Status of Nuclear Medicine in Latin America and the Caribbean: IAEA Analysis of Development in the Past 6 Years

Pilar Orellana[1], Fernando Mut[2], Enrique Estrada[1], Miriam Mikhail Lette[1], Olivier Pellet[1], Olga Morozova[1], Noura El-Haj[2], Juan C. Bucheli[1], Yaroslav Pynda[2], Tetiana Okolielova[2], Ariadna Cherit[1], Francesco Giammarile[1], and Diana Paez[1]

[1]Nuclear Medicine and Diagnostic Imaging Section, Division of Human Health, International Atomic Energy Agency, Vienna, Austria; [2]Division of Human Health, Department of Nuclear Sciences and Applications, International Atomic Energy Agency, Vienna, Austria; and [3]Nuclear Medicine Service, Italian Hospital, Montevideo, Uruguay

The Latin America and Caribbean (LAC) region is one of 5 United Nations (UN) Regional Groups, and its members compose 17% of all UN Member States (MS). It is one of the most urbanized regions in the world, with >80% of the population concentrated in urban areas, and represents about 8.4% of the world's population. Literacy is >91%, the global life expectancy is 75.2 years on average, the median age is 31 years, and the average annual population growth rate is 1.1% across the region. Current health expenditure as a percentage of gross domestic product (GDP) is 8.02% (range, 1.18%–11.7%) (*1*). In LAC, several factors have contributed to the decline in communicable diseases (CDs), but noncommunicable diseases (NCDs) are on the rise. These factors include demographic changes with an increase in life expectancy, lifestyle and environmental changes, and economic factors, among others (*2*). According to the Pan American Health Organization (PAHO) and the World Health Organization (WHO), the most prevalent NCDs (cardiovascular diseases, cancer, chronic respiratory diseases, and diabetes complications) are the leading causes of death in the region, resulting in 7 times more deaths than from infectious diseases. Overall, the age-adjusted mortality rate from NCDs is 441.3 per 100,000 population (*2,3*).

NCDs are currently a threat to economic growth and development for many nations, especially low- and middle-income countries (LMICs). According to WHO, a clear relationship is evident between premature NCD mortality and country income levels; in 2016, 78% of all NCD deaths and 85% of premature adult NCD deaths occurred in LMICs (*2,3*). Although the decline of infectious disease rates can be attributed to the success of public policies, health impacts associated with NCDs are not always reflected in the health system infrastructures of countries. Collectively, NCDs are the leading cause of preventable and premature mortality in LAC and responsible for significant—often catastrophic—out-of-pocket health expenditures for individuals and families. These costs exceed the ability of most public health care budgets to meet the demand for nuclear medicine (NM) examinations and treatments, given that most indications are related to NCDs. In addition, Latin America is among the regions significantly affected by the COVID-19 pandemic, which has exacerbated challenges in already overburdened health systems and impacted the management of patients with NCDs (*4*).

On September 25, 2015, at the Summit on Sustainable Development, the 193 MS of the UN unanimously adopted Sustainable Development Goals (SDGs) to improve the health status of vulnerable populations by ensuring universal and equitable access to quality health care, emphasizing the intention to significantly reduce the impact of both CDs and NCDs. Target 3.4 aims "to reduce premature mortality from NCDs by one-third through prevention and treatment by 2030" (*5*). Achieving this goal will require innovative health-for-all approaches and policies that link and synergize global efforts to reduce inequities, improve the world economy, and enhance national development. Today, most LAC nations are classified as middle-income countries, but significant heterogeneities are identified across different development indicators. Cross-country disparities in well-being at a given level of GDP per capita are glaring in LAC. Like most nations with emerging economies, LAC countries face great inequities in access to public services, a trend that has been consistent despite positive performance of GDP per capita during the last decade (*6*). This has translated into high mortality from NCDs, and the impact of the ongoing COVID-19 pandemic in health indicators is yet to be fully evaluated. Reversing mortality trends from NCDs in these subregions represents a major challenge, as well as an opportunity to target SDG 3 "Good Health and Well-Being." NM techniques can significantly contribute to the achievement of SDG 3.4, especially within the context of personalized health care according to contemporary standards. The purpose of this review prepared by the International Atomic Energy Agency (IAEA) is to evaluate and report on development of NM in the LAC region over a 6-year period (2014–2020).

Data and Analysis

An analysis of data collected throughout 2020 on the status and growth of NM in the countries of the LAC region was carried out by the Nuclear Medicine and Diagnostic Imaging Section of the IAEA and compared to that collected by the IAEA in 2014 and published in 2015 (*7*). For this analysis, we include data from the 21 countries that are part of the Regional Cooperation Agreement for the Promotion of Nuclear Science and Technology in Latin America and the Caribbean (ARCAL; referred to here as LAC). Data were collected from different sources, including from NM facilities and professionals; reports by participants at relevant IAEA meetings, expert missions, and consultancies; official data reported by MS and their facilities; and a thorough review of the literature. Data were compiled in the IAEA Nuclear Medicine Database (NUMDAB) and the Medical Imaging and Nuclear Medicine Global Resources Database (IMAGINE). NUMDAB includes data on the status of NM practices worldwide, with data on individual NM facilities, their personnel, equipment, and use of isotopes and radiopharmaceuticals (*8*). IMAGINE includes comprehensive data on medical imaging and NM resources, as well as information on infrastructure from >170 countries and territories (*9*). Both databases were designed to collect information on the availability of relevant resources in MS to support a comprehensive, evidence-based, and strategic approach for a systematic data validation process. The categories analyzed include equipment, radiopharmacy infrastructure and availability of radiopharmaceuticals, human resources, educational programs, geographic distribution of resources, types of procedures, and implementation of quality management systems. Changes are expressed in absolute numbers, percent change, and compound annual growth rate (CAGR), where appropriate.

Findings

Technology (Table 1)

Overall, the number of gamma cameras (GCs), including SPECT and hybrid SPECT/CT, increased by almost 2-fold (93%) between 2014 and 2020, from 1,231 to 2,376, representing a CAGR of 11.58%. A significant increase was especially observed in hybrid instruments (82.8%). Most countries indicated an increase in the total number of GCs; however, there was a decrease in Chile, where an increase in the number of SPECT/CT units was registered (replacing more than 1 GC in some cases), as well as in Venezuela, where the number of nonoperating centers grew significantly, and, to a lesser extent, in Peru. The countries with the highest number of GCs are Argentina, Brazil, Colombia, and Mexico. Brazil registered an increase of almost 4 times, going from 360 systems reported in 2014 to 1,333 in 2020, which could be due to underreporting in 2014. The only country with no NM facilities to date is Haiti.

TABLE 1
Nuclear Medicine Instrumentation in Latin American and Caribbean Region Countries, 2014 and 2020

Country	Income status*	Total no. GCs		GCs/million population		PET units/million population	
		2014	2020	2014	2020	2014	2020
Argentina	UMIC	270	389	6.70	8.74	0.6	0.9
Bolivia	LMIC	11	17	1.11	1.49	0.0	0.4
Brazil	UMIC	-	-	1.86	6.36	0.4	0.7
Chile	HIC	55	45	3.24	2.41	0.6	1.0
Colombia	UMIC	82	140	1.79	2.81	0.2	0.3
Costa Rica	UMIC	9	9	1.96	1.80	0.2	0.2
Cuba	UMIC	15	21	1.34	1.84	0.1	0.4
Dominican Republic	UMIC	13	14	1.30	1.28	0.1	0.5
Ecuador	UMIC	7	11	0.51	0.64	0.1	0.1
El Salvador	LMIC	2	7	0.33	1.09	0.0	0.0
Guatemala	UMIC	7	7	0.50	0.41	0.0	0.1
Haiti	LIC	0	0	0	0	0	0
Honduras	LMIC	2	4	0.27	0.43	0.0	0.0
Jamaica	UMIC	2	3	0.74	1.07	0.0	0.4
Mexico	UMIC	285	285	2.46	2.17	0.3	0.4
Nicaragua	LMIC	1	2	0.18	0.32	0.0	0.0
Panama	HIC	7	10	2.06	2.44	0.3	0.7
Paraguay	UMIC	5	6	0.79	0.87	0.2	0.3
Peru	UMIC	39	38	1.34	1.16	0.1	0.1
Uruguay	HIC	17	17	5.00	5.00	0.6	0.9
Venezuela	UMIC	42	18	1.47	0.56	0.2	0.3

*Income status as defined by the World Bank Group, 2020 (*13*).
GC = gamma camera; UMIC = upper-middle-income country; LMIC = lower-middle-income country; HIC = high-income country; LIC = low-income country.

