VOL 2 • NO 2

ePATIENT

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> ***" With the advent of SPECT and SPECT/CT technology, significant improvements in ventilation-perfusion imaging have been made not only in our ability to resolve subtle heterogeneity in ventilation and perfusion distributions but also in providing relative quantitation of ventilation and perfusion[1] "***

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> ***" We consider V/Q SPECT/CT to be superior in most clinical settings with better overall diagnostic performance[6] "***

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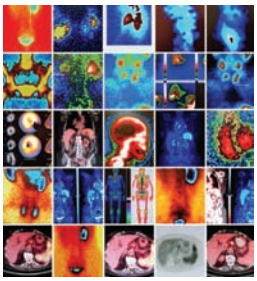

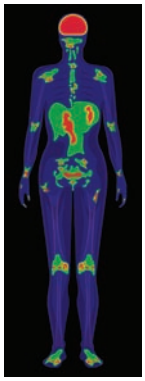

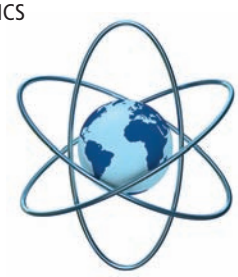

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Don't miss our next issue on Quantification and the second part of Theranostics (neuroendocrine tumors).

EDITORIAL BOARD

Dr. Lamoureux and I are thrilled to introduce our outstanding editorial board members. Through our travel and NM lecturing around the globe, we have met terrific scientists and colleagues. Most, if not all of them, are really passionate about and true advocates for the field of nuclear medicine. They strongly believe in the power, usefulness and safe use of NM diagnostic and therapeutic procedures for the betterment of public healthcare worldwide. We are delighted that the following leaders have embraced the concept of the Pangea-ePatient magazine and accepted to share their invaluable expertise and experience with patients, referring colleagues, health care administrators, government agencies and insurance companies.

Dr. Jean-Luc Urbain

Dr. François Lamoureux,
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INTRODUCTION TO THE FOURTH ISSUE

François Lamoureux
M.D.,M.Sc., FRCP(C)
President, CANM

Jean-Luc Urbain
M.D., Ph.D., CPE
Past President, CANM

Dr. Francois Lamoureux and I are pleased to introduce the fourth issue of our/your ePatient magazine. It is hard to imagine that three years have passed since we published the first edition of the magazine.

On behalf of the editorial board, we would like to thank everyone and all of you for your support, encouragements and praise for this unique international educational nuclear medicine tool and endeavors.

Since our first issue, additional international expert colleagues have joined our editorial board, Multimedia Concept, our publisher, has inserted a power language translator offering the magazine content in most known languages on earth and we have reached out to the entire nuclear medicine community to contribute to the educational endeavors of the magazine.

This issue is in fact a special issue dedicated to the partnership between the Society of Nuclear Medicine and Molecular Imaging and the Canadian Association of Nuclear Medicine. It celebrates the fact that Canada will be the Highlight Country at the 2019 meeting of the SNMMI which is held in Anahein, California from June 22nd until June 25th

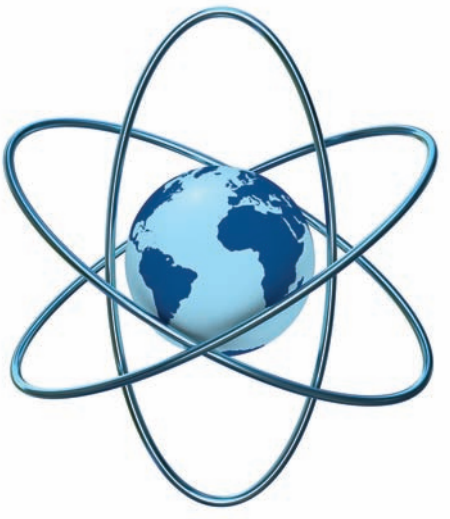
For this celebration, Dr. Lamoureux, the President of the Canadian Association of Nuclear Medicine will first give an overview of Canada during the opening ceremony. The CANM will have a large booth where Canadian specialty foods/beverage and other goodies will be offered.

On an educational point of view, the CANM and SNMMI have also organized four international interesting CME sessions with avant-garde content. The first session will illustrate the binary approach that Canada has taken for the lung ventilation/perfusion scintigraphic studies. Nuclear telemedicine solutions will be presented during the second session. International experts will then discuss the latest and future developments in Positron Emission Imaging. Finally the Theranostics 101 session will illustrate the hidden nuts and bolts of the treatment of neuroendocrine tumors.

Besides interviews and articles from colleagues around the globe, the content of this fourth edition largely reflects the lung scintigraphy and Theranostics sessions that we have organized at the SNMMI meetings.

We are hopeful that you will enjoy the new issue of your magazine and we are looking forwards to receiving your comments and eventually your article for publication in our fifth issue that is scheduled in the fall. ■

François and Jean-Luc



INTERVIEW WITH:

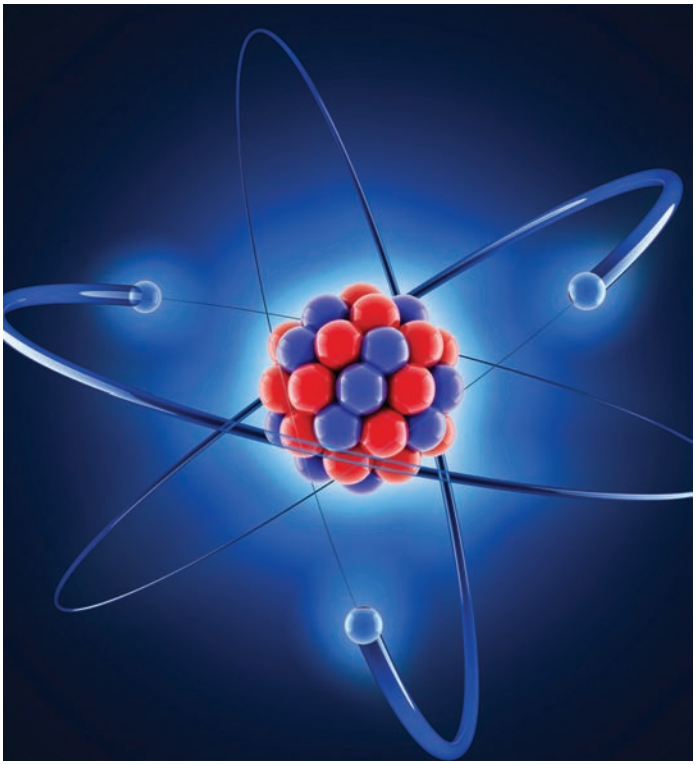
JEAN-LUC URBAIN
M.D., Ph.D., CPE
President elect WFNMB
Past President, CANM

"The WFNMB consists of groups, societies or associations acknowledged as representatives in each country that are primarily involved with research, education, training and/or practice in Nuclear Medicine and Biology."

Professor Jean Luc Urbain, you have just been elected President-elect (2020-2022) of the World Federation of Nuclear Medicine and Biology (WFNMB) by the international nuclear medicine community. Could you introduce our readers to your background and current situation?

The WFNMB was founded in 1970 in Mexico City and the first World Congress of Nuclear Medicine was held in 1974 in Tokyo and Kyoto, Japan. I discovered the WFNMB in 1990 when I was privileged to present my work in nuclear gastroenterology during the landmark meeting in Montreal. At the time I would have never imagined that Canada and the Canadian Association of Nuclear Medicine would, one day, enable me to successfully apply for vice Presidency of the WFNMB.

These past 28 years have been an interesting journey. Consultant in nuclear medicine at the Catholic University of Louvain in Belgium in the late eighties, Professor of Imaging and Medicine at Temple University and Fox Chase Cancer Center in Philadelphia and Chair of Molecular and Functional Imaging at the Cleveland Clinic in the early 21st century, I was fortunate to become City-Wide Chief and Chair of Nuclear Medicine at the Hospitals at Western University in London Ontario in 2003. From 2006 until 2011, I had the immense privilege to serve as the President of the Canadian Association of Nuclear Medicine (CANM). In 2014, the CANM decided to bid for the organization of the 2022 WFNMB Congress. While our bid was unsuccessful, we were able to develop a worldwide network of outstanding friends and colleagues. This confirmed the international reputation of educational excellence and collaborative work that the Association had built in the emerging world. In 2015, after the restructuring of the WFNMB, I was approached by members of the international nuclear medicine community to apply for the presidency of the WFNMB. After a dry run at the position in 2016, the Association's leadership convinced me to embrace the opportunity in 2018. Even though, last spring, I moved most of my practice to Wake Forest University in North Carolina, my election as Vice President of the WFNMB, this past October in Germany, represents a major and well-deserved accomplishment of the Canadian Nuclear Medicine Community and the CANM.



