Nuclear Medicine Scientists: Findings and Recommendations Based on a 2006 Survey

Nuclear medicine science is a critical foundation for the entire field of molecular imaging and nuclear medicine practice. Rapid evolution in the field makes the seminal contributions of nuclear medicine scientists even more important, because these individuals function as the key determinants of the direction and pace of future change. Nuclear medicine scientists play essential roles in generating the scientific and technological breakthroughs that lead to the new technologies, diagnostic procedures, and therapeutic processes that are currently transforming the entire field of medical imaging and health care delivery.

Despite the important contributions of nuclear medicine scientists, little reliable documentation is available describing who they are, what they do, their roles in employing organizations, what tasks they perform, and where they work. Their diverse scientific interests and roles in specialties in a number of disciplines (including but not limited to chemistry, physics, pharmacy, and computer science/engineering) add to the confusion. These scientists are scattered across varied health care settings, including academic medical centers, technology development firms, research organizations, and clinical provider offices, with few concentrations of scientific endeavor in single locales.

This survey was conducted in an effort to fill this data void and provide new information about the characteristics of nuclear medicine scientists and their contributions to the field of nuclear medicine, imaging, and medicine more generally. The information and insights provided in this report are designed to inform planners, policy makers, and educators interested in ensuring that nuclear medicine science flourishes in the future.

The Survey of Nuclear Medicine Scientists

This report is based primarily on the responses of nuclear medicine scientists to a survey conducted in the spring of 2006 by the Center for Health Workforce Studies at the University at Albany (NY) under a contract with the SNM. A questionnaire containing more than 60 items was administered to more than 4,000 nuclear medicine scientists whose names were drawn from the mailing lists of 8 professional organizations. This report is based on the 1,243 responses to the questionnaire, especially the 898 respondents who indicated that they were active in nuclear medicine science. After reducing the denominator for those who indicated they had no involvement in nuclear medicine or for whom original addresses were in error, this represented a response rate of 38.2%. A technical report providing a detailed summary of the survey responses and interpretive text is available on the SNM Web site at www.snm.org.

The following is a concise summary of key findings based on survey responses, including key themes covered in the questionnaire: personal demographics, education and training, entry into nuclear medicine, current work environment, salaries, recruitment of new scientists, attitudes about nuclear medicine, future plans, and certification and professional associations.

Findings from the 2006 Survey

A number of seminal concepts and themes in responses to the survey were identified and seem central to understanding the roles of nuclear medicine scientists both today and in the future.

- The clinical practice of nuclear medicine is highly dependent on nuclear medicine science for new tools and techniques. Nuclear medicine scientists play central roles in developing these new tools and techniques, although many years of effort are often required to translate scientific breakthroughs into clinical practice.
- The survey revealed no formal career pathways that lead scientists into nuclear medicine. Most current nuclear medicine scientists first considered nuclear medicine as a career in graduate school. Although this nonsystem may have worked satisfactorily in the past, more structured pathways to the profession would benefit the field—and society—in the future.
- Many nuclear medicine scientists focus their research efforts on narrow, technical subjects that yield only fragments of knowledge of little practical value by themselves. Better communication and coordination are needed to take scientific breakthroughs from the laboratory into clinical practice.
- Survey responses indicated that nuclear medicine science is both a global and a collegial enterprise with much cooperation and sharing. Many nuclear medicine science ventures are collaborations among scientists in the United States, Europe, Japan, and elsewhere.
- Funding support for nuclear medicine science, which comes primarily from the federal government, is both limited and fragile. The recent Department of Energy (DOE) decision to cut funds budgeted for basic nuclear medicine science research is a case in point. This cut could have a major negative effect on nuclear medicine in coming years.

- Business plays an important role in nuclear medicine science and practice. Nuclear medicine cameras developed by industry are essential to the delivery of diagnostic and therapeutic benefits of nuclear medicine to patients. Rules about ownership, use, and taxation of these cameras have a major impact on the development, purchase, and utilization of these high-tech tools.
- Survey responses indicated that nuclear medicine suffers from widespread public and regulatory agency misconceptions about the risks of radiation exposure. Despite the fact that radiation exposure from nuclear medicine procedures is a small fraction of that in conventional radiography, federal regulations treat radiopharmaceuticals on a par with much more dangerous radioactive substances.
- As in many cutting-edge fields of science, nuclear medicine science is entrepreneurial. Nuclear medicine scientists improvise their research programs and agendas based on a host of relationships and ventures. Funding comes from multiple sources. Career paths are often the result of serendipitous events, and progress is often affected by outside factors.