When analyzing the availability of GCs per million population, the average in the region increased from 2.16 to 3.66 (range, 0.0–8.7), with the highest growth observed in Argentina, Brazil, and Colombia. In Costa Rica, the Dominican Republic, Guatemala, and Mexico, there was a decrease in the number of cameras per million inhabitants, as the population grew while the total number of GCs remained stable. The only countries for which the average decreased significantly were Venezuela, from 1.47 to 0.63 per million, and Chile, from 3.24 to 2.41 per million.

Despite significant growth in the total number of GCs and a shift to hybrid technology, close to 7% of the operational GCs are planar, most of them small-field-of-view instruments used for specific imaging procedures, such as thyroid and renal scans, and to a lesser extent portable devices.

Currently, 17 of the 21 ARCAL MS have PET and/or PET/CT scanners, with a total of 309 in operation or in the process of being installed, >95% of which are hybrid PET/CTs. Significant overall gains in PET/CT systems took place in the region, representing a 90% growth and a CAGR of 11.25%. Argentina, Brazil, Chile, Panama, and Uruguay show the highest ratio of PET scanners per million inhabitants, and the overall regional average ratio increased from 0.3 to 0.5 (range, 0.0–1). Although the number of PET scanners in Costa Rica and Ecuador remained unchanged (1 and 2, respectively), there was a slight decrease in availability per million inhabitants as populations grew. El Salvador, Haiti, Honduras, and Nicaragua do not have PET facilities.

Radiopharmacy

Radioisotope production in LAC is limited. Argentina, Brazil, Chile, Cuba, Mexico, and Peru are the only countries that produce medical radioisotopes for diagnostic and therapeutic applications using research reactors. Only 4 countries manufacture ^{99}Mo ^{99m}Tc generators: Argentina, Brazil, Cuba, and Mexico, either through the import of fission ^{99}Mo from outside the region or through local production. Peru and Chile provide ^{99}Tc as a fission product from research reactors, and therapeutic agents are mostly imported from outside the region.

Radiopharmaceutical kits for labeling with ^{99m}Tc are mainly imported. However, 6 countries produce radiopharmaceutical kits for diagnostic procedures, either through government institutions (Argentina, Brazil, Chile, Cuba, Mexico, and Peru) or through private companies (Argentina, Brazil, Chile, Mexico, and Uruguay). Most manufacturers commercialize these products both within their own countries and throughout the rest of the region (*10*). Most of the countries have radiopharmacy units at operational levels 1 or 2, following the IAEA classification criteria (*11*). Regarding therapeutic agents, ^{131}I required for the treatment of thyroid diseases is produced to some extent in the region, as well as ^{153}Sm and ^{66}Ho. These therapeutic isotopes are locally produced in Argentina, Brazil, Chile, Mexico, and Peru. ^{177}Lu-DOTA and prostate-specific membrane antigen (PSMA) agents are imported and used clinically only in Argentina, Chile, Colombia, Cuba, Mexico, and Uruguay.

More than 90% of PET studies in the region are ^{18}F-FDG studies. Fifty-four cyclotrons are currently operative in the region, representing a 54% growth in the installed base from 2014 to 2020 (CAGR of 7.49%). All cyclotrons produce ^{18}F, and few are capable of producing ^{11}C, ^{13}N, or ^{15}O. ^{68}Ge/^{68}Ga generators have been introduced for labeling somatostatin peptide analogs and PSMA. ^{68}Ga-DOTA is already available in Argentina, Brazil, Chile, Colombia, Mexico, and Uruguay, and ^{68}Ga-PSMA is used in Brazil, Chile, Colombia, Mexico, and Uruguay. At the time of completing this publication, no therapeutic doses of ^{225}Ac-PSMA had been administered, but Colombia had performed successful labeling.

TABLE 2
Nuclear Medicine (NM) Physicians and Physicists in Latin American and Caribbean Region Countries, 2014 and 2020

Country	Avg. no. NM physicians/scanner		Medical physicists working in NM	
	2014	2020	2014	2020
Argentina	1.4	0.9	17	20
Bolivia	1.2	0.6	1	0
Brazil	0.7	0.6	25	31
Chile	0.7	0.9	2	7
Colombia	0.9	0.5	10	10
Costa Rica	0.5	0.8	1	5
Cuba	2.1	1.4	24	24
Dominican Republic	0.9	0.7	1	5
Ecuador	1.1	0.8	0	10
El Salvador	1.0	0.7	0	1
Guatemala	0.6	0.5	0	9
Haiti	0.0	0.0	0	0
Honduras	0.5	0.3	0	1
Jamaica	0.5	1.3	0	2
Mexico	0.7	0.9	6	20
Nicaragua	2.0	1.0	0	2
Panama	0.6	0.5	1	2
Paraguay	0.5	0.6	0	2
Peru	1.1	1.7	4	12
Uruguay	1.7	1.6	0	2
Venezuela	0.5	1.0	32	4

Human Resources

The 2,036 NM physicians in the region represent an increase of 61% since 2014. However, the availability of NM physicians per scanner (including both SPECT and PET) has decreased from an average of 1 in 2014 (*7*) to 0.76 on average (range, 0.3–1.7) in 2020. Cuba, Peru, and Uruguay are the countries with the highest ratios (Table 2). When analyzed on a population level, there are on average 3 NM physicians per million/population in the LAC region, similar to the levels registered in the Middle East and higher than those in Africa, but significantly lower than the average of 10 in Europe and North America (excluding Mexico) (*9*). Some NM physicians hold second specialty certification, most frequently in internal medicine, endocrinology, oncology, or cardiology. Recently, the introduction of hybrid modalities such as SPECT/CT and PET/CT has attracted more radiologists to the field. Cross-training of NM physicians in radiology is increasing, as well as training of radiologists in molecular imaging modalities, especially PET.

There are ∼2,200 NM technologists, with very inhomogeneous levels of training. A shortage of technologists persists in the region; moreover, the number of technologists per scanner decreased from 2014 to 2020. The availability of qualified NM technologists per machine varies from 0.3 to 4.0, with an average of 0.79, down from 1.6 in 2014 (*7*). Cuba, Nicaragua, Uruguay, and Venezuela showed the highest ratio of technologists per scanner.

The number of medical physicists working in NM increased from 124 to 169 in the period, indicating a growth of 34%; however, the number of physicists per center remains low (average, 0.1 per center). This may be the result of an insufficient number of graduates to keep up with the simultaneous increase in the number of facilities. Argentina, Brazil, Cuba, and Mexico have the highest number of these professionals working in NM, whereas Bolivia and Nicaragua have no medical physicists (Table 2).

An increase of 62% in radiopharmacists and radiochemists was observed in the region, for a total of 162, with Mexico and Uruguay having the largest numbers. Given the growth of cyclotron installations, the shortage of radiopharmacists and radiochemists is more evident, and meeting demands has become especially challenging.