In a nutshell, what is the WFNMB, which is it, what are its objectives and where is its head office?

The WFNMB consists of groups, societies or associations acknowledged as representatives in each country that are primarily involved with research, education, training and/or practice in Nuclear Medicine and Biology. While the previous activities of the WFNMB mainly consisted in holding successful World Congresses, under the leadership of Andrew Scott and his Australian team, the WFNMB took on a fundamental restructuring with the establishment of an internationally elected executive leadership and a permanent secretarial office based in Vienna, Austria. The primary role of the WFNMB is the progress and promotion of nuclear medicine throughout the many regions of the world. The integration of developed and developing countries through shared activities,

such as performing research on unique disease profiles in the developing world and training of people either on state-of-the-art equipment or under the expertise of world leaders in Nuclear Medicine, represents a major goal of the restructured WFNMB.

There is a great need for nuclear medicine to work in close synergy with all national and international associations and organizations. Do you believe that the WFNMB has precisely the desire and the assets necessary to assume this leadership?

The global economy and social media have created a very interdependent world and forced community like the WFNMB to embrace globalization, to assume responsibility for management of some regional/ national workshops and to assure continuity and educational quality in nuclear medicine.

The WFNMB works very closely with ALASBIMN, ARSNM, EANM, IAEA, SNMMI and WHO and strive to disseminate relevant educational nuclear medicine materials worldwide, to circulate established guidelines in emerging countries, to enhance the appropriateness of practice, improve the quality of nuclear medicine, lead to better patient outcomes, improve cost-effectiveness and identify required areas of research and collaborative initiatives. These initiatives are only possible through the support and collaboration of the national nuclear medicine associations and societies from across the world like the CANM.

The Canadian Nuclear Medicine Association has long been a preferred partner of the WFNMB. In 1990, Professor Étienne LeBel from Sherbrooke took over the presidency and, from 2020, you, past-president of the CANM, will lead the way. How do you think the CANM could continue this important collaboration with the WFNMB and its international partners?

Canada is a very open and generous country that excels at developing close collaboration with emerging countries and at significantly contributing to the improvement of human health across the globe through governmental, professional and private venues. The CANM has a long history of international initiatives to provide nuclear medicine supplies, equipment, education and financial resources to nuclear medicine communities across the globe, particularly in Africa and in the Middle East. The breakdown of the Chalk River reactor in the late

"Since the inception of our field, the regional and national medical imaging communities and associations have done an outstanding job to educate their members about radiopharmaceuticals and nuclear medicine equipment and their clinical use."

"The vision and mission of the Pangea project and magazine is very similar to the initiatives of the WFNMB. I believe that this new original educational tool could be a major attribute to the tasks and endeavors of the WFNMB in the years to come."

2000s' triggering a world supply shortage of medical isotopes. Its recent closure and the close contacts that we have developed with our international friends and colleagues from all over the world are a constant reminder that our small Canadian Nuclear Medicine Community and Association cannot thrive on Canadian national views, perspectives and initiatives only. Like the Royal College of Physicians and Surgeons of Canada, whose educational strengths and values are cherished and implemented across the globe, the CANM is poised to provide leadership in educational, clinical and research initiatives to the patients in the world that are less well served by the health care system in their countries. I am confident that the current and future leadership of the CANM will actively continue its vocational vision and mission and contribution to international endeavors and to support the WFNMB initiatives towards the emerging world continue.

Pangea is a concept that you cherish. Can you remind us of its origin and its essence? Is not PANGEA a wonderful tool for your work at the helm of the WFNMB?

Since the inception of our field, the regional and national medical imaging communities and associations have done an outstanding job to educate their members about radiopharmaceuticals and nuclear medicine equipment and their clinical use. Unfortunately, and unlike radiology and cardiology, the nuclear medicine community and NM associations/societies have not proactively and consistently outreached to their stakeholders (referring physicians, government agencies, hospital administrators…). As a result, the nuclear medicine field has largely remained a self-contained and limited environment that is now struggling to thrive.

About ten years ago, Dr François Lamoureux, President of the Quebec Association of Nuclear Medicine, decided to embark into a provincial outreach effort outside the Quebec nuclear medicine community. He started an educational magazine in French called "Le Patient" (http://www.lepatient.ca). The basic principle of "Le Patient" resides in the writing of short articles by nuclear medicine professionals that are easily readable/understandable by referring practitioners, health care executives and government agencies personnel. The idea behind the Pangea project was to "export" to the worldwide NM community the concept of the magazine "Le Patient" and to explain and educate in simple terms prescribing physicians, patients, health authorities and hospital administrators from across the world about current and future nuclear medicine diagnostic tests and therapies.

We published our first issue of the Pangea-ePatient (http://www.nmpangea.com) magazine in 2016, just before the EANM meeting in Barcelona. Over the past two years, Pangea-ePatient has been embraced by most regional and many national associations of nuclear medicine as a major educational resource for the non- nuclear medicine professionals. The vision and mission of the Pangea project and magazine is very similar to the initiatives of the WFNMB. I believe that this new original educational tool could be a major attribute to the tasks and endeavors of the WFNMB in the years to come. ■

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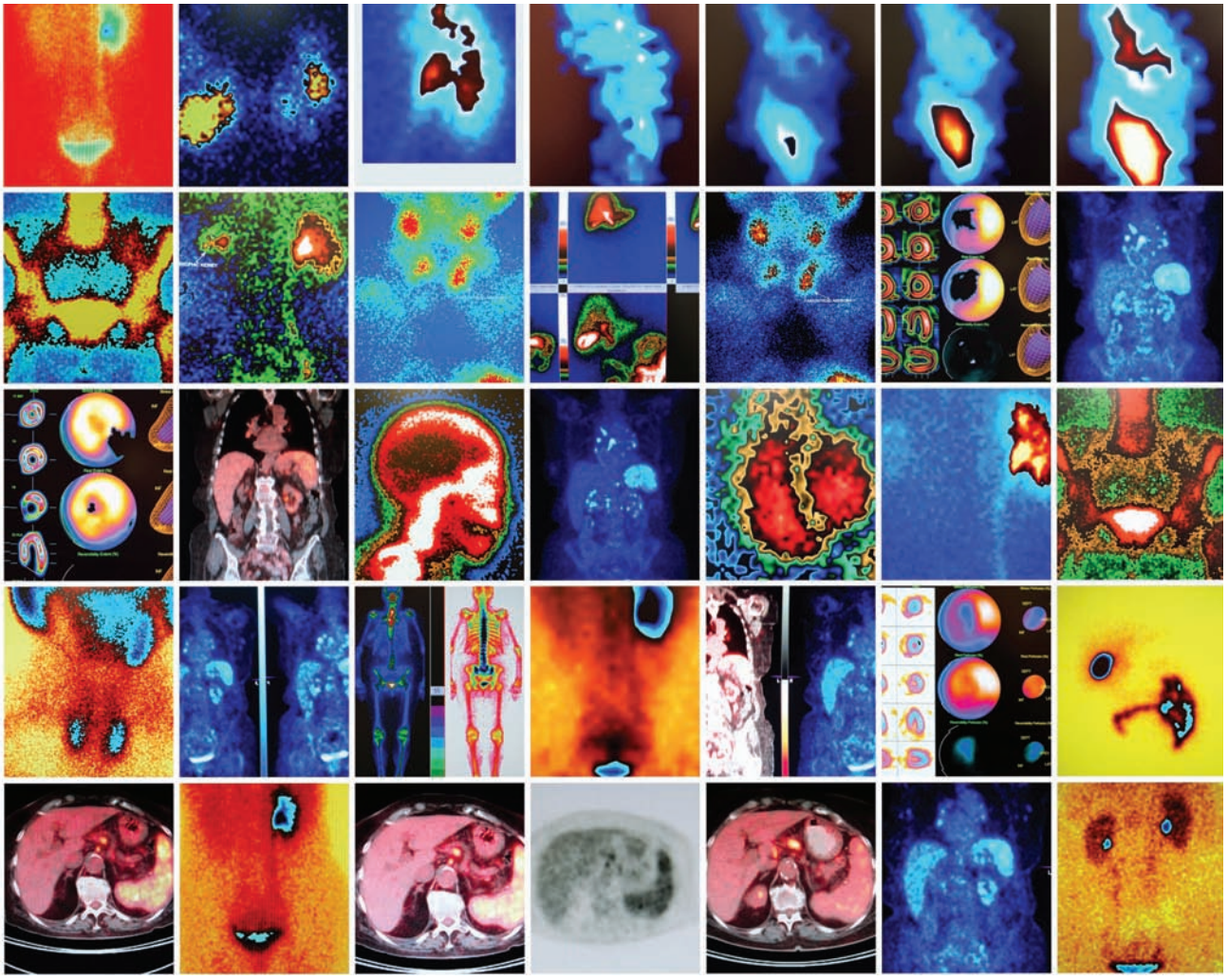
Canadian Association of Medical Radiation Technologists

