a role in the treatment of advanced neuroblastoma, and it is possible that the anti-CD20 therapeutic agents will be used in the future in pediatric B-cell lymphomas.

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Newsline: Our colleagues in radiology have been confronted in the past 5 years with well-publicized studies indicating that pediatric exposure in routine CT examinations has often been considerably higher than required for quality imaging. Yet we don't hear that much about this topic in nuclear medicine. Now that hybrid imaging is securing a place in the nuclear imaging suite and also with the advent of new and more effective therapies, is this a topic that should be brought more to the forefront in nuclear medicine?

Gelfand: Diagnostic CT is a major source of medical radiation exposure in children and adolescents. My colleagues at Cincinnati Children's Hospital have been leaders in dose reduction in pediatric CT, lowering beam current levels (mAs) to the lowest levels that are consistent with high-quality CT imaging. In general, dose reductions of about 50% have been achieved. Over the last 5 years, application of such lower dose levels has spread steadily from leading pediatric hospitals to other medical centers.

A tougher question is utilization. The number of CT examinations in children has grown rapidly. Some of this expansion is appropriate. At our hospital, a review of CT studies performed to rule out appendicitis indicated that our utilization was appropriate. But utilization should be monitored everywhere, formally or informally.

In nuclear medicine, the administered activity determines the radiation dose. Beginning 25 years ago, a number of physicians experienced in pediatric nuclear medicine have regularly published lists of suggested administered activities, usually based on weight, for pediatric nuclear medicine imaging. In the area where I live, it appears that word got out, because for the last 10 to 15 years, when we receive studies from other hospitals, the administered activities are usually reasonable.

The arrival of hybrid imaging, including PET/CT and SPECT/CT, is another challenge. At our hospital, the effective dose for a "low dose" diagnostic CT for a study of the chest, abdomen, and pelvis is about 50% higher than the effective dose for the ^{18}F-FDG PET scan. The effective dose for a "localization" CT scan at minimum exposure settings is about 30% to 50% less than the PET scan, and

the effective dose for an attenuation-only scan is very low. As PET moves from oncologic imaging into imaging of benign conditions, how we perform the CT part of the PET/CT will be the most important determinant of total effective dose from the procedure. The same is true for SPECT/CT with ^{123}I- or ^{99m}Tc-labeled radiopharmaceuticals.

The good news is that, as we move studies from ^{67}Ga imaging to ^{18}F-FDG PET, the effective radiation dose received by the patient from the radiopharmaceutical will fall significantly.

Newsline: It has been difficult to perform nuclear medicine research in pediatric patients because of limitations on radiation exposure. How can progress in adult nuclear medicine and basic research be translated to aid children with serious diseases? Should we urge the research community and regulatory bodies to endorse conscientious but extended nuclear medicine research in this population?

Gelfand: The performance of research studies in children and adolescents with new radiopharmaceuticals is a big problem. Everyone is aware of the incredible surge in knowledge in human molecular biology. This knowledge base is being constantly applied in pediatrics. The opportunities for research in molecular imaging are immense, but the barriers are high. In the United States, initial studies in adults can often be performed using the Radioactive Drug Research Committee (RDRC) mechanism. The current RDRC regulations have limited pediatric dose levels to 10% of those allowed in adults, which is too low to allow research studies with PET radiopharmaceuticals. We want to limit radiation dose in the pediatric population. However, useful research has been hampered by limits that may be appropriate for the general pediatric population but too restrictive for children with cancer and other serious diseases associated with shortened lifespans. The U.S. Food and Drug Administration (FDA) is currently working on a revision of the RDRC regulations. The pediatric nuclear medicine community in the United States has asked the FDA to liberalize the RDRC regulations to allow somewhat higher radiation doses for research in children with cancer and other diseases with reduced life expectancy, in order to facilitate research with PET radiopharmaceuticals in children with these diseases.

Research in the United States can also be performed under an Investigational New Drug (IND) exemption. The FDA has made real efforts to facilitate IND applications. Still, an IND application requires more effort for the investigator than an RDRC application, and, in some cases, the supporting data for an IND application cannot be acquired at reasonable cost.

Newsline: The numbers of individuals who have devoted their careers to pediatric nuclear medicine is relatively small (perhaps in part because of the long-held notion that children's nuclear medicine should be merely a titrated version of adult diagnosis and therapy). Should we as a profession be encouraging more of our trainees to focus on this area of practice?

Gelfand: If nuclear medicine is going to move forward in the United States, with high-quality, proactive teaching, there must be well-trained individuals practicing nuclear medicine at academic medical centers and major hospitals. These are the people who can teach nuclear medicine, and some of them will be clinical researchers as well. They are in short supply. In pediatric nuclear medicine, the shortage is even more acute. Many of the leaders at the major children's hospitals in the United States recognize that it is important to have an academic and research leader in nuclear medicine in their departments, but we need to train additional leaders. We need to encourage physicians who are going into nuclear medicine to train themselves for academic careers, and, particularly those who are going into pediatric radiology, to seriously consider additional training in nuclear medicine. In reality, the physicians who currently practice nuclear medicine must provide the inspiration to the next generation of physicians to become the future leaders.