Important Issues for Nuclear Medicine Science

According to respondents, a number of important issues are currently facing nuclear medicine science, including:

- Maintaining a critical mass of nuclear medicine scientists to support a steady flow of scientific advances and breakthroughs;
- Understanding, maintaining, and developing mechanisms by which new scientists are attracted into the field;
- Promoting adequate funding for nuclear medicine research to sustain the flow of knowledge and information to stakeholders;
- Maintaining adequate levels of reimbursement for clinical nuclear medicine studies to help support appropriate clinical and scientific research;
- Creating and sustaining centers of excellence in nuclear medicine research, education, and practice where scientific research and exploration can flourish;
- Supporting initial and continuing education and training to ensure competent replacements for those who leave the field; and
- Publicizing the relative safety of current nuclear medicine procedures with the hope that government regulations can be relaxed in the future.

Key Study Findings

With as few as 1,500 practitioners, nuclear medicine scientists constitute a very small segment of the health workforce in the United States—and a tiny component of the entire labor force. Their small numbers are not indicative of their importance to both the health care system and the larger economy. They play important roles in developing and applying advanced technologies that have resulted in exciting new paradigms of medical diagnosis and treatment over the past several decades.

The contributions of these scientists have not gone unnoticed. By many measures, this cadre of highly educated and creative professionals has been well rewarded for their efforts. Salaries are generally commensurate with education levels. Professional roles and responsibilities are varied and interesting. Demand for scientists appears to exceed supply, while opportunities for fulfilling scientific work abound.

These conclusions are based on the survey responses summarized here. The survey responses also highlight concerns about nuclear medicine science that deserve attention by policy makers and other stakeholders.

Geographic and Demographic Data. Figure 1 shows that, compared with the overall population, survey respondents were overrepresented in New England, the Northeast, Mid Atlantic, Midwest, and Southwest and underrepresented in the Southeast, Mountain, Pacific, and Northwest regions. Survey respondents were 83% men and 17% women (compared with 49% and 51%, respectively, in the general population). In 2006, 28% of active nuclear medicine scientists were born outside the United States, a pattern similar to that for physicians (32% of active nuclear medicine physicians were international medical graduates).

Education. The highest degrees of 59% of active nuclear medicine scientists were doctoral degrees (PharmD, PhD, MD, DO, JD, DVM, and SciD). About 25% held master's degrees, and 14% held bachelor's degrees. More than 1 in 4 (27%) active nuclear medicine scientists earned bachelor's degrees in physics, followed by 22% in pharmacy, and 19% in chemistry. Four percent indicated they had dual majors. Among scientists indicating plans to seek additional degrees, almost half (46%) indicated their chosen discipline was "other." The most frequently cited "other" degree sought was the MBA. Of the 35% of nuclear medicine scientists who already held doctoral level degrees and expected to pursue additional education in the next 5 years, the most frequently selected level was "other." This included education in business administration, health care administration, hospital administration, molecular and medical pharmacology, and molecular physiology.

Entering Nuclear Medicine Science Careers. More than one-third (36%) of current nuclear medicine scientists first learned about nuclear medicine science during their undergraduate education. An additional 22% of current nuclear medicine scientists learned about nuclear medicine opportunities at the master's level. About one-third of current nuclear medicine scientists (33%) learned about opportunities in nuclear medicine in their doctoral program or medical school (19%) and/or during postdoctoral training (14%). A much larger percentage (60%) of respondents younger than age 30 first learned of opportunities in nuclear medicine science in their undergraduate years than those in the 50–59-year age group (35%).