PROFILE: NUCLEAR MEDICINE TECHNOLOGISTS IN CANADA



Nuclear medicine technologists (NMTs) are an integral part of the Canadian healthcare system. They are the healthcare professional responsible for performing diagnostic and therapeutic procedures, providing essential information to radiologists and nuclear medicine physicians for interpretation and diagnosis. In Canada, there are approximately 2,000 NMTs across the country. Every year these NMTs perform approximately 1.4 million SPECT/CT and PET/CT exams plus countless other exams and radionuclide therapies.

NMTs use their expert knowledge of medical imaging equipment, procedures and practices to deliver high-quality diagnostic imaging and therapeutic services. They manage and operate a variety of imaging systems including: SPECT/CT, PET/CT and bone mineral densitometry. They can also operate PET/MR equipment with additional education and training in magnetic resonance imaging. Examples of nuclear medicine procedures include: bone scans, renal function scans, myocardial perfusion scans, FDG scans for tumour imaging, thyroid scans and thyroid therapies.

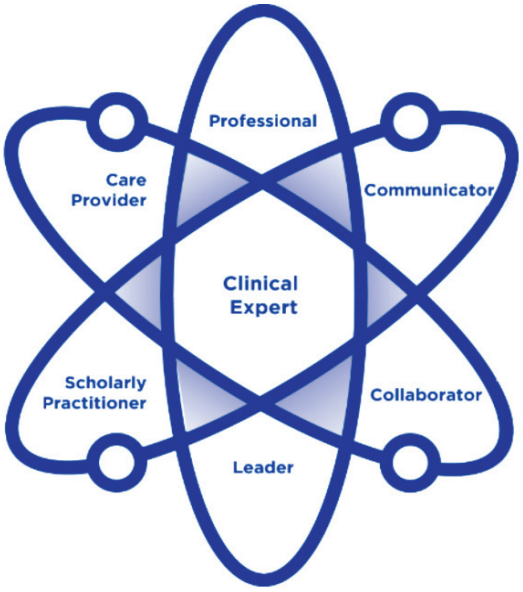


Figure 1: Roles of the Entry-Level Nuclear Medicine Technologist in Canada[3]

NMTs are becoming more involved in therapies like Radium-223 for castration-resistant prostate cancer with bone metastases and theranostic procedures like Ga-68/Lu-177 dotatate for unresectable gastroenteropancreatic neuroendocrine tumors (GEP-NETs). Precision medicine and theranostics are an exciting and emerging area of nuclear medicine practice.

In addition to the above, NMTs perform radiopharmacy and laboratory procedures which involves preparing, dispensing, administering and performing quality control on the radioactive tracers administered to patients. Some NMTs work in central radiopharmacies or at cyclotron facilities.

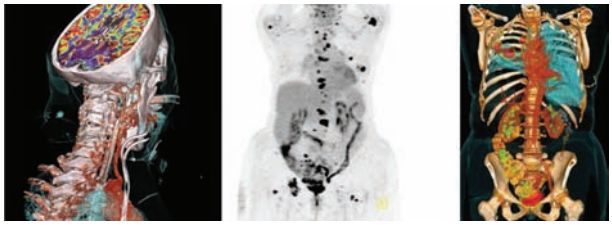
As a primary point of contact for patients on their healthcare journey, NMTs in Canada also provide education about the procedures and treatments to be performed. They ensure the care provided is safe, appropriate, evidence-informed and tailored to individual patient needs, and answer patient questions to increase understanding and alleviate anxiety and stress. Canada has both diploma and degree programs for Nuclear Medicine Technology. To become certified to work in Canada, graduates of Canadian accredited programs must successfully complete the Canadian Association of Medical Radiation Technologists (CAMRT) National Certification exam in Nuclear Medicine Technology*. International applicants must apply to have their credentials, language and work experience assessed before they can be deemed eligible to write the Canadian certification exam. Each year the CAMRT certifies approximately 60 new NMTs.

The CAMRT has recently embarked on a project to revise the competency profile for entry-level Medical Radiation Technologists in Canada. The competency profile outlines the practice requirements for NMTs at entry-to-practice. The CanMEDS framework has been adopted and adapted for medical radiation technology practice. In this framework, Medical Radiation Technologist (MRT) competencies are grouped thematically under seven distinct roles: Professional, Communicator, Collaborator, Care Provider, Scholarly Practitioner, Leader and Clinical Expert. This framework links the required competencies to the roles NMTs play in patient care and service delivery, highlighting the contributions NMTs make within the larger healthcare environment.

For most provinces in Canada, Nuclear Medicine Technology is a regulated profession. This means that there are very specific requirements laid out for NMT scope of practice, as well as the maintenance of competence.

NMTs in Canada are highly-educated and highly-skilled professionals with clinical expertise in nuclear medicine imaging equipment, procedures and practice. They are communicators, collaborators, care providers, leaders and scholarly practitioners, and accompany patients through every scanning procedure in a caring, professional way. NMTs are an essential part of the interprofessional healthcare team, providing the link between compassionate patient and family-centered care and the sophisticated diagnostic imaging technology. ■

*or in Quebec, the OTIMROEPMQ exam



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Graphic adapted from: CanMEDS 2015 Physician Competency Framework

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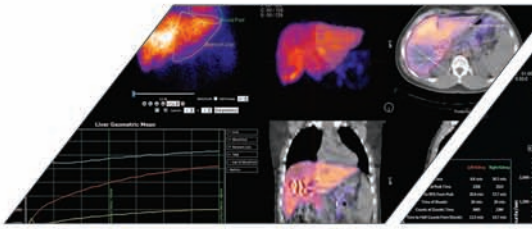