Professional education

Countries like Argentina, Brazil, Colombia, Chile, Dominican Republic, Mexico, Peru, Uruguay, and Venezuela have tertiary educational institutions for training of NM physicians in accredited programs conferring a specialty degree or diploma. However, postdegree educational programs differ among these countries, considered as primary specialties in some (with a duration of 3–4 years) and as subspecialties of internal medicine or radiology in others, with an average duration of 2 years. In Venezuela, for example, training in this area forms part of a broader program in radiation medicine, including both radiotherapy and NM.

Levels of education and training for technologists differ from country to country. Formal university degrees are offered in Argentina, Brazil, Chile, Costa Rica, Cuba, Dominican Republic, Guatemala, Jamaica, Mexico, Peru, and Uruguay. In most cases, training focuses not only on NM but also includes other areas of "radiation medicine," such as radiology and radiotherapy. Uruguay is the only country with a specific university degree for NM technologists. However, the number of formally trained technologists does not meet demand, and many positions are filled by individuals with training in other areas. In Brazil, for example, many positions are occupied by licensed biologists or laboratory technicians. In Colombia "bacteriologists" receive some specific training in NM.

Many countries have postgraduate educational programs in medical physics, including Argentina, Brazil, Chile, Costa Rica, Cuba, Colombia, Dominican Republic, Jamaica, Mexico, Peru. and Uruguay. In general, the offer of training programs has significantly increased during recent years. Medical physics is a recognized profession, and medical physicists play a central role in ensuring the safe and effective practice of NM and perform a variety of technical tasks. However, their work is not always well defined and is frequently not understood by health care professionals and health care authorities. Medical physicists are not always recognized as health professionals, a circumstance that can be observed in most of the countries in the region, thus leading to a lack of formal positions in most hospitals and institutions. A few countries, like Cuba, have established a regulatory requirement for the mandatory involvement of medical physicists in NM activities, but the general acceptance of this requisite depends on availability of competent professionals. Conversely, most medical physicists tend to prefer more attractive areas such as radiotherapy, especially in terms of remuneration. According to PAHO data from 2013 (*12*), 72% of medical physicists in the region dedicated their work to radiotherapy and only 14% to NM.

With reference to radiopharmacists and radiochemists, some countries have established university programs, including Argentina, Brazil, Costa Rica, Cuba, Mexico, and Uruguay, with graduates having access to master's or PhD degrees in most cases. These professionals, many of whom are involved in academic and research initiatives, commercial activities (such as manufacturing of generators and cold kits), and the handling of PET radiopharmaceuticals, have substantially contributed to the development and expansion of diagnostic and therapeutic applications of NM in LAC. In countries with no regular training programs, professionals working in this area have been trained abroad.

Continuing professional development

In addition to formal training programs in many countries of the region for all professions required for the practice of NM, many continuing professional development opportunities are available through activities organized or sponsored by local or regional scientific societies, as well as by the IAEA. The Latin American Association of Biology and Nuclear Medicine Societies (ALASBIMN) has a Continuing Education Committee that organizes training courses during their congress, which takes place every 2 years, and sponsors several activities organized by the respective NM society members.

The IAEA has continued to play a major role in improvement of human resources, sponsoring several regional and national training courses covering a wide spectrum of subjects, including basic sciences, technical and clinical issues, radiopharmacy, radiation safety, and quality management, among others. The IAEA has also supported a large number of NM professionals for activities such as international residency training, fellowships and scientific visits, short trainings, and international conferences dedicated to cardiac imaging, molecular imaging, and theranostics. More recently, the IAEA has established cooperation agreements and strategic partnerships with important international organizations such as the SNMMI, the European Association of Nuclear Medicine, and the American Society of Nuclear Cardiology, which have enabled access for >1,000 participants from the region to ebinars and other continuing medical education activities. It is expected that these educational events will expand in the near future, reaching a wider audience of professionals.

Availability of scanners and income status

Data compiled by the IAEA and included in the IMAGINE database (*9*) indicate a correlation between the availability of scanners and income status as defined by the World Bank (*13*) (Table 1). For example, the average number of scanners in low-income countries is 0.039 SPECT cameras and only 0.006 PET scanners per million population, whereas in high-income countries these respective averages are 17.6 and 3.5. In LAC, the availability of SPECT and PET scanners is markedly higher in high-income countries such as Chile, Panama, and Uruguay and in upper-middle-income countries such as Argentina, Brazil, Colombia, and Mexico, than in lower-middle-income nations like Bolivia or Honduras and Nicaragua. On average in LAC, 1 SPECT scanner served >468,261 people in high-income, 584,102 in upper-middle-income, and 1,631,564 in lower-middle-income countries. The difference is even more staggering when the number of people served by 1 PET scanner is analyzed. Whereas 1 PET served 1,164,313 in the high-income countries of the region, it served 2,903,124 in upper-middle-income (more than double) and a shocking 11,400,000 people in lower-middle-income countries (Fig. 1).

In most of the countries analyzed, except Cuba and Venezuela, >70% of resources are located in the private sector, despite the fact

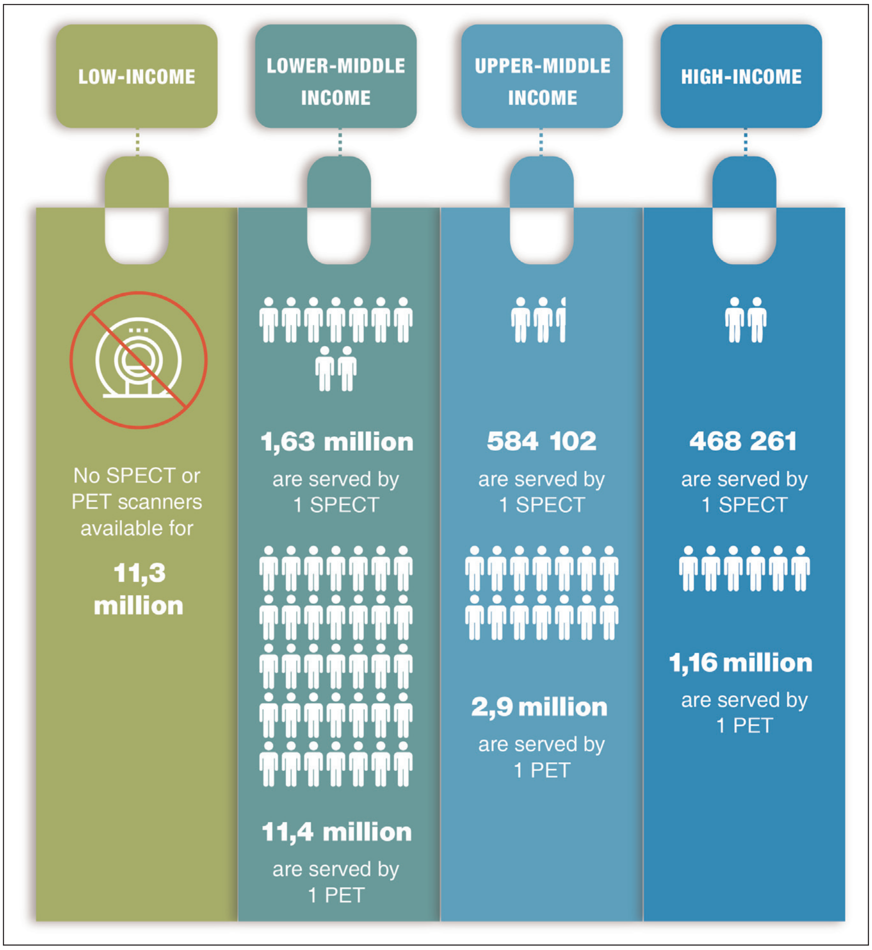


FIGURE 1. Average number of people served by 1 SPECT and by 1 PET scanner in the Latin America and Caribbean region, correlated with income status.

that health care is provided for the majority of the population through the public system. However, in some countries, at least part of the public demand is covered by government subcontracting of NM services to the private sector. NM facilities are predominantly concentrated in capital cities and other large urban communities; this is more pronounced for PET than for SPECT or SPECT/CT.