Nearly 500 survey respondents identified 279 different careers that preceded their work in nuclear medicine. These

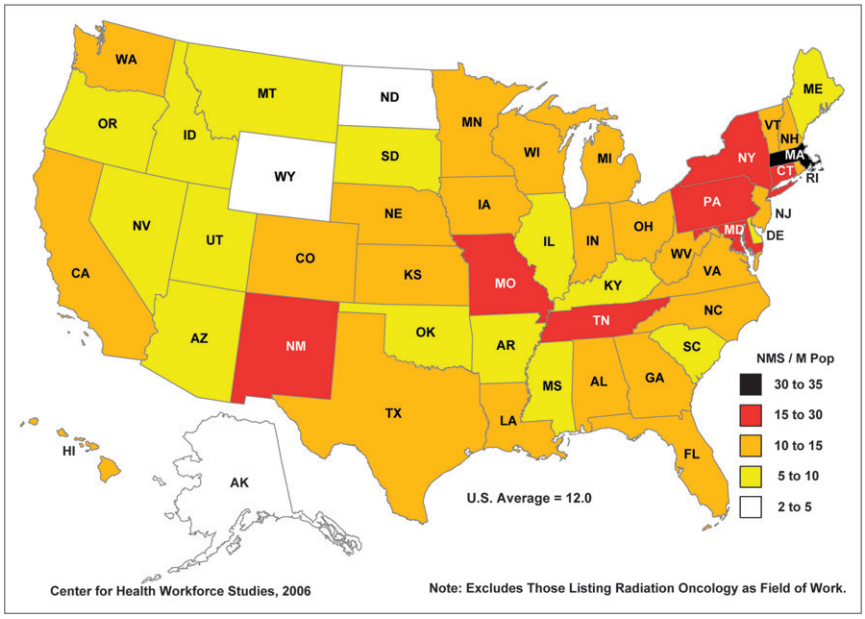

FIGURE 1. Estimated number of nuclear medicine scientists per million population in the United States, 2006.

careers ranged from aeronautical engineering and archaeology to veterinary medicine and x-ray crystallography. This breadth of experience suggests that the current field of nuclear medicine science represents a synthesis of a very broad range of scientific and nonscientific interests and experiences.

Current Work Setting. Table 1 indicates that medical centers were the most common primary work setting among active nuclear medicine scientists. More than 1 in 4 (28%) worked primarily in academic medical centers and another 23% worked in hospitals/medical centers. Another 18% of nuclear medicine scientists worked primarily in radiopharmacies. Nearly half (48%) of active nuclear medicine scientists reported a secondary employment setting. The 3 secondary work settings reported most were hospitals/medical centers (9%), academic institutions (6%), and academic medical centers (6%). More than one-third of nuclear medicine scientists (34%) had worked for their current primary employer for 5 years or less and another 18% had worked for their current primary employer between 6 and 10 years.

Forty-five percent of active nuclear medicine scientists worked in either a nuclear medicine center in a radiology department, a radiology department, or a nuclear medicine department. This suggests strong ties to clinical care for a large fraction of nuclear medicine scientists. Nuclear medicine scientists were not involved solely in basic science work in laboratory settings. A high percentage (70%) of respondents worked in a department that provided clinical nuclear medicine services. The most frequently cited functions of scientists in clinical departments were radiation safety monitoring (42%) and professional/patient education (41%). Only 9% of active nuclear medicine scientists worked in academic research departments, and 7% worked in corporate research and development (R&D) departments. An additional 1% of nuclear medicine scientists worked in corporate sales and marketing.

Branch of Science. The branches of science with which respondents identified most closely were physics (33%), pharmacy (20%), chemistry (14%), computer science and engineering (3%), some combination of these 4 areas (16%), and "other" (15%), indicating the interdisciplinary nature of nuclear medicine science (Fig. 2).

Research and Development. Nearly half (46%) of nuclear medicine scientists responding to the survey indicated that they worked in R&D. Among scientists in R&D, a majority (63%) worked in radiopharmaceutical development.

TABLE 1
Primary and Secondary Employment Settings of 898 Active Nuclear Medicine Scientists, 2006

Employment setting	Primary	Secondary
Academic medical center	27.6%	5.5%
Hospital/medical center	23.2%	8.9%
Radiopharmacy	18.3%	4.0%
Academic institution	5.9%	6.2%
Consulting company	5.2%	4.9%
Pharmaceutical company	4.5%	1.2%
Research organization	3.9%	4.1%
Self-employed	2.0%	4.8%
Technology/instrument company	1.9%	0.7%
Oncology specialty center	1.3%	1.0%
Freestanding radiology center	0.9%	1.3%
Outpatient hospital clinic/center	0.6%	1.7%
Freestanding NM center	0.2%	0.8%
Physician office/private radiologist	0.2%	0.6%
Cardiology specialty center	0.2%	0.7%
Staffing organization	0%	0.1%
Mobile unit	0%	0.1%
Other	1.8%	1.0%
None/Missing	2.3%	52.4%