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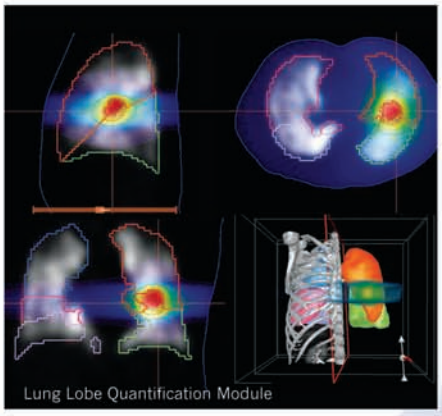
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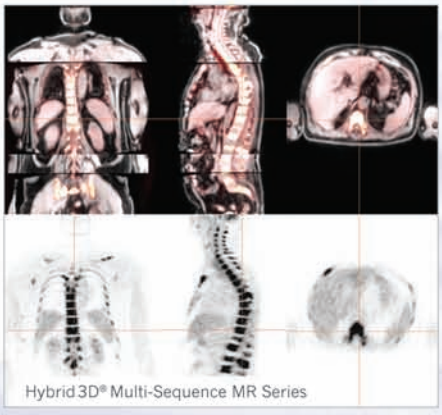
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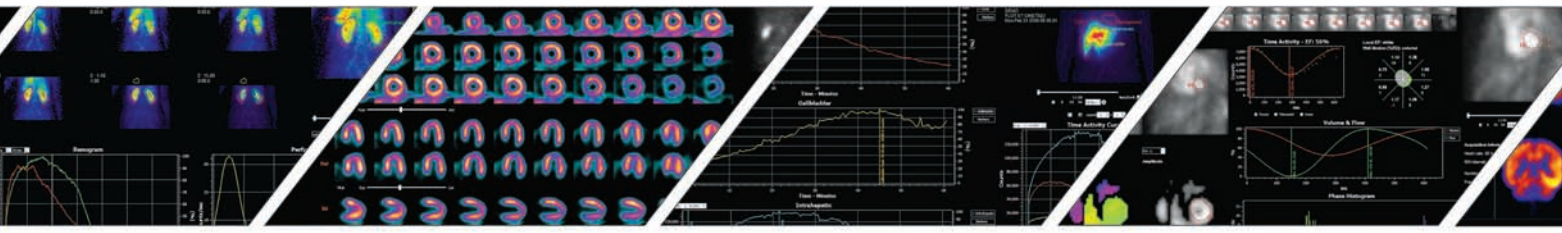
Historically, nuclear medicine has benefited from excellent software but, rarely on a single platform. One computer is generally used to display a certain type of exam, another to archive the data and, another is used for specific or dedicated applications. This lack of integration and the non-uniformity of components, continues to cause serious workflow obstacles for professionals working in imaging departments.

With crucial input from customers around the world, nuclear medicine pioneers, the HERMES R&D team has developed Hybrid Viewer PDR™: A unique and user-friendly software for Processing, Display and Reporting (PDR). This all-in-one tool allows the display of all medical imaging modalities (including angiography and ultrasound), image fusion (SPECT-PET-CT-MR) including analysis of this data, processing of conventional nuclear medicine and, the ability to generate medical reports. This technology is used on 6 continents and present in a majority of state-of-the-art NM Departments.

The raw and processed data is stored in a metadata VNA in DICOM, native format, MS-Word™, MS-Excel™, .wav audio files, Adobe PDF™, etc. fully integrating with existing equipment in today's departments under a single master worklist.

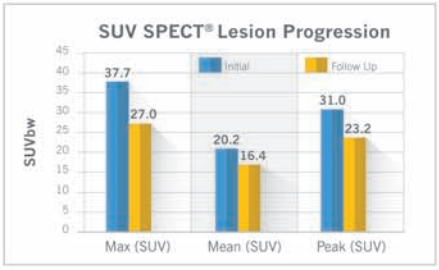
CONNECTED BY HERMES™

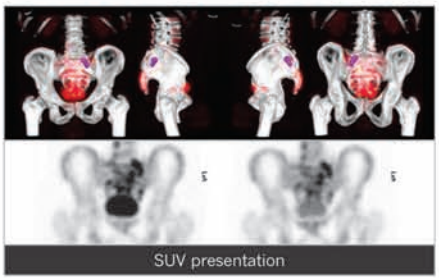
From the early days of nuclear medicine, quantification has been a key aspect; self-defining the practice and at the same time distinguishing from other imaging modalities. The arrival of Positron Emission Tomography (PET and its SUV scale) certainly contributed to advances in the field, but the essence of nuclear medicine still remains the Single Photon Emission Computed Tomography (SPECT) environment for a vast majority of medical centers. The new breed of cameras coupled with CT components and optimized with advanced reconstruction tools started paving the way for the day when a SUV scale, similar to the one used in PET, would help us quantify images obtained from SPECT-CT scanners. Despite the increasing availability of PET, the number of specific tracers used with this technique is still suboptimal. Absolute SPECT-CT quantification (SUV) is now available and opens the door to a plethora of possibilities with dozens of proven tracers already in use.



RECONSTRUCTED BY HERMES™

The HERMES SUV SPECT® revolutionizes quantitative imaging by exploiting the use of SPECT's full potential in regions where a large portion of the population still does not have access to PET and/or associated reimbursements. HERMES SUV SPECT® software algorithms enable a conversion of the recorded counts per voxel into activity per unit volume with SUV calculations, providing essential and accurate quantitative results.




SUV presentation

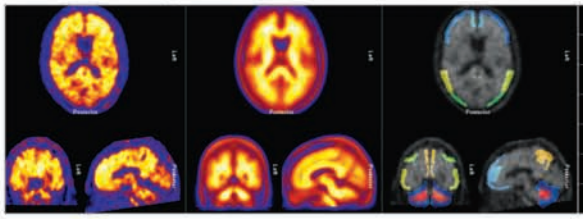
Combined with attenuation correction from a hybrid SPECT-CT scanner or SPECT-only camera (utilizing an independent CT) and a Monte Carlo-modeled scatter correction, HERMES SUV SPECT® brings SPECT-CT scanners from any manufacturer to the next level.

QUANTIFIED BY HERMES™

Mostly used for teaching purposes or display modelling, 3D applications enable automatic lesions detection or the ability to establish more accurate diagnostics in comparison with still largely used 2D tools. These amazing results can be obtained with the help of advanced segmentation methods especially useful with quantitative pulmonary studies. The Hybrid Viewer™ 3D module proceeds with an automatic co-registration of the SPECT-CT (and separate diagnostic CT if needed), an automatic L/R Lung and airways segmentation, a quick inter-lobar fissure definition, a fissure definition quality control, a lobar ventilation and perfusion quantification and an automatic report generation. Knowing that accurate results can drastically change the optimal surgical approach, comparative studies have been conducted between current 2D techniques (planar anterior image or real anterior reprojection divided in 6 segments) and 3D segmentation techniques. Preliminary results have shown differences ranging between -10% to +48% in the assessment of accurate volume calculation in ml. Similar tools for automatic hepatic and kidney segmentation are now available and will help promoting for a closer collaboration between quantitative imaging and surgical departments.

HERMES is extremely proud to participate in high-level research to support healthcare professionals in the detection and treatment follow-up of diseases such as epilepsy, brain tumors, schizophrenia, Parkinson's and most recently Alzheimer's. The market debut of NeuraCeq™, recently approved by Health Canada and commercialized by Isologic, synergizes HERMES efforts in assisting nuclear medicine physicians in university facilities as well as in community hospitals, by providing them with normal templates for a precise and reliable quantification of the patient illness state. This Isologic-HERMES partnership facilitates the utilization of the renown BRASS™ (Brain Registration & Analysis Software Suite) application, appearing in more than 350 scientific publications and presentations around the world and validated with over 2 million patients.

HERMES BRASS™ Quantification with NeuraCeq™ from Isologic



Region Name	SUVr (Z)
Average SUVr	**1.65 (2.13)**
L Frontal Ctx	1.52 (2.92)
R Frontal Ctx	1.68 (4.24)
L Ant Cingulate	2.15 (5.50)
R Ant Cingulate	2.31 (5.12)
L Occipital Ctx	1.30 (1.00)

POWERED BY HERMES™

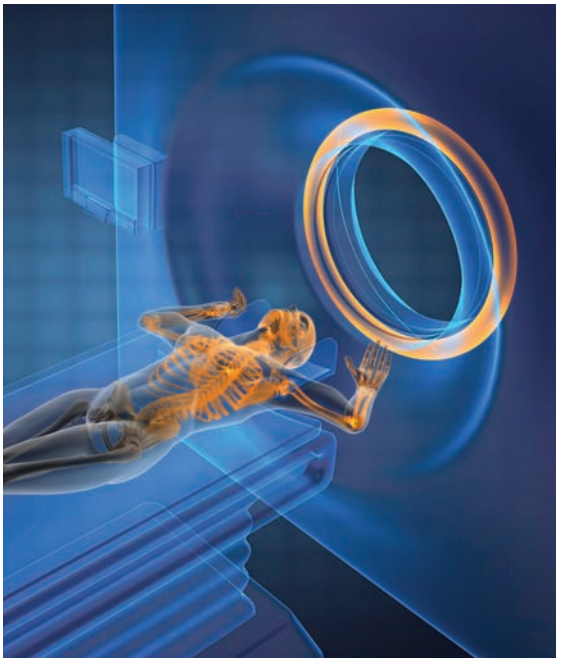
HERMES VNM™ includes HERMES VNA (Vendor-Neutral Archive) combined with the power of a complete clinical medical imaging platform, tailor-made for multi-vendor sites/multi-facilities integration. HERMES provides cost effective solutions worldwide from enterprise-wide architecture & infrastructure to storage, reading, analysis and processing services on its systems or via HERMES cloud, TeleHERMES™.