Types of procedures

According to data obtained from NUMDAB, which represents about 10% of all NM departments in the region, >90% of procedures performed in a typical NM setting in LAC are diagnostic, involving SPECT and/or PET. For general NM studies, cardiac, bone, and renal scintigraphy are the most commonly performed. Hybrid SPECT/CT is mostly used for attenuation correction of cardiac scans and/or for anatomic localization (parathyroid, orthopedics, MIBG, etc.). PET applications are growing quickly, currently representing about 5%–10% of total NM examinations, with oncologic applications accounting for >90%. Sentinel node detection and other types of radioguided surgery are increasing rapidly in most countries, although the number of intraoperative gamma probes and procedures were not included in this survey.

Approximately 5% of total NM procedures are therapeutic, the vast majority of which entail the use of radioiodine for hyperthyroidism and thyroid cancer. However, in some countries there has been increased use of new therapeutic agents, such as somatostatin peptide analogs and PSMA labeled with ^{177}Lu for neuroendocrine tumors and prostate cancer, respectively.

Quality management

The IAEA has developed Quality Management Audits in Nuclear Medicine (QUANUM) (*14–17*), a comprehensive program introduced in 2007 and periodically updated. It has significantly contributed to enhancing the quality and safety of clinical NM services in IAEA MS. It has promoted establishment of quality management systems, adoption of quality culture, and implementation of systematic reviews of all processes involved in the practice of NM, with the goal of improving the overall quality of clinical services provided by NM departments. As part of the support provided to MS, the IAEA has conducted 76 QUANUM audits worldwide, 22 of which were in 7 LAC countries. In addition, 5 multidisciplinary teams of professionals, including nuclear physicians, radiopharmacists, medical physicists, and technologists, have been trained as auditors and >1,000 NM professionals have received some training in quality management applied to NM.

Discussion

NM has an established role in evaluation of patients with a wide spectrum of diseases. Whether it is applied in oncology, cardiology, nephrourology, orthopedics, rheumatology, or even neuropsychiatry, NM functions as one of the main drivers of disease management. The clinical indications of radionuclide therapies are also advancing rapidly. The availability of new tracers has propelled the growth of both diagnostic and therapeutic applications of NM globally.

Although NM is a growing market and its clinical applications are expanding rapidly along with the need for personalized medicine, access to medical imaging and health care as a whole is not equitable. Wealthier regions and individuals have more access to medical imaging. As reported in the IAEA IMAGINE database (*9*), the availability of SPECT and PET scanners per million population varies greatly, with overwhelming differences when correlated with income status or geographic distribution. According to analysis conducted by the IAEA on development of NM in LAC from 2014 to 2020 and presented here, there has been a significant growth in NM equipment in the region, with a CAGR of 11.58% for SPECT and 11.25% for PET. The observed growth is well above the global average of 7.72% CAGR (2016–2019) for both modalities reported in the Market Research Future Report (*18*). Latin America accounted for 16.24% of the NM market share in the Americas in 2018, which in turn comprises 53.10% of the global NM market share, followed by Europe with a 23.76% share (*18*).

Regarding the number of cyclotrons, there has been an increase to 54, from 35 available in 2014, which represents a CAGR of 7.49%

Despite the significant growth observed during the period analyzed, the number of GCs (including SPECT/CT) per million inhabitants in LAC is 3.7, which is much lower than that observed in high-income countries such as the United States (45.17), Canada (15.72), or European countries, where it varies between 6.7 and 16 GCs per million inhabitants. The average number of PET scanners per million population in the LAC is 0.5 (0.0–0.93), which is also well below that of the United States (7.3), Australia (3.15), Canada (1.44), or Europe (2.0 average; range, 0.1–8.0) (*9,19,20*).

Reasons for the regional expansion of NM include greater economic stability, more awareness about the importance of nuclear techniques in management of prevalent diseases, increased capacity building, and the continuous support of international organizations such as the IAEA through national and regional projects, as well as strong public/private partnerships and government commitment to better health care options. The availability of almost all current diagnostic applications, as well as the introduction of novel therapeutic agents, endows the region with the potential to provide NM services consistent with international standards. The observed growth in molecular imaging and therapy gives cause for optimism, as does the progressive acceptance of theranostics as a valid strategy to manage patients in a more personalized and effective fashion.

A significant number of well-qualified, highly competent professionals are available in the region, and tertiary-level educational programs are in place in many countries, covering all disciplines needed for the practice of NM. These strengths are reinforced through horizontal cooperation among nations, especially in training of human resources and supply of consumables and radiotracers. The cited growth in hardware coincides with a significant increase in the numbers of medical physicists, although greater recognition as valued members of the NM team is still needed (*21,22*). Over the same period, the number of NM physicians and radiopharmacists increased by >60%. However, the number of technologists remained the same. Human resources remain insufficient to meet population-based, evidence-based health care demands. Due to rapidly emerging therapies and imaging techniques, continuous professional development is essential and can be achieved only through collaboration. Events held by national and international scientific societies and agencies play an important role in strengthening educational and strategic support, mainly through organization of continuing education activities.

In some countries, NM services are still insufficient. The main factors affecting the expansion and sustainability of NM include (but are not limited to): the magnitude of the required investment, high operational and maintenance costs, shortages of qualified personnel, and limited supplies of radiopharmaceuticals. As stated in our previous report (*7*), one of the main challenges in the region remains insufficient development of specific health policies, hindering the growth of the specialty. These should include active and open collaboration between regulators, public health authorities, academia, and the NM community, leading to a wider coverage of procedures by health providers based on solid scientific evidence. A rational assessment of the potential impact of state-of-the-art imaging technologies in public health and related costs should result in positive recommendations toward the growth of NM in the region, based in most cases on a favorable cost/benefit ratio. If the expected outcome is to treat prevalent conditions in a better and faster way, the new technology is likely to reduce utilization of other less efficient methods and therefore reduce total costs per patient, with better clinical results.

Great regional heterogeneity in the availability of both technology and skilled human resources persists. Within countries, imaging systems are disproportionately distributed in large urban settings and preferentially within private over public sectors. These issues, coupled with continued deficits in production of radioisotopes for both diagnostic and therapeutic uses, still result in many patients remaining marginalized.

As previously mentioned, NM serves a cross-cutting role in addressing several population-based public health priorities, especially in the management of NCDs. Although NM grew substantially in the LAC region over the past 6 years, current capacities still fall short of meeting the increasing demands of a large proportion of patients. Awareness of this situation should stimulate continuous support to MS in rational strategic planning, so the benefits of appropriate nuclear technologies can be further extended to all people.

Limitations

A substantial part of the collected data was based on voluntary contributions from NM experts and professionals across the region. Although the IAEA has systems in place to ensure the maximum level of validation of data provided, the consistency and accuracy of estimates are strongly dependent on input given by collaborators and on available information sources.

Although data for this report were collected until mid-2020, the effect of the COVID-19 pandemic is not reflected in the results. Recent surveys carried out by the IAEA reveal a significant decrease in the number of NM procedures in April and May 2020, registering a decline of SPECT procedures by 54%, PET studies by 36%, and radionuclide therapies by 45%. The LAC region was one of the most affected, with a 63% reduction in PET studies and >70% reduction in SPECT studies and radionuclide therapies (*23*). A survey conducted by the IAEA Noninvasive Cardiology Protocols Study group reflected a significant decrease in the volume of diagnostic cardiac procedures performed during the pandemic (*24,25*). Air transport shutdowns have likely affected radiopharmaceutical supplies in many countries, and health investment from public and private sectors may have been reallocated toward infrastructure and logistics to address the pandemic.