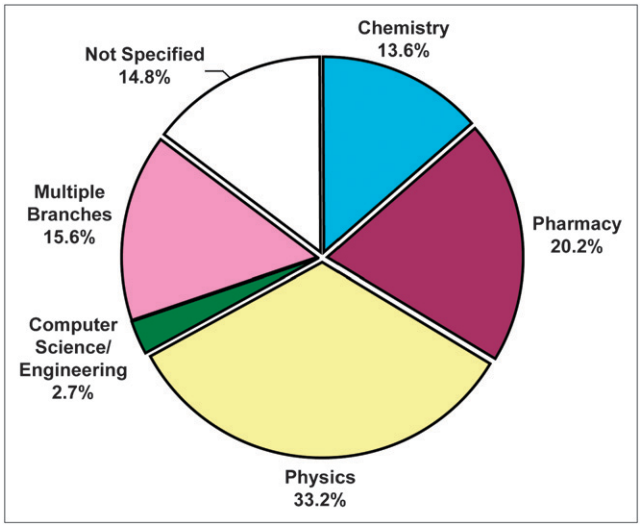

FIGURE 2. Branches of science in which active nuclear medicine scientists work, 2006.

About half of respondents (48%) working in R&D worked in in vivo research, whereas 23% worked in in vitro research. The percentage of active nuclear medicine scientists working in technology development (45%) was more than twice that working in either radionuclide development (20%) or cellular/molecular biology research (20%).

Most scientists in R&D reported working in academic medical centers (43%) or colleges/universities (25%). Private corporations employed 22% of survey respondents engaged in R&D. "Other" R&D settings included national laboratories and research institutes.

Roles and Tasks. The umbrella of nuclear medicine science covers myriad research activities and scientific roles (Fig. 3). The roles reported by nuclear medicine scientists included: basic science research only (20%), applied research only (3%), technical support only (15%), administrative support only (5%), 2 or 3 of these roles (30%), all 4 roles (12%), and "other" (15%). Of scientists reporting basic science research as their primary role, 37% worked in radiopharmaceutical development and 35% worked in "other" areas. Of scientists reporting their primary role as applied research, roughly equal percentages indicated research in image processing (18.6%), new applications (18.1%), and "other" (18.1%). Of scientists reporting their primary role as technical support, 36% reported working in radiopharmaceutical preparation and 31% in radiation safety. Of scientists reporting administrative support as their primary role, 35% were involved in regulatory oversight and 30% educated other clinicians and professionals.

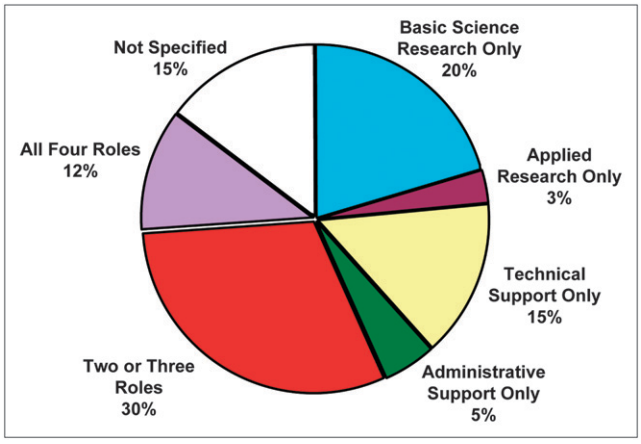

FIGURE 3. Primary tasks and roles of active nuclear medicine scientists, 2006.

Salaries. The mean annual salary of active nuclear medicine scientists in 2006 was $123,800, and the median was $108,000. Additional details about salaries are provided in the full report. Although nearly half (49%) of survey respondents indicated that nuclear medicine salaries were competitive in the marketplace, 28% indicated that salaries in academic environments were not competitive with corporate salaries.