SUPPORTED BY HERMES™

HERMES provides its expertise by employing a solid team, dedicated to quantitative molecular imaging World-wide. Company offices are located in Sweden, the United Kingdom, China, the United States and Canada.

Dr. Rodrigo Jaimovich, M.D
Past-President of ALASBIMN
Professor, Nuclear Medicine
at Clinica las Condes S.A
Chili University, Chili

APORTE DEL SPECT/CT EN TÉCNICA DEL GANGLIO CENTINELA PARA CÁNCER DE MAMA



La adecuada evaluación del compromiso ganglionar axilar en cáncer de mama es de tremenda importancia tanto para el pronóstico del paciente así como para la toma de decisiones acerca de la terapia. En algunos casos puede implicar una mayor acción quirúrgica que incluya el vaciamiento ganglionar de la axila, o bien aumentar los campos a irradiar durante la radioterapia. Además muchas veces el status ganglionar define si se debe agregar quimioterapia como terapia adyuvante.

La técnica del ganglio centinela se ha transformado en la mejor forma de evaluar el compromiso axilar en cáncer de mama ya que identifica al primer ganglio tributario del drenaje linfático proveniente del tumor. Al identificar ese ganglio se puede resecar y analizar en forma exhaustiva con técnicas histoquímicas. Se ha demostrado que la capacidad predictora del status axilar a partir del ganglio centinela es muy buena, sobre el 95%, por lo que un estudio de ganglio centinela negativo predice con un alto nivel de certeza que el resto de los ganglios axilares no tienen diseminación tumoral.

Para identificar el ganglio centinela se utilizan dos técnicas que se basan en el mismo principio, una radioisotópica y otra con colorante. En ambas se inyecta una dosis de radiofármaco o colorante en la mama, generalmente en región periareolar en el cuadrante del tumor, de forma intradérmica. Posteriormente se espera a que el trazador (radioactivo o colorante) migre a través del sistema linfático hasta encontrar un ganglio en su camino donde se acumula progresivamente. En el caso de la técnica con radioisótopos se realiza una imagen para demostrar la acumulación en el o los ganglios centinelas, se marca su ubicación para posteriormente ir a la resección quirúrgica. En pabellón se utiliza un detector portátil de radiación para ayudar a encontrar los ganglios radioactivos. En muchos centros se utilizan ambas técnicas en forma complementaria, realizando la marcación radioisotópica pre-operatoria, y en pabellón se agrega además el colorante. La combinación de ambas técnicas es la que mejores resultados ha reportado en cuanto a la correcta identificación del ganglio centinela.

Si bien la técnica radioisotópica ha demostrado excelentes resultados, existen algunas variaciones respecto a la forma original de adquirir las imágenes. En otros tumores donde también se identifica el ganglio centinela como el melanoma maligno, se ha planteado combinar las imágenes planares con una adquisición tomográfica (SPECT) a las cuales se les agrega una imagen anatómica (CT) que sirve tanto para mejorar la calidad de imagen como para dar un correlato espacial a la imagen de medicina nuclear. Esto es de particular interés en los melanomas de cabeza y cuello debido a la complejidad de las estructuras y espacios cervicales, donde se ha demostrado la superioridad de la técnica híbrida SPECT/CT sobre la planar tradicional en la detección del ganglio centinela.

La experiencia de la técnica de ganglio centinela con SPECT/CT en cáncer de mama es variada, reportándose algunas situaciones donde se obtienen beneficios con la técnica de imágenes híbridas. La indicación del SPECT/CT más común es la no visualización del ganglio centinela en las

imágenes planares. Esto puede ocurrir por diversas razones, siendo la principal la superposición de la radioactividad del sitio de inyección con la ubicación del ganglio centinela, quedando este último oculto. Otra causa es que la radioactividad acumulada en el ganglio centinela sea muy baja, impidiendo que sea visualizada en las imágenes planares. Las imágenes tomográficas con técnica SPECT/CT permiten identificar los sitios de radioactividad y diferenciarlos del sitio de inyección. Además la reconstrucción de las imágenes con esta técnica entrega una mejor resolución, superior a la planar, por lo que se logran identificar ganglios muy pequeños y/o con baja captación. Esto ha permitido disminuir la cantidad de estudios donde no se lograba identificar los ganglios centinela mediante las imágenes pre-operatorias.

Otra condición donde la técnica híbrida ha demostrado superioridad es la correcta identificación de sitios de drenaje atípico. Existe un porcentaje de pacientes donde el drenaje linfático no se dirige a la región axilar ipsilateral, siendo posible un drenaje hacia la cadena mamaria interna o a región supraclavicular. Este tipo de drenaje puede darse en forma exclusiva o concurrente con el drenaje hacia axila. La correcta identificación del territorio de drenaje permite a los cirujanos tomar decisiones acerca de la potencial resección de esos ganglios con drenaje atípico. Además, se ha postulado que la presencia de drenajes atípicos cuando no se identifica drenaje axilar puede reflejar una mayor probabilidad de que esos ganglios estén comprometidos. La explicación de este último fenómeno sería que, al infiltrarse los ganglios con metástasis tumorales, se bloquea su capacidad de captar el trazador, por lo que se "salta" a la siguiente estación ganglionar.

Se ha descrito una dificultad en la marcación del ganglio centinela en pacientes obesas, existiendo una correlación directa entre el valor creciente del índice de masa corporal y la menor tasa de detección de ganglios centinelas mediante la técnica planar tradicional. Esto se debe a la mayor atenuación que ocurre por la mayor profundidad de los ganglios. Cuando se realiza la técnica de SPECT/CT con la consiguiente corrección de atenuación, la tasa de detección de los ganglios aumenta significativamente.

Si bien no hay reportes de disminución del tiempo operatorio en pacientes que se realizan la técnica de ganglio centinela en cáncer de mama con método SPECT/CT versus planar, existe la referencia de esta disminución en casos de melanoma maligno. La información entregada por el SPECT/CT sí es apreciada por los cirujanos en términos de contar con la mayor cantidad de referencias para la exitosa localización del ganglio centinela. Lo primero es el número correcto de ganglios que muestran captación,

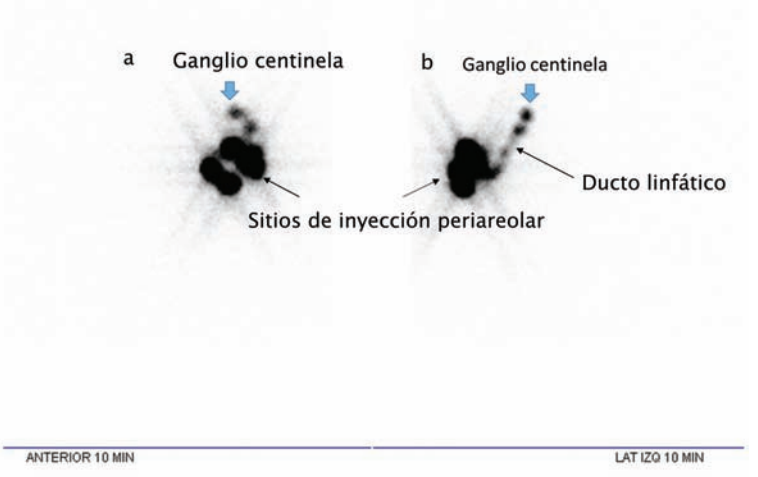


Figura 1
Proyección anterior (a) y lateral (b) de mama izquierda con sitios de inyección periareolar (4), ducto linfático y ganglio centinela.