Conclusion

NM is a well-established and recognized medical specialty in the LAC region, regarded as a fundamental tool to confront the challenges of the increasing prevalence of NCDs. As the molecular bases of chronic diseases are better understood, patient-tailored diagnostic and treatment modalities are becoming more available, allowing an evidence-based rationale for patient management. The growth in NM and particularly in hybrid imaging instrumentation reflects increasing acceptance, despite substantial investments required to meet demand. Although efforts should continue to focus on preventive measures and primary care, technology improvements remain essential to address large sectors of the population living longer and being progressively affected by degenerative conditions and NCDs. The shortage of specialized personnel to effectively manage complex equipment such as cyclotrons and hybrid scanners (SPECT/CT and PET/CT), as previously clearly identified, seems to be resolving (at least partially) through the establishment of training programs in NM, medical physics, and radiopharmacy in several countries.

One important factor for development of the specialty was found to be awareness of clinicians about applications of NM in management of prevalent diseases in the region. With this in mind, progress remains to be made in reinforcement of cross-specialty educational activities. Although the assistance of international organizations such as the IAEA has continued through national and regional projects, stronger public/private partnerships and government commitments are essential to enable communities to take full advantage of the benefits offered by NM.

REFERENCES

1. Pan American Health Organization. *Health in the Americas. Summary: Regional Outlook and Country Profiles*. 2017 ed. Washington, DC: Pan American Health Organization, 2017.
2. World Health Organization. *Noncommunicable Diseases Country Profiles 2018.* Geneva, Switzerland: World Health Organization; 2018.
3. Pan American Health Organization. *Core Indicators 2019. Health Trends in The Americas.* Washington, DC: Pan American Health Organization; 2019.
4. World Health Organization. *Coronavirus Disease (COVID-19) Dashboard.* Available at: https://covid19.who.int/table. Accessed on March 20, 2021.
5. United Nations. *Transforming Our World: The 2030 Agenda for Sustainable Development.* Available at: https://sdgs.un.org/2030agenda. Accessed on March 20, 2021.
6. Organisation for Economic Co-operation and Development Centre. *Latin American Economic Outlook 2019: Development in Transition.* Paris, France: OECD Publishing; 2019. Available at: https://doi.org/10.1787/g2g9ff18-en. Accessed on March 20, 2021
7. Paez D, Orellana P, Gutierrez C, Ramirez R, Mut F, Torres L. Current status of nuclear medicine practice in Latin America and the Caribbean. *J Nucl Med.* 2015;56:1629–1634.
8. International Atomic Energy Agency. Nuclear Medicine Database. NUMBAD. Human Health Campus Website. https://https://nucmedicine.iaea.org/data. Accessed January 21, 2021.
9. International Atomic Energy Agency. Medical Imaging and Nuclear Medicine Global Resources Database (IMAGINE). Human Health Campus Website. Available at: https://humanhealth.iaea.org/HHW/DBStatistics/IMAGINE.html. Accessed on March 21, 2021.
10. Cutler CS, Bailey EA, Kumar V, et al. Global issues of radiopharmaceutical access and availability: A nuclear medicine global initiative project. *J Nucl Med.* 2020;62(3):422–430.
11. International Atomic Energy Agency. *Operational Guidance on Hospital Radiopharmacy: A Safe and Effective Approach.* Vienna, Austria: International Atomic Energy Agency; 2008. Available at: https://www-pub.iaea.org/MTCD/Publications/PDF/Pub1342/Pub1342_web.pdf. Accessed on March 21, 2021.
12. Renha SK. Quality and safety in radiology. State of medical physicists in Latin America. Presentation. Pan American Health Organization (PAHO); 2013. Available at: https://www.paho.org/hq/dmdocuments/2013/6-Kodlulovich-world-radiology-day.pdf. Accessed on March 21, 2021.
13. World Bank Group. World Bank Data. https://data.worldbank.org/indicator/Published2020. Accessed January 21, 2021.
14. International Atomic Energy Agency. *Quality Management Audits in Nuclear Medicine Practices. IAEA Human Health Series No. 33.* 2nd ed. Vienna, Austria: International Atomic Energy Agency; 2015. Available at: https://www-pub.iaea.org/MTCD/Publications/PDF/Pub1683Web-68161172.pdf. Accessed on March 20, 2021.
15. Dondi M, Torres L, Marengo M, Massardo T, Mishani E, Van Zyl Ellmann A, et al. Comprehensive auditing in nuclear medicine through the International Atomic Energy Agency Quality Management Audits in Nuclear Medicine (QUANUM) Program. Part 1: the QUANUM program and methodology. *Semin Nucl Med.* 2017;47(6):680–686.
16. Dondi M, Torres L, Marengo M, Massardo T, Mishani E, Van Zyl Ellmann A, et al. Comprehensive auditing in nuclear medicine through the International Atomic Energy Agency Quality Management Audits in Nuclear Medicine Program. Part 2: Analysis of results. *Semin Nucl Med.* 2017;47(6):687–693.
17. Dondi M, Paez D, Torres L, Marengo M, Delaloye AB, Solanki K, et al. Implementation of quality systems in nuclear medicine: Why it matters. An outcome analysis (Quality Management Audits in Nuclear Medicine Part III). *Semin Nucl Med.* 2018;48(3):299–306.
18. Global Nuclear Medicine Market Research Report. Forecast 2025. Edt. Market Research Future, 2020.
19. Eurostat. Healthcare resource statistics. Technical Resources and Medical Technology Statistics Explained. Data extracted in August 2020. Source: Statistics Explained (https://ec.europa.eu/eurostat/statisticsexplained/) - 24/09/2020. Available at: https://ec.europa.eu/eurostat/statistics-explained. Accessed January 21, 2021.
20. IMV Medical Information. 2020 PET Imaging Market Summary Report. Available for purchase at: https://imvinfo.com/product/2020-pet-imaging-market-summary-report/. Accessed March 20, 2021.
21. Chanta W, Montezuma R, Caricato P. Status of medical physics in Central America. *Med Phys Int.* 2019;7:17–24.
22. Guzman S. Status of medical physicist collaborations and projects in Latin America. Presented at the 57th annual meeting of the American Association of Physicists in Medicine. 2015; Anaheim, CA. Available at: https://www.aapm.org/education/VL/vl.asp?id=4766. Accessed on March 20, 2021.
23. Freudenberg LS, Paez D, Giammarile F, Cerci J, Modiselle M, Pascual T, et al. Global impact of COVID-19 on nuclear medicine departments: An international survey in April 2020. *J Nucl Med.* 2020;61(9):1278–1283.
24. Einstein A.J, Shaw LJ, Hirschfeld C, Williams MC, Villines TC, Better N, et al. on behalf of the INCAPS COVID Investigators Group. International impact of COVID-19 on the diagnosis of heart disease. *J Am Coll Cardiol.* 2021;77(2):173–185.
25. Cerci RJ, Vitola JV, Paez D, et al. COVID-19 impact on the diagnosis of cardiac disease in Latin America: The IAEA Non-invasive Cardiology Protocols Study of COVID-19. Manuscript submitted for publication. 2021.