Mentors and Mentoring. Although nearly 3 in 5 (60%) active nuclear medicine scientists had a mentor in nuclear medicine in the past, only about one-third (35%) of nuclear medicine scientists indicated that they now mentor a potential nuclear medicine scientist. A majority (81%) of scientists not personally mentored were not currently mentoring prospective scientists. However, among those scientists who *were* mentored in the past, less than half (45%) were currently mentoring prospective scientists. The fact that more than half of scientists in all age groups had a nuclear science mentor suggests that mentoring is important for recruiting new scientists.

Recruitment of New Scientists. About 1 in 3 (36%) nuclear medicine scientists participated in recruitment of new scientists. Respondents working in chemistry (50%) or in multiple branches (46%) of nuclear medicine science were most likely to be involved in recruitment of new professionals. Overall, 86% of active nuclear medicine scientists from all branches of science indicated that few qualified candidates were available. Only 4% of scientists indicated that *no* qualified candidates were available to fill open positions. Nuclear medicine scientists working in academic institutions (71%), research organizations (67%), and academic medical centers (61%) were more likely to recruit new postdoctoral students. Scientists working in academic institutions (50%) were the most likely to recruit new PhD students. Scientists working in consulting companies (88%) and in pharmaceutical companies (71%) preferred to recruit experienced professionals. Survey respondents suggested multiple strategies to improve recruitment of new professionals into nuclear medicine science, including improved salaries (47%), more support for graduates in related fields (36%), more nuclear medicine fellowships (34%), endowed training grants (33%), and a national public relations campaign for nuclear medicine (28%).

Attitudes About Nuclear Medicine. When asked to indicate current issues that affect nuclear medicine scientists,

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respondents were consistent across all branches of science in selecting "government regulation" (61%) as a significant issue. "Reimbursement and financial issues" were also consistently chosen by 60% of scientists and were selected more often by pharmacists (68%) than other categories of scientist. Among all response options, "restriction on imports of nuclear material" was the *least* selected (except "other") with only 9% of respondents. Table 2 indicates that respondents generally agreed with the statement that nuclear medicine will continue to grow in importance in health care (with an average score of +1.02 on a –2 to +2 scale). This opinion was supported by general *disagreement* with the statement that nuclear medicine will become *less* important in the future (–0.88). Respondents also generally agreed with the statement that the costs of nuclear medicine studies will increase in the future (+0.74).

Respondents agreed that nuclear medicine science will become more integrated in the future (+0.75). They also agreed that regional centers of nuclear medicine science research and development should be established (+0.70), although there was less agreement that such centers would *actually* be established (+0.16).

Three in 5 (59%) scientists agreed or strongly agreed that shortages of nuclear medicine scientists will limit future research. More than half (55%) believed that molecular imaging science will enhance employment opportunities for nuclear medicine scientists. Only 21% of respondents indicated that nuclear medicine research is more restricted in the United States than in other countries. Two in 5 scientists (44.8%), however, expressed the opinion that scientists in the United States encounter more regulatory barriers to progress than scientists in other countries.

Sustaining Nuclear Medicine Science Careers. In all branches of science except chemistry, almost two-thirds of active nuclear medicine scientists indicated that continued reimbursement for nuclear medicine procedures by Medicare and other insurance carriers was needed to sustain careers in nuclear medicine. Many of these scientists worked in hospitals and other clinical settings. More than one-third (38%) of respondents indicated that continued financial support for nuclear medicine research was key to sustaining a career in nuclear medicine. Almost three-quarters of chemists (70%) indicated this as a key factor for career sustainability in the future, a response consistent with the high percentage of chemists found in "basic research–only" roles. Only 14% of respondents indicated that relaxation of federal regulations was a key factor for sustaining future careers in nuclear medicine.

Future Career Plans. Regional differences were observed in the future career plans of nuclear medicine scientists. Greater proportions of scientists in the Midwest (12%) and Northwest (11%) regions than in other regions expected to seek jobs outside nuclear medicine science over the next 5 years. Although 21% of nuclear medicine scientists in the Mid Atlantic and 18% of scientists in the Northeast region expected to seek other jobs in nuclear medicine science in the next 5 years, only 7% of scientists in the Mid Atlantic and 3% of scientists in the Northeast expected to do so.