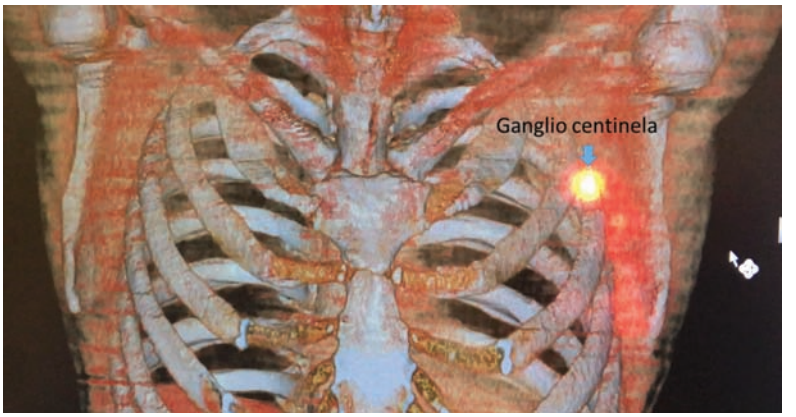


Figura 2
Misma paciente con adquisición SPECT/CT demostrando la ubicación del ganglio centinela con sus relaciones anatómicas cercanas.

diferenciarlos correctamente de captación en ductos linfáticos. Además el CT entrega una adecuada posición del ganglio, en cuanto a profundidad, relación con otras estructuras (músculos, vasos, pared costal) y eventuales ubicaciones atípicas como ya se mencionó.

La técnica del ganglio centinela se ha instalado como parte de la mejor forma del manejo de la cirugía del cáncer de mama. La correcta identificación de este ganglio permite entregar una información relevante al equipo tratante ya que permite definir el pronóstico de la paciente y su eventual tratamiento. Esta técnica se ha visto mejorada con la incorporación de las imágenes híbridas con el SPECT/CT, especialmente relevante en casos donde la técnica planar no logra detectar adecuadamente el ganglio centinela. ■

Bennett S. Greenspan,
MD, MS, FACNM, FACR, FSNMMI, FAAPM
Immediate Past President, SNMMI

MY YEAR AS PRESIDENT OF SNMMI, JUNE, 2017 – JUNE 2018 AN INCREDIBLE ODYSSEY

SOCIETY OF NUCLEAR MEDICINE AND MOLECULAR IMAGING

Achievements:
It was an incredibly productive and exciting year. I was elected Vice President-Elect in May, 2015. By automatic succession, I became President-Elect in June, 2016, and President of SNMMI on June 14, 2017, at the end of the 2017 SNMMI Annual Meeting. As would be expected, there were many issues to address over the year. We had had weekly conference calls with Leadership to discuss these and other issues. We also had the Fall Board meeting, Mid Winter Meeting, and Annual meeting. In addition, there were several chapter meetings to attend and present the SNMMI Update (I attended 5 of them), three required international meetings, and several other meetings of various types. At the international meetings, as well as our own SNMMI Annual Meeting, I met with leaders of several international organizations. It was fantastic and invigorating. It was also interesting to see that many or the same problems and challenges we face are also encountered by other societies. There are certainly differences as well, due to different societal structures and different regulations.

In addition to the numerous meetings throughout the year, the SNMMI had multiple accomplishments. We added to our development of Appropriate Use Criteria, which will be used by referring physicians to order advanced diagnostic imaging test on their patients. We are also continuing to update our Procedure Standards. Some of these are joint guidance documents with the European Association of Nuclear Medicine (EANM), American Society of Nuclear Cardiology (ASNC) and the International Society of Magnetic Resonance in Medicine (ISMRM). I signed a Memorandum of Understanding (MOU) with four societies during the year – the Japanese Society of Nuclear Medicine (JSNM), the International Atomic Energy Agency (IAEA), EANM and SNM-India.

The Multilateral Consensus Conference on the use of I-131 in the therapy of differentiated thyroid cancer was formed and the first meeting was held in Martinique in January, 2018. The basis for developing this attempt to reach a consensus on use of I-131 arose out of the 2015 American Thyroid Association (ATA) Guidelines for treatment of thyroid cancer, which a number of us in Nuclear Medicine believed that I-131 was under-used and under-appreciated in these guidelines. One of the major goals of the first meeting was to develop a collegial and collaborative working relationship between Nuclear Medicine and Endocrinology. Four societies were involved – SNMMI, ATA, EANM and the European Thyroid Association (ETA). We did achieve a collegial and collaborative working relationship, so I believe the first meeting was a huge success. We developed nine Martinique Principles for working together to advance the treatment of thyroid cancer for the betterment of patients. Within these Principles, we also established that the following definitions should be used: overall treatment of thyroid cancer with I-131 is known as I-131 therapy, and components within this therapy are remnant ablation, adjuvant treatment, and treatment of known malignant disease. The nine Martinique Principles can be found in the April, 2019 edition of the journal Thyroid, and the June, 2019 issue of the Journal of Nuclear Medicine (JNM). This consensus conference is actually a major initiative in having several societies working together with the goal to advance understanding of thyroid malignancies, improve therapeutic results, and to improve patient care.

There has been continued success of Nuclear Medicine Global Initiative, which was initiated in 2012 by Fred Fahey, as President of SNMMI. The first project was to establish global harmonization of administration of radiopharmaceuticals for pediatric nuclear medicine studies. It was a joint effort of 13 societies, including the World Federation of Nuclear Medicine and Biology (WFNMB), of which SNMMI and CANM are member societies, IAEA, SNMMI and the Canadian Association of Nuclear Medicine (CANM), and this has been highly successful. The 2nd project is a study of availability of radiopharmaceuticals for nuclear medicine studies throughout the world. This project is nearing completion, with the WFNMB as the lead society.

We have made some progress in developing federal funding for domestic (USA) production of Mo-99. SNMMI has been heavily involved in a number of advocacy issues, mainly involving reimbursement.

I formed two new committees during my tenure as President. One is the Committee on Training and Education for Competence in Radionuclide Therapy. This is in response to the US Nuclear Regulatory Commission (NRC), which asked for input from stakeholders to evaluate training and experience requirements for AUs to provide RN therapy, and whether the requirements should be reduced. Our committee produced a guidance document that was sent to the NRC, which included a proposed curriculum for AUs (which I wrote) that should represent a minimum standard of knowledge and skill.

The other committee tackles a long-standing controversial issue evaluation the validity of the Linear No-Threshold hypothesis to estimate carcinogenic risk from exposure to low-level radiation. This is a collaborative effort with the American Society for Radiation Oncology (ASTRO), the American Association of Physicists in medicine (AAPM) and the Health Physics Society (HPS). This is an important issue, as it has a major impact on regulations and other far-reaching implications.

Meetings:
One of the real pleasures of my term of office was the opportunity to travel and attend international meetings. The experience of visiting other countries was exciting and fascinating. I visited 6 in all – Canada, Japan, Austria, India, Martinique (which is actually part of France), and Australia. They were all wonderful hosts, and I had many interesting discussions.

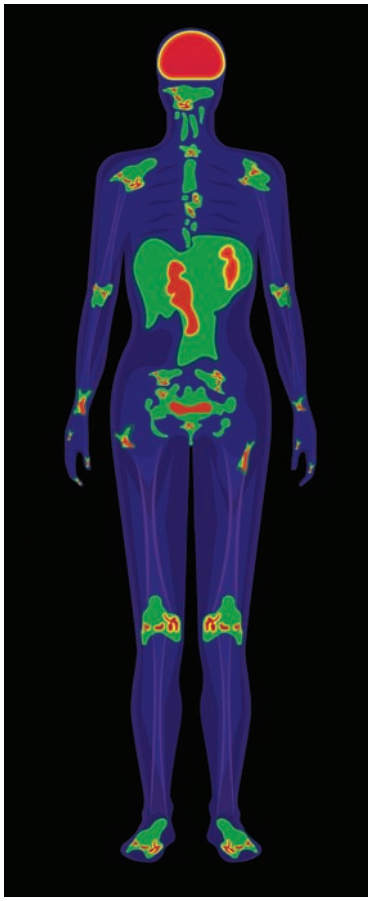
In October, 2017, I attended the AOCNMB and gave 2 presentations – "Quality and Value in NM, the SNMMI Approach", "Future of NM". It was a fantastic experience to travel to Japan. I flew to Tokyo, which essentially took 2 days with the time change, and took a train from Tokyo to Yokohama, which was the meeting site. Their trains are precisely on time, which I had not previously experienced. The meeting was very high quality, and the food was fantastic. I was also able to observe a couple of cultural events, which were wonderful. Later in October, I attended the EANM annual meeting in Vienna, Austria. This was another outstanding meeting. It has many similarities to the SNMMI annual meeting, and frankly, was of even higher quality, especially since they have access to radiopharmaceuticals that we don't. Austria is world famous for its pastries, which are truly outstanding.