SNMMI Statement: The Effect of COVID-19 Vaccination on FDG PET/CT

On March 30, SNMMI released the following statement on FDG-avid reactive lymphadenopathy on PET/CT in patients following COVID-19 vaccinations:

Reactive lymphadenopathy has been reported in up to 16% of patients following COVID-19 vaccination with the mRNA (Pfizer/BioNTech, Moderna) vaccines; this side effect has not been reported to date with the AdV vector vaccine (Janssen/Johnson & Johnson) (*1–5*). Some guidelines (National Comprehensive Cancer Network) recommend delay of imaging by 4–6 weeks following the COVID-19 vaccine if it will not affect patient outcomes (*2*). It is not known at this time if delaying imaging by 6 weeks after the second dose of COVID-19 vaccine is sufficient to ensure resolution of FDG-avid lymphadenopathy.

As with some other vaccinations, such as the influenza vaccine, FDG uptake can also occur at the COVID-19 vaccine injection site. Development of FDG-avid lymphadenopathy is generally ipsilateral to the site of vaccine injection. In addition to the axillary nodes, lymph nodes in the ipsilateral lower internal jugular and supraclavicular stations may also demonstrate FDG uptake. Physicians in the SNMMI COVID-19 Task Force have also anecdotally observed splenomegaly/increased splenic uptake following COVID-19 vaccination. Additional information will be shared on this platform as it becomes available.

The COVID-19 Task Force makes the following recommendations based on the currently available information (*1–7*):

1. Recognize that FDG-avid lymphadenopathy can occur in the axillary (and possibly lower cervical/supraclavicular) station(s) ipsilateral to the site of injection and can be seen for 4–6 weeks or longer after the most recent dose of vaccine.
2. Patient questionnaires should be revised to include information about the date(s) and site(s) of vaccination and which vaccine was administered.
3. For patients with a history of breast and head and neck cancers, the vaccine should be administered in the contralateral arm whenever possible.

REFERENCES

1. Doss M, Nakhoda SK, Li Y, Yu JQ. COVID-19 vaccine-related local FDG uptake. *Clin Nucl Med.* 2021;46(5):439–441.
2. National Comprehensive Cancer Network. Recommendations of the NCCN COVID-19 Vaccination Advisory Committee. Available at: https://www.nccn.org/covid-19/pdf/COVID-19_Vaccination_Guidance_V2.0.pdf. Accessed on April 19, 2021.
3. Centers for Disease Control and Prevention. Local reactions, systemic reactions, adverse events, and serious adverse events: Pfizer-BioNTech COVID-19 vaccine. December 13, 2020. Available at: https://www.cdc.gov/vaccines/covid-19/info-by-product/pfizer/reactogenicity.html. Accessed on March 6, 2021.
4. Centers for Disease Control and Prevention. Local reactions, systemic reactions, adverse events, and serious adverse events: Moderna COVID-19 vaccine. December 20, 2020. Available at: https://www.cdc.gov/vaccines/covid-19/info-by-product/moderna/reactogenicity.html. Accessed March 6, 2021. 2021.
5. Centers for Disease Control and Prevention. Local reactions, systemic reactions, adverse events, and serious adverse events: Janssen COVID-19 vaccine. February 26, 2021. Available at: https://www.cdc.gov/vaccines/covid-19/info-by-product/janssen/reactogenicity.html. Accessed on March 6, 2021.
6. Grimm L, Destounis S, Dogan B, et al. Society of Breast Imaging: SBI recommendations for the management of axillary adenopathy in patients with recent COVID-19 vaccination. Available at: https://www.sbi-online.org/Portals/0/Position%20Statements/2021/SBI-recommendations-for-managing-axillary-adenopathy-post-COVID-vaccination.pdf. Accessed on March 8, 2021.
7. Lehman CD, Mendoza DP, Succi MD, et al. Unilateral lymphadenopathy post COVID-19 vaccination: A practical management plan for radiologists across specialties. *J Am Coll Radiology.* 2021. Published on March 4 ahead of print.

SNMMI Fellowships for NCTN Cooperative Group Participation

The National Cancer Institute (NCI) National Clinical Trials Network (NCTN) cooperative cancer groups include the ECOG-ACRIN Cancer Research Group, Alliance for Clinical Trials in Oncology, Children's Oncology Group, SWOG Cancer Research Network, and NRG Oncology. The cooperative groups are important drivers for the future practice of oncology patient management. With the increasing importance of radiopharmaceutical therapies, nuclear medicine physician participation in the design and implementation of NCTN clinical trials is essential. To help ensure that nuclear medicine physicians have an active voice in the activities of these groups, the SNMMI Value Initiative approved in March the creation of 6 Cancer Cooperative Group Junior Faculty Mentorship Awards. This 1-year award will support nuclear medicine physician participation at 2 in-person cooperative cancer group meetings and will provide $2,000 to cover costs of travel to the meetings. To encourage this participation, the new grants will pair each junior faculty member with a senior member in the respective cooperative groups.

To kick off this initiative, 21 junior and senior nuclear medicine physicians participated on March 24 in a conversation with Lalitha Shankar, MD, PhD, Chief, NCI Clinical Trials Branch. Dr. Shankar gave an overview of the cooperative group structure, advised the junior members on opportunities in each, and answered questions in an informative and interactive discussion period. This group will continue to meet biannually, and Dr. Shankar will present a continuing education session on the activities of the NCTN at the SNMMI Annual Meeting in June. Additional eligibility and application information is posted on the SNMMI website at Cancer Cooperative Group Junior Faculty Mentorship Award (smarterselect.com).

SNMMI

From the ABNM: Adoption of Progressive Leave Policy for Residents and Fellows

Leonie Gordon, MBChB, Associate Executive Director, American Board of Nuclear Medicine

Starting in July 2021, all American Board of Medical Specialties (ABMS) member boards with training programs of 2 or more years duration will allow for a minimum of 6 weeks away once during training for purposes of parental, caregiver, and medical leave, without exhausting time allowed for vacation or sick leave and without requiring an extension in training. In July 2020, the ABMS announced the adoption of a progressive leave policy offering all residents and fellows more flexibility and increased autonomy in making life decisions, especially regarding family and parental leave. Creating a policy that was more realistic and compassionate, the ABMS member boards believed it would improve quality of life for residents and fellows and support women physician trainees by allowing greater leave flexibility and (hopefully) help narrow the gender gap in career advancement. The new policy applies to all trainees in programs of 2 or more years duration and to eligibility for Initial Certification.

The development of the new ABMS Policy on Parental, Caregiver, and Family Leave was initiated following a report from the Accreditation Council on Graduate Medical Education (ACGME) Council of Review Committee Residents in June 2019. An ABMS Task Force on Parental Leave was established, and ABMS and ACGME cosponsored a workshop on resident and fellow parental and family leave in early February 2020 that brought together more than 80 multidisciplinary stakeholders to explore this issue and make recommendations for improvement. There was a high level of engagement from ABMS boards to address this important issue for physicians in training, and the new policy reflected the member boards' commitment to maintaining high standards for physician training while preserving trainees' physical and emotional well-being. The consensus from participants was that improving current leave policies was not only an appropriate but a necessary advancement to improve the training environment for residents and fellows.

The ABMS-approved policy offered all member boards, such as the American Board of Nuclear Medicine (ABNM), the flexibility to create a parental, family, or medical leave protocol that best suits the training required for each specialty. ABMS policy applies to training programs that are 2 years or longer, and so does not apply to nuclear medicine training programs of 12–16 months. Some examples are international medical graduates who need 12 months of nuclear medicine training in the United States, radiologists in a 12-month nuclear radiology fellowship program, diagnostic radiology residents in a 16-month nuclear radiology pathway during residency, and radiologists in the American Board of Radiology alternate pathway. ABNM leave policy states that leave for any reason, such as vacation, illness, or family leave, may be taken as permitted by the local institution's graduate medical education office or equivalent, and/or applicable rules of the ACGME. In the absence of such rules, up to 6 weeks (30 working days) of leave are permitted per academic year. When nuclear medicine training is longer than 1 year, the average length of leave should not exceed 6 weeks per academic year. If leave exceeds these limits, as permitted or required by state or federal regulations, the program director must have a plan approved by the ABNM to compensate for lost educational time.