Certification and Professional Associations. Nuclear medicine scientists held a variety of different certifications, depending on their branch of science. These included certifications by the American Board of Health Physics, the American Board of Science in Nuclear Medicine, the American Board of Medical Physics, the American Board of Radiology, and the Board of Pharmaceutical Specialties. Nuclear medicine scientists were also certified by a variety of other credentialing organizations, including the American Board of Nuclear Medicine and the Nuclear Medicine Technology Certification Board. A complete list of other responses is available in the full report.

Professional Association Memberships. Respondents indicated a variety of reasons for membership in professional groups, including annual meeting opportunities (64%), publications (63%), education opportunities (59%), and peer interaction (58%). The professional associations in which respondents reported membership included the: SNM (56%), American Association of Physicists in

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TABLE 2
Attitudes of Current Nuclear Medicine Scientists About the Future of Nuclear Medicine, 2006

Statement	No. of respondents	Mean scores	SD
Nuclear medicine will become more important.	883	1.02	0.83
Nuclear medicine will become less important.	876	−0.88	0.86
Nuclear medicine costs will increase.	885	0.74	0.84
Increased accuracy will offset increased costs.	880	0.49	0.85
Increasing costs of nuclear medicine will restrict usage.	882	−0.02	0.93
Shortages of nuclear medicine scientists will limit research.	880	0.56	0.87
Shortages of nuclear medicine physicians will limit access.	877	0.38	0.93
Shortages of nuclear medicine technologists will limit patient access.	876	0.38	0.92
Reimbursement for nuclear medicine will be reduced.	877	0.51	0.80
Nuclear medicine science will become more integrated.	878	0.75	0.73
Regional nuclear medicine R&D centers should be created.	877	0.70	0.89
Regional nuclear medicine R&D centers will be created.	876	0.16	0.76

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Medicine (35%), Health Physics Society (16%), American Pharmacists Association (13%), American Chemical Society (12%), Academy of Molecular Imaging (11%), and the IEEE (11%).

Maintaining Professional Currency. The 2 most cited ways for maintaining professional currency were attendance at professional meetings (40%) and reading professional journals (39%).

Additional Recommendations. A broad spectrum of narrative comments and suggestions were provided by survey respondents in response to a free-form question. Although space does not permit their inclusion here, these comments provide a fascinating overview of current perspectives on nuclear medicine science. The complete database of such responses is available with other results from the survey on the SNM Web site.

Five Themes for the Future

The recommendations that follow were based on the impression of the authors, based on survey results, that nuclear medicine science and its related education programs are fragmented and disorganized. These recommendations are organized into 5 broad categories, each dealing with a different aspect of the scientific environment. Several of the categories are relevant to segments of the nuclear medicine workforce beyond nuclear medicine science. Some of the tasks may be easily accomplished; others will require concerted effort by teams of stakeholders from many fields and many organizations.

(1) Attract strong candidates into nuclear medicine science. As with any enterprise, nuclear medicine science will flourish to the extent that it recruits and retains intelligent, creative candidates to design and conduct the research studies that will lead the field into the future. This can be accomplished through a variety of mechanisms, including:

- *Earlier exposure to nuclear medicine for potential candidates*. All of those interested in science, engineering, or medicine should hear about nuclear medicine early in their college careers. SNM and other organizations should prepare and distribute flyers, press releases, public interest ads, and other mechanisms to inform high school and college students about career opportunities in nuclear medicine.
- *Career development network*. Publicize and use SNM's Internet-based job posting system. This will facilitate the process of notifying interested scientists and students about career opportunities in nuclear medicine science and connecting candidates with job opportunities.
- *Encourage mentoring*. This survey documented the importance of mentoring to the development of nuclear medicine scientists, especially those involved in advanced research. Perhaps the SNM career network could be extended to encourage and guide research scientists and managers to get involved in mentoring as a way of improving the flow of new talent.
- *Better nuclear medicine job opportunities*. This is a challenging task that will entail reaching out to organizations that hire nuclear medicine scientists and other professionals involved in the practice of nuclear medicine. It will also require communication with organizations and agencies that provide funding for nuclear medicine research and reimbursement for clinical practice.

(2) Increase funding for nuclear medicine science and research. Funding was cited by many survey respondents as a critical issue for nuclear medicine science. Several avenues are available for improving funding for this core activity.