I was invited to attend the SNM-India annual meeting, which was held in December, 2017, in Delhi, India. This was another amazing experience. The meeting was also of very high quality. I gave a presentation on Quality and Value of Nuclear Medicine and also on the Future of Nuclear Medicine. One of the speakers mentioned that India used to follow the lead of the US, "and now the US can follow our lead". This is actually true. They also have access to radiopharmaceuticals that we cannot yet use. The food was also amazing. I was warned not to eat any food that was uncooked, especially salads, and not to drink water that had not been bottled or boiled. I followed these instructions carefully and did not get sick.

In January, 2018, I attended the Multilateral Consensus Conference in Martinique, which is an overseas region of France. The food was excellent. So was the weather, although we were inside for most of two days. Martinique is a gorgeous island, with beautiful beaches and lush vegetation. Getting there was not easy, as Air France flies from Miami, and stops in Haiti and Guadelupe, so it takes all day to get there. It is easier to fly on Air France from Paris, which has a direct flight.

I was invited to give a presentation at the CANM annual meeting in March, 2018 in Vancouver. I presented "Nuclear Medicine Value as Seen by a Nuclear Medicine Professional". This was also a very high quality meeting, and highly enjoyable. The hosts were fantastic.

The final international meeting I attended in 2018 was the WFNMB in Melbourne Australia, in April, 2018. This was in conjunction with the ANZSNM. I gave a presentation on "Quality and Value of Nuclear Medicine" at the Australasian Association of Nuclear Medicine Specialists Symposium in Melbourne, just prior to the WFNMB meeting. The meetings were outstanding – superb presentations, great food, and the hosts were fantastic.



My final meeting of my Presidency was the SNMMI annual meeting in Philadelphia, June 21-27, 2018. I was in charge of the meeting, which was a big responsibility. Fortunately, there were many excellent SNMMI staff helping to coordinate the meeting, which went very smoothly. The Plenary sessions were excellent. I gave an overview of the accomplishments of SNMMI over the previous year, and two other presentations. It was a very successful meeting and a very successful year.

One important lesion is that there is a lot of excellent NM practiced throughout the world, and it was interesting and refreshing to be a part of it. These meetings also allow for a greater appreciation of other cultures, as well as varying approaches for problems and challenges in NM. This was a truly wonderful experience, and an amazing year!

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CANM ACMN

The Canadian Association of Nuclear Medicine
Association canadienne de médecine nucléaire

The Canadian Association of Nuclear Medicine (CANM) is in the process of establishing national guidelines for the performance and interpretation of Nuclear Medicine procedures in Canada with the aim to support the Nuclear Medicine specialists of Canada with readily accessible information as well as the hope of standardizing procedures across Canada as much as possible.

Our first initiative was a review of V/P SPECT Lung Scanning for Pulmonary Embolism. A subcommittee of four Nuclear Medicine specialists who have extensive experience in Lung Scanning was established. This group did a review of guidelines and approaches and quickly determined that the EANM guidelines from 2009 were ideal for Canada, and we quickly endorsed these guidelines.

Our group, however, felt that it was important to review some more up to date literature and to establish an executive summary and a short review for quick and easy reference for both the Nuclear Medicine specialist and the referring Physician.

Our committee hopes that readers find our approach useful. **(View page 46)**

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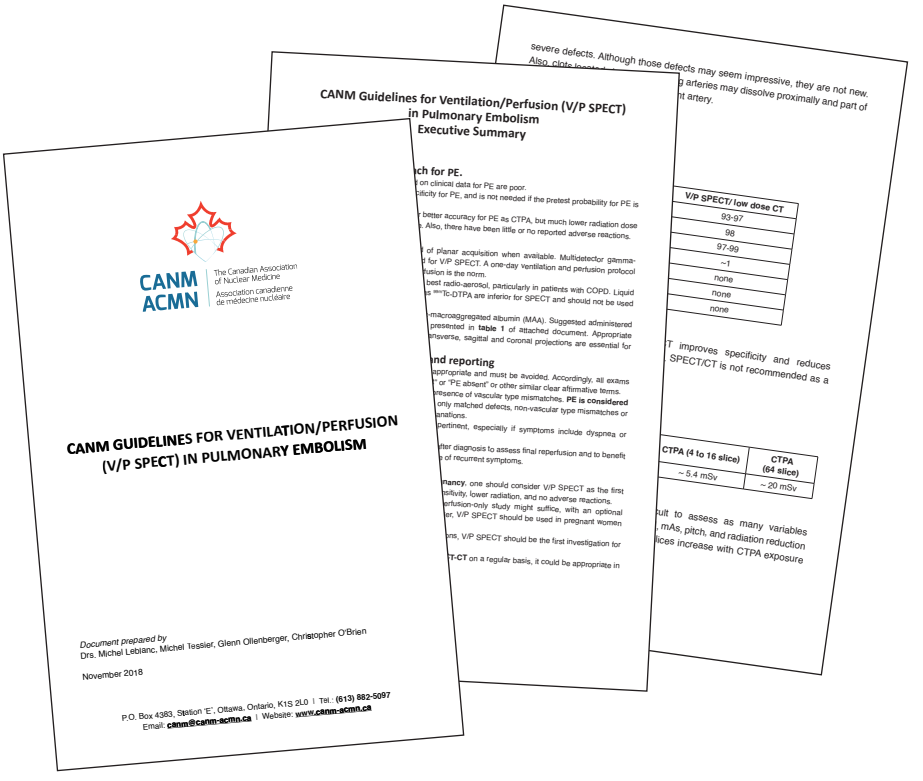
DR. MICHEL TESSIER

DR.GLENN OLLENBERGER

DR.MICHEL LEBLANC



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Spotlight on:
Society of Nuclear Medicine and Molecular Imaging

The Society of Nuclear Medicine and Molecular Imaging (SNMMI) is a nonprofit scientific and professional organization representing more than 17,000 nuclear medicine professionals worldwide. The Society's Outreach Committee works to help patients and the medical community—including referring specialists, as well as nurses, technologists, and other healthcare providers—understand the value and appropriate uses of nuclear medicine. Through the Committee and its Working Groups, the Society offers a variety of practical resources for both healthcare providers and patients.

Resources for HCPs

SNMMI Roadshows

The Society offers healthcare providers education on nuclear medicine topics through a variety of roadshow symposiums throughout the United States. Roadshows currently ongoing or under development provide education on neuroendocrine tumor therapies, DaT SPECT scan reading and interpretation, and lymph node mapping. For a current listing of roadshows and to register for events in your area, visit www.snmmi.org/outreach.

Speakers

SNMMI regularly provides speakers on nuclear medicine topics for national, regional, and state medical society meetings, as well as institutional grand rounds and other events. If your organization would like to have an expert speaker on a nuclear medicine and molecular imaging topic, please email outreach@snmmi.org for more information.

Information Sheets

SNMMI is developing a series of information sheets for physicians, directing them to helpful resources related to specific nuclear medicine procedures. The "Quality and Value of Nuclear Medicine" sheets also include a link to the Medicare Physician Fee Schedule for Nuclear Medicine Procedures, Radiopharmaceuticals, and Drugs. The first sheet, on cardiology, is complete; sheets on additional topics will be completed in summer 2019 and can be found at www.snmmi.org/pbinfosheets.

Appropriate Use Criteria Factsheets


SNMMI AUC Factsheet for Bone Scintigraphy in Breast Cancer

The SNMMI, working with numerous medical societies including the American Society of Clinical Oncology, North American Neuroendocrine Tumor Society, Society for Pediatric Radiology, Society of Thoracic Surgeons, Society of Interventional Oncology, European Association of Nuclear Medicine, and others, is developing a series of Appropriate Use Criteria (AUCs) to describe when, and how often, certain diagnostic procedures should be performed.

These criteria are developed using a systematic review of evidence followed by a process that includes identification of relevant clinical scenarios, a systematic synthesis of available evidence, and individual and group ratings of the scenarios using a formal consensus process.