Leonie Gordon, MBChB

Many boards, as well as residents and fellows, were encouraged and relieved at the change in policy and believed it to be long overdue. By recognizing the importance of time away for birthing parents, non-birthing parents, adoptive/foster parents, and surrogates, the policy acknowledges that families come in different forms and that each parent plays a vital role in the development of a child.

Allowing greater leave flexibility for women physicians in training is a critical step toward gender equity in medicine. Many women have contended with the consequences of taking too much leave, including perceived burdens on co-residents, delayed graduation, lost fellowships, or inability to meet board certification requirements. These consequences have undoubtedly affected the career trajectory of women physicians, but the hope is that greater leave flexibility will not force someone to choose between having a child and career advancement.

Learn more about the new ABMS policy at: https://www.abms.org/policies/parental-leave/ and about ABNM training requirements at: https://www.abnm.org/index.php/exam/training-requirements/.

A Challenging and Rewarding Year

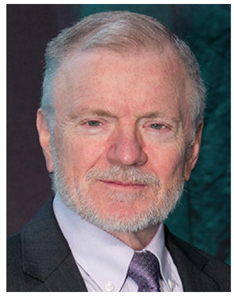
Alan B. Packard, PhD, SNMMI President

This has been an incredibly challenging year, both for SNMMI as an organization and for each of us personally. But throughout this crazy year, I have been continually impressed by the way SNMMI members and staff have worked together to get things done. Despite the challenges of this being an entirely virtual year, working together we have accomplished a great deal.

Last spring, SNMMI was faced with the challenge of transitioning from an in-person Annual Meeting to its first-ever Virtual Annual Meeting with less than 2 months of lead time. The Scientific Program Committee and staff met this challenge by putting together a virtual meeting that succeeded beyond all expectations, with more than 8,000 registrants and very positive feedback from attendees.

In preparing for the 2021 Annual Meeting, we have had more time to plan and more experience in presenting content virtually. And we have learned that a large number of people would like to attend our meetings, but are for various reasons unable to attend in person. This year's Annual Meeting will allow us to welcome these people virtually once again, with expanded content presented on a more refined platform. Moving forward, we expect that future SNMMI meetings will be "hybrid," mixing an exciting in-person meeting with valuable virtual content.

Developing new networking opportunities for our members has been another significant challenge this past year. One of my favorite things about scientific meetings is the opportunity to see friends and colleagues and meet new people. This hasn't been possible this year, so we have implemented new ways for people with similar interests to gather virtually. For example, the Radiopharmaceutical Sciences Council and the Center for Molecular Imaging, Innovation, and Translation teamed up to host "Drink & Think" sessions focused on topics of interest to their members, such as the challenge of running a radiochemistry laboratory during the COVID-19 lockdown last summer and the implementation of USP <825>. Other groups within SNMMI are now planning similar get-togethers.



Alan B. Packard, PhD

One important outcome of these virtual gatherings has been greater engagement of younger SNMMI members. One challenge moving forward will be to continue to actively engage younger members and attendees from other specialties once we return to in-person meetings. I would like to encourage everyone to make an effort, both now and once we are again able to gather in person, to welcome younger members and those from other specialties to our meetings and society activities.

The objectives of developing new networking opportunities and "building bridges" came together with the creation of the Diversity, Equity, & Inclusion Task Force. Among the accomplishments of this task force was implementation of "Intentional Gatherings," opportunities for members with diverse backgrounds to come together and share their experiences in the nuclear medicine community and within SNMMI. The need to build bridges has never been greater than in the past several years, and this is a significant step in that direction.

I would also like to thank our Value Initiative partners for their support this past year. It has been an extraordinarily challenging year not only for clinicians, scientists, and technologists but also for our partners in industry, who have nevertheless continued to work with us to advance the important programs supported by the Value Initiative.

In closing, I would like to once again thank my friends and colleagues within the society and the SNMMI staff for their help and support throughout this past year. Together we have managed to accomplish far more than we expected when we started this journey, and none of this would have happened without your hard work and dedication. Thank you, all!

Each month the editor of Newsline selects articles on diagnostic, therapeutic, research, and practice issues from a range of international publications. Most selections come from outside the standard canon of nuclear medicine and imaging journals. These briefs are offered as a monthly window on the broad arena of medical and scientific endeavor in which nuclear medicine now plays an essential role. The lines between diagnosis and therapy are sometimes blurred, as radiolabels are increasingly used as adjuncts to therapy and/or as active agents in therapeutic regimens, and these shifting lines are reflected in the briefs presented here. We include a small section on noteworthy reviews of the literature.

^{131}I Remnant Ablation and Postoperative Outcomes

Hay et al. from the Mayo Clinic (Rochester, MN) reported on March 17 ahead of print in *Mayo Clinic Proceedings* on a study designed to determine whether radioiodine remnant ablation reduces cause-specific mortality or tumor recurrence rates after bilateral lobar resection in patients with low-risk adult papillary thyroid cancer. The study included the records of 2,952 such patients who underwent resection over a 60-y institutional period. Twenty-year grouped analyses showed that ^{131}I remnant ablation was administered in 3% of patients from 1955 to 1974 (period 1), 49% from 1975 to 1994 (period 2), and 28% from 1995 to 2014 (period 3). During the earliest period, the cause-specific and tumor recurrence rates after bilateral lobal resection were 1.0% and 6.8%, respectively. After resection + ablation these respective rates were 0% and 5.9%. The corresponding rates for period 2 were 0.3% and 7.5% for resection alone and 0.9% and 12.8% for resection + ablation. In period 3, the corresponding rates were 0% and 9.2% for resection alone and 1.4% and 21% after resection + ablation. Additional analyses showed nonsignificant differences in tumor recurrence rates for node-negative and -positive patients undergoing resection alone or resection + ablation. Fifteen-year locoregional recurrence rates did not identify significant differences in these groups. The authors summarized their findings that radioiodine remnant ablation administered to patients with low-risk adult papillary thyroid cancer over a 60-y period did not reduce rates of either cause-specific mortality or tumor recurrence. They concluded that they would not recommend radioiodine remnant ablation for such patients undergoing bilateral lobar resection with curative intent.

Mayo Clinic Proceedings

^{68}Ga-FAPI PET/CT and Checkpoint Inhibitor–Associated Myocarditis

In an article published on February 25 in *Frontiers in Cardiovascular Medicine* (2021;8:614997), Finke et al. from University Hospital Heidelberg, DZHK (German Center for Cardiovascular Research), DKFZ (German Cancer Research Center), and DZL (German Center for Lung Research) (all in Heidelberg, Germany) reported on a study of the utility of ^{68}Ga–fibroblast-activation protein inhibitor (^{68}Ga-FAPI) PET/CT in detecting immune checkpoint inhibitor (ICI)–associated myocarditis. The retrospective study included imaging from 26 patients who had received ICI therapy. Tracer uptake in the 23 patients with no signs of cardiac disease was compared with that in the 3 patients with suspected ICI-associated myocarditis. These 3 patients underwent cardiac catheterization, with biopsies assessed for inflammatory cells. Lymphocyte infiltration was found in biopsied myocardium. Additional clinical and laboratory assessments showed electrocardiographic abnormalities and wall motion abnormalities on echocardiography. These 3 patients' PET/CT results showed higher cardiac uptake (SUV_{median}, 1.79) than that in the 23 patients who had received ICIs but had no signs of immunologic adverse effects or cardiac impairment (SUV_{median}, 1.15). The authors concluded that ^{68}Ga-FAPI "may be used in order to identify affected patients at an early stage," and that, when integrated into cancer stage diagnostics, such imaging contributes to cardiac risk stratification in addition to biomarkers, electrocardiography, and echocardiography.

