The New Molecular Medicine

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"Two roads diverged in a wood, and I—I took the one less travelled by,
And that has made all the difference."
Robert Frost

My good friend, Doug Maynard, wants a new direction for nuclear medicine. So do I, but along a different road from that proposed by Doug.

We are traveling down a road leading to a new nuclear medicine, an independent specialty, based on the concept that diseases can be characterized by in situ molecular abnormalities. Advances in our understanding of intra-and intercellular communication will revolutionize the practice of medicine. Diagnoses will be molecular, treatment will be molecular and monitoring the response to treatment will be molecular.

In the late 1960's and early 1970's, Merrill Bender, Joe Ross, Dave Kuhl, Dub Tauxe and others from a variety of medical specialities struggled to have nuclear medicine recognized as an independent specialty. We succeeded in founding the American Board of Nuclear Medicine, but our joy was dampened when we learned that there would be an alternative pathway. "Grandfathering" into the specialty of nuclear medicine would require simply passing a written examination. Thereafter, three months of training in nuclear medicine would qualify radiologists to practice nuclear medicine as well as radiology. Experience has shown that this amount of training is inadequate as the complexity of nuclear medicine continues to increase, for example, in the development of nuclear cardiology, positron emission tomography and single-photon emission computed tomography. What should be done?

Should nuclear medicine be: (1) a subspecialty of radiology; (2) a part of several organ-oriented specialties, such as cardiology and neurology; or (3) an independent specialty, based on the tracer principle and applying advances in the basic sciences of physiology, molecular biology, genetics and biochemistry to the care of patients and the study of human disease? I am in favor of the latter direction, lest nuclear medicine become fragmented and neglected, or, at least, be the low man on the totem pole.

In Japan, organ-oriented physicians perform nuclear medicine procedures as part of their practice. In the United States, we seem to be moving in that direction. Half of the nuclear medicine studies on out-patients are performed by specialists other than radiologists or nuclear medicine physicians. In sharp contrast, throughout the European community, nuclear medicine has been recognized officially as an independent specialty. In countries such as France, government regulations limit the practice of a physician to one specialty. Thus, in Europe nuclear medicine is likely to grow and flourish as an independent specialty.

In the United States, many young radiologists enter an additional year of training in fields such as neuroradiology, pediatric radiology or cardiovascular/interventional radiology. Organized (ACR) and academic radiology (SCARD) encourage radiologists to perform nuclear medicine procedures as part of their organ-oriented subspecialty. As Doug stated: "Many radiologists will want to participate in the performance and interpretation of nuclear medicine studies." We live in an age of specialization, where it is not possible for a radiologist to keep up with advances in all imaging specialties.

What is wrong with making organ-oriented specialists expert in nuclear medicine? Why not? Because an orientation toward a single organ or organ system, whether by a radiologist or anyone else, is based on an out-dated concept of medicine and disease. Disease does not involve single organs, but involves the integrated biology of the entire body. An example is the viewing of arrythmias of the heart as a problem in intercellular communication, today an important focus of nuclear medicine research. Cancer is no longer thought of as a disease of a specific organ, but as a failure and imbalance of growth-promoting and growth-suppressing factors, such as somatostatin. Analogs of the latter, labeled with $^{111}$In, are able to characterize subsets of many types of cancer.

Modern scientific medicine is moving away from an
organ orientation, and is advancing by leaps and bounds through a holistic approach to disease, exemplified by revolutionary advances in human genetics, immunology, oncology, endocrinology, neuropsychiatry and molecular biology, all of which are holistic approaches to disease. The new, integrated, global approach of nuclear medicine goes beyond anatomy and gross pathology to physiology and molecular medicine. In the future, localized diseases are likely to become the exclusive domain of surgeons, a field in which an anatomical orientation will continue to advance dramatically through advances in anatomical and pathological imaging.

In the practice of molecular medicine, patients’ problems can be viewed as molecular dysfunction, not structural abnormalities (structure and function converge at the molecular level). Molecular “slices of life” provided by nuclear medicine will join histopathology as a way to characterize disease.

Doug has reorganized his department into organ system divisions, including neuroradiology, cardiovascular/interventional and abdominal radiology. He has “dismantled sections of ultrasound, magnetic resonance imaging and computed tomography.” How long will it be before he has dismantled nuclear medicine, a course of action being taken by many radiology chairmen, and contemplated by others? They just don’t seem to be able to dismantle nuclear medicine without the deficiencies in this approach becoming apparent.

Why have Doug and other chairmen of radiology departments found it difficult to recruit residents into nuclear medicine? The bright young men and women in radiology today do not suffer from “mural dyslexia.” They can read the handwriting on the wall. They recognize that nuclear medicine plays a secondary role in American radiology departments. They do not opt for nuclear medicine, despite the excitement, inventiveness and progress being made in nuclear medicine, as indicated by the high quality and importance of the papers being presented at the annual meetings of the Society of Nuclear Medicine. These advances are what make cardiologists, neurologists, oncologists and other specialists so eager to take over nuclear medicine procedures. Radiology residents will not be attracted into nuclear medicine by cajolery. This continuing failure will lead to a vacuum, which, if not filled by nuclear medicine experts, will be filled by cardiologists, neuropsychiatrists, oncologists and other specialists.

As I have visited nuclear medicine departments in the United States and many other countries, I have seen the progress being made by specialists in nuclear medicine working closely with other specialists, such as cardiologists. Sound bridges can be built between solid pillars, each specialist respecting the essential role played by other specialists. As in the past, some young cardiologists and neurologists will choose to convert to fully-trained nuclear medicine physicians, just as endocrinologists and others did in the early days of nuclear medicine.

In Europe now and, I hope, in the United States soon, nuclear medicine will become an independent specialty, not just a subspecialty of any other specialty. As the complexity of the field increases, only full-time specialists will have the combined clinical, conceptual and technical expertise required for the field to achieve its full potential. Nuclear medicine, more than any other specialty, is applying the revolutionary advances in genetics, in vivo molecular biology and biochemistry to the care of the sick and the preservation of health, translating science into service. While continuing to serve as consultants to other specialists, they will also provide continuing care for selected patients, for example, in the use of NanoRx probes in the treatment of diseases such as neuroendocrine tumors.

The excitement of nuclear medicine remains the best kept secret in medicine. Medical students often encounter only physicians interpreting studies that they do not fully understand, or who have chosen to enter nuclear medicine for reasons other than the excitement of its science. While the students don’t know much about nuclear medicine, they are aware of medical politics and economics. They know that what they see, they are likely to get. If nuclear medicine evolves into molecular medicine, then bright, intelligent, innovative, well-trained, far-sighted young men and women will beat the doors down to get into the field.

Radiology residents will continue to be encouraged to enter the specialty of full-time nuclear medicine, but cannot be counted on to be the most fruitful pool of candidates for recruitment. Despite their common use of electromagnetic radiation as a source of information, the basic orientation of radiology and nuclear medicine are different. The major focus of radiology is anatomy, even when it is anatomy in motion, as in measurement of blood flow. Nuclear medicine is based on the tracer principle, which is fundamentally a principle of chemistry.

Nuclear medicine needs to recruit medical students of the type found in MD/PhD programs, students interested in science as well as sickness, and who are interested in solving patients’ problems as well as scientific problems. Only those who keep their eyes on the horizon will find the right road. If we recruit clinical scientists into a truly independent specialty, one day we will be able to say that nuclear medicine has truly become molecular medicine.