- *Government funding of basic research*. The federal government has always been a primary source of support for nuclear medicine science. On the clinical side, this often occurs under the auspices of the National Institutes of Health (NIH). On the basic science side, limited funding is available through the DOE. It is important to ensure that both of these funding streams are maintained.
- *Broad-based funding for applied research*. Corporate and foundation funding for nuclear medicine research should be encouraged and expanded, not only in private labs but in the labs of academic institutions. A steady stream of scientific breakthroughs and technical advances is critical for moving the practice of nuclear medicine forward to its full potential.
- *Adequate reimbursement to support clinical research.* As Medicare and other third-party payers seek ways to reduce the cost of health care, it is essential that they do not cut funding so much that clinical nuclear medicine research is eliminated. Such research is critical for confirming the efficacy of new diagnostic tools and techniques and new therapeutic protocols. It is also important not to abdicate responsibility for PET/CT and other fusion imaging procedures to radiologists as these technologies become more common.
- *Adequate funding for nuclear medicine by NIH*. Ensuring that an appropriate share of NIH funding is devoted to research related to nuclear medicine will be a continuing concern. SNM should continue to work to ensure that nuclear medicine is a high priority for NIH funding. New therapies based on nuclear medicine protocols offer especially promising opportunities for funding.

(3) Educate the public about the value, safety, and future potential of nuclear medicine procedures. Many of the regulatory restrictions and limitations on nuclear medicine appear to be based on misconceptions held by the public, elected officials, and government bureaucrats about the safety of radioactive materials used in nuclear medicine

practice and research. A set of concerted initiatives would help to correct these misconceptions.

- *Legislative and agency briefings*. It is important to correct misconceptions in legislative arenas about the safety of nuclear medicine procedures, especially in agencies responsible for regulating nuclear medicine protocols and substances. Done effectively, this will lower barriers to the introduction of new radiopharmaceuticals and nuclear medicine procedures and protocols.
- *Public education programs*. Although perhaps less important than legislative briefings, public education about nuclear medicine science needs additional attention. This will promote legislative agendas, stimulate public interest in nuclear medicine, and support efforts to recruit new scientists.
- *Communication networks*. An important goal of this initiative is to promote communication between the nuclear medicine community and its constituents, supporters, and stakeholders. A variety of communication mechanisms are envisioned, including the Internet, newsletters, press releases, and periodic reports.
- *White papers*. As new nuclear medicine tools and techniques are introduced into practice and as new scientific breakthroughs take place in research organizations across the country, it is important that information be shared with those in the communication networks. A variety of different vehicles are envisioned, including policy white papers, briefing memos, and press releases.

(4) Reorganize nuclear medicine research and education around centers of excellence in nuclear medicine. Given the small size of the nuclear medicine enterprise in the United States, it is not possible to have viable research efforts in more than a small number of facilities. The vision presented in this report is for a series of perhaps 10 or 12 regional centers of excellence in nuclear medicine geographically dispersed around the country. These centers ideally would be located in academic research institutions or consortia that already have a significant presence in nuclear medicine. Each center would support a critical mass of clinicians, investigators, mentors, educators, scientists, administrators, and equipment to serve the clinical and scientific needs of its region. In addition, each center would have responsibility for coordinating nuclear medicine research and clinical services in its home region. The result would be a much more cost-effective approach to both the conduct of nuclear medicine research and the provision of clinical services. Each of the regional centers would coordinate several aspects of nuclear medicine science and practice, including:

- *Professional education*. This would include clinical education for physicians, technologists, and technicians; scientific education for researchers, investigators, and technical support staff; and public education for policy makers and the general public.
- *Scientific research*. Each center would have a full range of capabilities for clinical research, basic science research, theoretical research, and applied research. Depending on the interests and capabilities of investigators and funding, the centers could be encouraged to specialize in 1 or more subfields of nuclear medicine.
- *Infrastructure development*. Each regional center would have appropriate infrastructure to support a wide range of clinical, basic science, and educational activities. This would include such major equipment as cyclotrons and supercomputers, as well as the latest in imaging equipment and mass data storage. This infrastructure would support not only research but also education and clinical service.
- *Communication networks*. An important element would be incorporation of the latest in communication capabilities to permit both internal and external networking. The opportunity to cross-fertilize efforts of all the centers and to connect with researchers elsewhere would multiply the impact of the core capabilities that each center brings to the field. The centers could also play an important role in public education and legislative briefings.
- *Strong ties with vendors and corporations*. A special effort should be made to attract vendors into the networks of partners of these centers. Encouraging earlier sharing of ideas would accelerate the introduction of new pharmaceuticals, cameras, and other technologies into practice.
- *Special interest groups*. Patients, consumers, ethicists, foundations, regulators, and other interested parties should also be encouraged to join as partners in the center. These additional perspectives would strengthen the centers' teams, help maximize the impact of the centers, and ensure that the centers serve the public interest.