Frontiers in Cardiovascular Medicine

PET/CT, CT, and EBUS/TBNA in NSCLC Staging

Al-Ibraheem et al. from the King Hussein Cancer Center (Amman, Jordan), Essen University Hospital (Germany), the Università di Bologna (Italy), and the International Atomic Energy Agency (Vienna, Austria) reported on March 17 in *BMC Medical Imaging* (2021;21[1]:49) on a study of the comparative diagnostic accuracy of ^{18}F-FDG PET/CT, CT, and endobronchial ultrasound/transbronchial needle aspiration (EBUS/TBNA) in preoperative mediastinal lymph node staging of non–small cell lung cancer (NSCLC). The single-institution retrospective study included the records of 101 patients diagnosed with NSCLC, 57 of whom had histopathologic confirmation of disease. ^{18}F-FDG PET/CT, when compared with CT alone, was found to have better sensitivity (90.5% and 75%, respectively) for all patients as well as in patients with histopathologic confirmation (83.3% and 54.6%, respectively). In addition, PET/CT showed higher specificity in mediastinal lymph node staging than CT in all patients (60.5% and 43.6%, respectively) and in the histopathology-confirmed subgroup (60.6% and 38.2%, respectively). The negative predictive values of mediastinoscopy, EBUS/TBNA, and PET/CT were 87.1%, 90.91%, and 83.33%, respectively, with overall accuracy highest and similar for mediastinoscopy (88.6%) and EBUS/TBNA (88.2%), followed by PET/CT (70.2%). Analysis by nodal stage produced similar comparative results. Using PET/CT and EBUS/TBNA in patients with histopathologic confirmation, 28 true-positive and true-negative findings were correlated with final N staging. Lymph nodes with $SUV_{max} > 3$ on PET/CT were significantly more likely to be true-positive. PET/CT also identified metastatic lymph nodes in 4 patients that were not identified on EBUS/TBNA. The authors concluded that multimodality staging of mediastinal lymph nodes in NSCLC is essential for accurate staging and appropriate management and that ^{18}F-FDG PET/CT has better overall diagnostic utility than CT. They added that the "SUV_{max} of mediastinal lymph nodes can help in predicting metastases," but that a positive ^{18}F-FDG PET/CT mediastinal lymph node finding (particularly if such a result would change the treatment plan) should be verified by histopathology.

BMC Medical Imaging

^{99m}Tc-MAA and ^{89}Y-Brem SPECT/CT TNRs

In an article published on February 25 ahead of print in the *Journal of Vascular and Interventional Radiology*, Villalobos et al. from Emory University School of Medicine (Atlanta, GA) reported on studies quantifying the relationship between tumor-to-normal ratios (TNRs) attained from ^{99m}Tc-macroaggregated albumin (^{99m}Tc-MAA) and posttreatment ^{90}Y-bremsstrahlung SPECT/CT in patients with hepatocellular carcinoma (HCC) treated with glass microspheres. The study included 90 patients with HCC who underwent a total of 204 ^{99m}Tc-MAA and ^{90}Y-bremsstrahlung SPECT/CT scans for ^{90}Y-glass microsphere radiation segmentectomy or lobar treatment. Regions of interest around targeted tumor and nontumoral liver tissue were assessed and compared for the 2 imaging procedures. Mean TNRs for ^{99m}Tc-MAA and ^{90}Y-bremsstrahlung SPECT/CT were 2.96 ± 1.86 and 2.29 ± 1.10, respectively. Mean TNRs in lobar treatments were 2.88 ± 1.67 and 2.17 ± 0.89 for ^{99m}Tc-MAA and ^{90}Y-bremsstrahlung SPECT/CT, respectively. Mean TNRs in radiation segmentectomy were 3.02 ± 2.01 and 2.39 ± 1.25 for ^{99m}Tc-MAA and ^{90}Y-bremsstrahlung SPECT/CT, respectively. TNRs from the 2 SPECT/CT procedures showed overall a moderate correlation. The authors concluded that the "TNR attained from ^{90}Y-bremsstrahlung SPECT/CT is often underestimated, positively correlated with, and less variable than that attained from ^{99m}Tc-MAA SPECT/CT."

Journal of Vascular and Interventional Radiology

^{68}Ga-PSMA PET/CT and Mesorectal Lymph Node Metastases

Leitsmann et al. from University Medical Center Göttingen (Germany) reported on March 1 in *Frontiers in Surgery* (2021;8:637134) on a study describing mesorectal lymph node metastasis as a potential key index in ^{68}Ga–prostate-specific membrane antigen (^{68}Ga-PSMA) PET/CT imaging for recurrent prostate cancer. The prospective study included 12 men with biochemical recurrence after primary therapy who prospectively underwent baseline ^{68}Ga-PSMA PET/CT imaging showing mesorectal lymph node metastases. Eight of these patients underwent follow-up ^{68}Ga-PSMA PET/CT to evaluate treatment response. The median prostate-specific antigen (PSA) level on initial PET/CT was 5.39 ng/mL, and all patients had subsequent changes in therapeutic management. Androgen deprivation therapy (ADT) was initiated in 7 patients, and 1 restarted initial ADT. Three patients also received salvage radiation therapy, and docetaxel chemotherapy was initiated in 1. Decreases in PSA levels were detected in all patients after a median of 10 mo (median, 2.05 ng/mL). Six of the 8 patients who underwent follow-up ^{68}Ga-PSMA PET/CT showed a decrease or complete absence of PSMA uptake in the mesorectal lymph nodes. The authors concluded that "mesorectal lymph node metastases detected by ^{68}Ga-PSMA PET/CT seem to be a relevant localization of tumor manifestation and may serve as index lesion in the treatment of recurrent prostate cancer." They added that in addition to the known benefits of ADT and salvage radiation, in cases where imaging can identify sole mesorectal lymph node metastases individualized therapy (such as salvage lymphadenectomy or defined-field radiotherapy) could be options.

Frontiers in Surgery

Reviews

Review articles provide an important way to stay up to date on the latest topics and approaches through valuable summaries of pertinent literature. The Newsline editor recommends several general reviews accessioned into the PubMed database in February and March. van Oostenbrugge and Mulders from Radboud University Medical Center (Nijmegen, The Netherlands) provided an overview of "Targeted PET/CT imaging for clear cell renal cell carcinoma with radiolabeled antibodies: Recent developments using girentuximab," published on March 17 ahead of print in *Current Opinion in Urology*. In an article published on March 2 in *Frontiers in Endocrinology (Lausanne)* (2021;12:640117), Arifin and Bulte from Johns Hopkins University/School of Medicine (Baltimore, MD) reviewed the current advantages, limitations, and clinical utility of "In vivo imaging of pancreatic islet grafts in diabetes treatment." De la Vieja and Riesco-Eizaguirre, from the Instituto de Salud Carlos III, the Hospital Universitario de Móstoles, and the Universidad Francisco de Vitoria (all in Madrid, Spain), summarized "Radioiodide treatment: From molecular aspects to the clinical view" in the February 27 issue of *Cancers (Basel)* (2021;13[5]:995). In an article published on March 16 ahead of print in *Future Oncology,* Bagguley et al. from the Peter MacCallum Cancer Centre (Melbourne), the E.J. Whitten Prostate Cancer Research Centre at Epworth (Melbourne), the University of Melbourne (Parkville), St. Vincent's Hospital (Darlinghurst), Royal Melbourne Hospital (Parkville), and Austin Hospital (Heidelberg; all in Australia) detailed "The role of PSMA PET/CT imaging in the diagnosis, staging, and restaging of prostate cancer."