

# The Future of Nuclear Medicine

David Mankoff

*University of Pennsylvania, Philadelphia, Pennsylvania*

As I noted in the Wagner Lecture at this year's Society of Nuclear Medicine and Molecular Imaging Annual Meeting, nuclear medicine (NM) is an ever-changing and rapidly advancing practice in which clinical advances are driven by closely allied efforts in physics, chemistry, biology, and translational research relevant to radiopharmaceutical imaging and therapy. This multidisciplinary intersection of research and practice drives innovation in our specialty. These principles were clearly on broad display at the 2023 Annual Meeting, especially for the combination of molecular imaging diagnostics and radiopharmaceutical therapy (i.e., theranostics). The dynamic nature of NM requires frequent adaptation of our clinical practice and the closely aligned topic of clinical training. This issue of *The Journal of Nuclear Medicine* includes several contributions that offer opinions on how to address these needs, with an emphasis on the practice of theranostics and on NM training in the United States.

Leading the way is a thought-provoking editorial by Michael Graham (1), a former president of the Society of Nuclear Medicine and Molecular Imaging, and 3 invited perspectives that present alternative opinions and additional considerations (2–4). Dr. Graham's editorial laments that, in the United States, "We are simply not producing very many high-quality academic NM physicians." He argues that, unlike other countries where NM is a separate and independent practice, the United States allows radiologists with limited training in NM to include NM in their practice. He also raises concerns that, whereas radiologists with specialty NM training are clinically competent and support the practice of NM, they often are not academically inclined. Dr. Graham suggests steps to address these concerns by requiring a minimum of a full year of NM specialty training (versus the current U.S. standard of 4 mo) to be certified for NM clinical practice, adding a year to the current U.S. NM residency guidelines to be used for research or additional training in radiopharmaceutical therapy, and a strong informational campaign to attract to the specialty. Dr. Graham argues that these steps are critical to the future of NM in the United States and are urgently needed to avoid having the rest of the NM world "leave us behind."

The 3 accompanying invited perspectives provide some additional data and thoughts on the topic. Segall, Watts, and Frey—leaders in the American Board of Nuclear Medicine (ABNM)—provide data on NM training and certification (2). They note a decline in ACGME-certified NM residencies from 61 in 2006 to 36 in 2022 and an increase in the fraction of foreign trainees in U.S. programs over the same period. Although there has been a relatively stable number of ABNM-certified physicians since 2015, there was a decline in NM residency trainees from a total of 166 in 2008 to

a nadir of 74 in 2016 and currently a total of 80. The authors note, however, that the total NM trainee count does not include an increasing number of integrated 16-mo nuclear radiology trainees who are enrolled in diagnostic radiology residency program and go on to certify in NM through the ABNM. This group of trainees accounted for 26% of the certifications in 2022. Overall, there has been an increase in practicing ABNM-certificate holders from an average of 59% since 2015 to 70% in the last 5 y, with a 5% drop in NM certification by trainees holding certificates in specialties other than radiology. The authors were not able to draw conclusions on whether dual radiology–NM training affects whether certificate holders choose to pursue academics versus private practice, noting that a "robust" 43% of current ABNM certificate holders are in self-declared academic practices.

A perspective written by Drs. Grady, Mankoff, and Schuster, entitled "Stronger Together—Collaboration Will Only Enhance Patient Care," offers some opinions and suggestions counter to the Graham editorial (3). The authors note that advancement of NM practice has benefited from the multidisciplinary training of NM physicians and "the breadth of disciplines embraced by the field—clinical imaging and therapy, molecular biology, physics, chemistry, and mathematics." The authors disagree with Dr. Graham's premise that NM needs to be a fully independent specialty to be able to thrive in the era of molecular imaging and theranostics. They cite prior examples in which controversy caused by disruptive technology was solved through collaborative development of rigorous common requirements and approaches to training physicians in the new technology. This was the case for hybrid imaging training (e.g., PET/CT), which was jointly addressed by bringing elements of anatomic imaging training (radiology) and molecular imaging training (NM) together and collaborating to set training standards. The authors agree with Dr. Graham on the need for more training in radiopharmaceutical therapy for all NM trainees and call for requiring similar training for physicians in other specialties who contribute other relevant skills and who also practice radiopharmaceutical therapy, such as radiation oncologists. The authors also provide examples of the contributions that dual training in NM and radiology have brought to NM research, as well as important related developments, such as the emergence of formal radiology physician–scientist training programs in the United States—programs that are heavily populated by trainees who ultimately specialize in NM. The authors argue that elevating training requirements for NM imaging and therapy, rather than restricting practice by legislation, is the best way to ensure the future of the specialty in the United States.