(5) Enhance SNM as a key advocate for nuclear medicine science. SNM can play important roles in implementing this vision of the future for nuclear medicine and molecular imaging. The different stakeholders have much to gain or lose, depending on the strategies and priorities chosen to move nuclear medicine science forward. Several strategies are possible, including:

- *Coordinated strategies for educating nuclear medicine scientists, physicians, and technologists*. The diversity of scientific disciplines in nuclear medicine science, although essential for advancement,

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elected terms as historian of the SNM, a position that he relished. He originated the Newsline "History Corner" series in *The Journal of Nuclear Medicine*. At the time of his death he was working on a biography of German physicist Philipp Lenard, a series of vignettes on nuclear medicine, and a textbook on decision analysis for medical students. He greatly enjoyed all of these endeavors and commented, "My attempt at full retirement failed miserably."

A memorial service was held at St. Paul Lutheran Church in Oakland, CA, on February 4. As the pastor said at the service, "Dennis was always more interested in hearing about others than in talking about himself." As a consequence, few people knew the full scope of his talents. Yet for all who knew him, whether in medicine, music, or community service, he was a good friend who will be greatly missed.

He is survived by his 2 sons: Jim, of Orange, CA, and Bill, of Seattle, WA. Contributions may be made in his name to the Education and Research Foundation for the SNM, 1850 Samuel Morse Drive, Reston, VA 22090, or the Salvation Army.

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can frustrate efforts to create and maintain the professional identity of nuclear medicine scientists. Annual professional meetings, educational opportunities, interaction with peers, and peer-reviewed journals were cited by the majority of survey respondents as reasons for membership in professional associations. These activities should be encouraged and enhanced.

- *Continuing education in nuclear medicine*. The current professional enrichment activities of SNM are an important aspect of this initiative. Although most survey respondents indicated that they belong to professional associations relevant to their scientific disciplines (e.g., physics, pharmacy), SNM provides an important interdisciplinary forum for exchange of professional ideas and information. This should be continued and expanded.
- *Policy leadership for nuclear medicine science*. Survey respondents expressed concern about the lack of current research funding, difficulty in obtaining source materials for research, the current approval process for radiopharmaceuticals, and lack of visibility of nuclear medicine scientists to other medical and health professionals. Advocacy is needed to: address issues related to public policy, regulatory guidelines, funding issues, and infrastructure development for nuclear medicine science; build articulated curricula for clinical and scientific programs to prepare and maintain a competent and competitive scientific workforce; and increase public understanding of the benefits and safety of nuclear medicine, the usefulness of radioactive materials, and the value of nuclear medicine research.
- *Cooperative nuclear medicine venture leadership*. It seems unlikely that any single organization will dominate the nuclear medicine landscape. There are simply too many threads and themes for a single organization to manage or control. This creates an important opportunity for SNM to continue to serve as the conductor of the "nuclear medicine orchestra." This should be possible to the extent that SNM can help the various constituents to achieve their respective objectives, while shepherding the entire field of nuclear medicine into the future.
- *Public relations campaigns for nuclear medicine*. Strategies and ideas without dissemination and action are like 1 hand clapping—they don't make much noise or have much impact. SNM should assume the critical role of promoter of nuclear medicine science—and nuclear medicine practice, more generally—to the public. This would enhance SNM's image with the public and, more important, with its professional constituents: the physicians, scientists, technical staff, facilities, and vendors that make up the nuclear medicine industry.
- *Legislative lobbying for nuclear medicine*. Advocacy at the federal level is critical for preservation of the science of nuclear medicine. The small size of the profession creates challenges for building reputation and recognition. Nevertheless, it is essential that government policy makers and bureaucrats be informed of the changes that should take place to enable nuclear medicine to reach its full potential.

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