In a perspective entitled "Redesigned Curricula, Stringent Licensing Criteria, and Integrated Independence are Conditions for a Bright Future for Nuclear Medicine in the United States,"

a different opinion is offered by Drs. Czernin and Calais (4), who argue that Dr. Graham's suggestions to save NM in the United States are "are not sufficiently far-reaching." The authors propose a 4-y NM training program that matches the approach used by many countries outside the United States. For both NM-only and dual-specialty trainees, they propose 3 y of mandatory training that includes rotations in relevant specialties that make heavy use of NM imaging or therapy (e.g., cardiology, oncology, and endocrinology) and a focus on research and the rapidly advancing practice of theranostics. Beyond changes in training, the authors also call for integrated but independent NM departments with the programmatic and fiscal autonomy to "foster a sense of ownership that is among the strongest drivers of progress and success in research and the clinic." They emphasize the importance of this approach in ensuring the continued research that supports the advancement of NM practice. The authors argue that, although the prevailing U.S. model of having NM as a subspecialty in radiology departments ensures desirable collaboration, it is not sufficient to ensure the future of the specialty. They argue that the "integration of some aspects of training and practice" with radiology does not preclude the independence of NM as its own autonomous specialty. Acknowledging that implementation of their proposed approach will take time and will not address the immediate need for better-trained NM physicians in the United States, the authors suggest quickly implementing 1-y fellowships emphasizing therapy to jumpstart the process.

Accompanying this series of editorial contributions is a "Discussions with Leaders" contribution in which Dr. Czernin discusses the topic of integrated independence with 3 NM leaders from different types of practices: the director of an independent private NM practice and research center (Dr. Delpassand), the chair of a U.S. academic radiology department (Dr. Rohren), and the chair of an international independent NM department (Dr. Weber) (5). The discussion echoes the theme of the editorial and perspectives, namely how to ensure a bright future for NM in the United States, with an emphasis on theranostics. The leaders have similar thoughts on the importance of theranostics. Dr. Delpassand describes how creating a small and nimble NM-focused practice provides a venue for innovation and the type of research needed to achieve advancements, and he emphasizes the need for continued development of new theranostic radiopharmaceuticals and their translation into clinical practice. Dr. Rohren notes that "we are only scratching the surface of what can be accomplished with theranostics" and cites the importance of dosimetry and combination therapy in moving the field forward. Dr. Weber agrees with Dr. Rohren's emphasis on combination therapy and adds the need to better understand and manage the toxicities of radiopharmaceutical therapy alone and in combination with other treatments. Dr. Weber describes the high volume of theranostic procedures in his NM-dedicated department at the Technical University of Munich, noting some differences in the mix of procedures compared with the United States. Dr. Weber notes that there is less emphasis on  $^{18}\text{F}$ -FDG PET/CT in Germany than in the United States, and Dr. Czernin surmises that it might be the emphasis on reimbursement for  $^{18}\text{F}$ -FDG PET/CT in the United States that has hindered clinical radiopharmaceutical therapy development in this country.

On the topic of training and certification, the leaders all agree on the need to refine and improve training requirements for theranostics to ensure that patients in the United States get optimal care. The leaders differ somewhat, however, on how to get there. Dr. Delpassand calls for the revamping of U.S. NM training programs to meet this need, including a significantly revised NM training curriculum emphasizing theranostics. Dr. Rohren agrees with the need for more theranostics-trained physicians but notes that skills learned in some specialties beyond NM—diagnostic radiology, radiation oncology, and medical oncology—could all contribute to supporting the demand for more theranostics-trained specialists; he suggests using a fellowship-based approach emphasizing NM but perhaps open to trainees from other specialties. Dr. Weber emphasizes the need for better training on how to manage cancer patients, including skills in understanding the technology, delivering therapy, and collaborating with other specialties, citing radiation oncology training as an example that encompasses these skills.

Where do these thoughtful and thought-provoking discussions leave us? All the contributors agree on the importance of multidisciplinary clinical training and research in advancing NM practice and on the need for more dedicated theranostics training in the United States to optimize patient care. They differ, however, in suggesting how we might achieve these goals—through collaborative multidisciplinary training programs and practice, through revamping and expansion of dedicated NM training programs, or through implementation of integrated but fully independent NM departments using approaches similar to those in many European countries. Although we in the United States have different opinions on the optimal approach to advance our specialty, I am optimistic that our agreement on the importance of NM as a specialty, the need for multidisciplinary training, the growing importance of theranostics, and, most importantly, our desire to deliver the best possible care to our patients will serve as a basis for charting the path forward. It is my hope that the range of opinions expressed in this issue will spark much-needed dialog, which will advance our specialty in the United States and set an example for practices around the world.

## DISCLOSURE

No potential conflict of interest relevant to this article was reported.

## REFERENCES

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