To date, AUCs have been published on the following topics:

- Somatostatin Receptor PET Imaging in Neuroendocrine Tumors
- FDG PET/CT Restaging and Response Assessment of Malignant Disease
- Hepatobiliary Scintigraphy in Abdominal Pain
- Ventilation/Perfusion Imaging in Pulmonary Embolism
- Bone Scintigraphy in Prostate and Breast Cancer
- Amyloid Imaging

AUCs are currently under development for the following topics:

- Gastrointestinal Tract Imaging
- Infection Imaging
- PET-Myocardial Perfusion Imaging
- Prostate Cancer
- Differentiated Thyroid Cancer

Factsheets with the AUCs, including charts offering ratings-at-a-glance, are available for physician office use at www.snmmi.org/auc.

Resources for Patients

www.DiscoverMI.org
This website, created specifically to meet the needs of patients, offers videos, factsheets, and information on a variety of diseases and conditions as well as nuclear medicine procedures.

Patient Factsheets
SNMMI offers dozens of patient factsheets on various diseases and procedures as well as the general information factsheets on "What is Nuclear Medicine and Molecular Imaging?" "What is PET?" "Optical Imaging," "About Clinical Trials," and "Nuclear Medicine and Radiation Safety." Many factsheets are available both in English and Spanish. To view and download, visit www.snmmi.org/factsheets.

SNMMI offers numerous videos for patients to help them understand the role of nuclear medicine and molecular imaging in diagnosing and treating disease.

Patient Education Day
Each year, the SNMMI and its Patient Advocacy Advisory Board offer a Patient Education Day in conjunction with the SNMMI Annual Meeting. This free, full-day program includes general session presentations on topics such as an introduction to nuclear medicine, radiation safety and clinical trials; breakout sessions on specific disease areas; a tour of relevant technologies in the SNMMI exhibit hall; and a networking lunch and reception.

The 2019 SNMMI Patient Education Day is being held June 23 at the Hilton Anaheim in Anaheim, California. Breakouts this year will focus on cardiac disease, neuroendocrine tumors, and prostate cancer. The full program can be found at www.snmmi.org/ped.

SNMMI's Patient Advocacy Advisory Board

The SNMMI works closely with a Patient Advocacy Advisory Board (PAAB) to keep its members informed of the patient perspective with regard to nuclear medicine; to advocate for legislative, policy and insurance coverage decisions that promote quality patient care and ensure patient access to care; and to educate patients and caregivers on nuclear medicine diagnostic and therapy procedures.

Organizations currently represented on the SNMMI's PAAB include:

- Alzheimer's Association
- Colon Cancer Alliance
- FORCE: Facing Our Risk of Cancer Empowered
- GO2 Foundation for Lung Cancer
- Lymphoma Research Foundation
- Men's Health Network
- NorCal CarciNET Community
- Susan G. Komen Foundation
- ThyCa: Thyroid Cancer Survivors' Association
- WomenHeart: The National Coalition for Women with Heart Disease
- ZERO: The End of Prostate Cancer

Patient advocacy groups interested in applying for representation on the PAAB should email outreach@snmmi.org.

Paige Bennett, MD
Nuclear medicine/molecular imaging specialist
Wake Forest University Health Sciences, North Carolina, USA

NUCLEAR MEDICINE EDUCATION VIA THE SOCIAL MEDIA SITE INSTAGRAM

Social media plays a prominent part in the general public's daily routine and primary information source on topics ranging from politics to medicine, regardless of occupation. In this article, the medical professional population is our primary interest. One recent study found that up to 94% of medical students, 79% of residents, and 42% of practicing physicians use social media [1], making it an ideal platform for integrating education into the medical professional's daily routine.

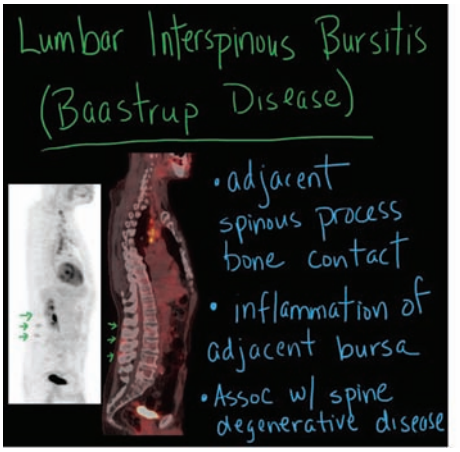
Since nuclear medicine is a visually oriented profession, social media sites that allow for image and video content such as Twitter, Instagram, and Facebook can be valuable educational tools. Because of their ubiquitous use, hierarchical/vertical educational barriers are diminished. For example, students, technologists, residents, and practicing physicians can all access the sites. Other educational barriers are decreased as well: people worldwide can participate and web-based computer translation systems have helped ease language issues. In addition, social media sites by definition are interactive, allowing for comments and questions from learners and teachers.

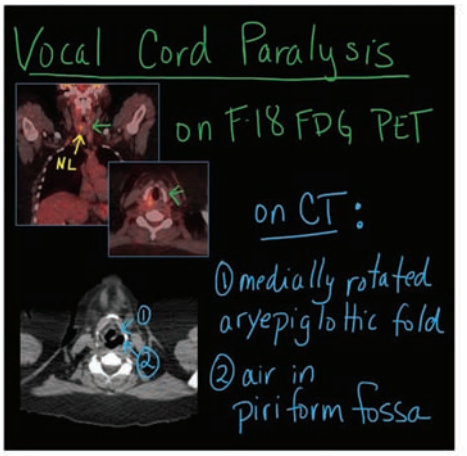
In an effort to reach learners of nuclear medicine on social media sites, the Instagram page @nuclear_radiology was created in 2016. Posts focus on interpretive skills for nuclear medicine and PET, nuclear medicine and radiology board preparation, and quality control/artifact identification. The site currently has over 6000 followers and has high levels of user interaction with posts (approximately 150 to 300 likes per post). This site joins several radiology-based educational accounts that are available to users on Instagram and Twitter, including:

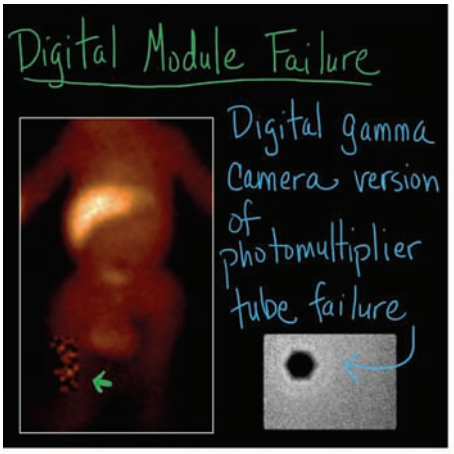
@thexraydoctor
@nuclear_radiology
@dr_nuclear
@Cincykidsrad
@Arrs_radiology
@Radiologyacr
@Radiopaedia

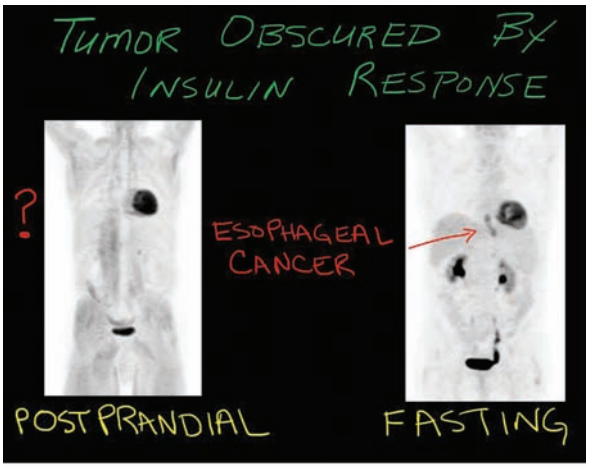
Example Cases

Some of the downsides of using social media for medical education include lack of peer review,









inefficient teaching methods, and a bias in academia against social media since it is often used for seemingly frivolous pursuits (popularity, narcissism, too much information/skin). Future directions for improving medical education on social media sites include:

1. Incorporating more evidence-based medicine: Studies demonstrate improved learning when directly comparing normal cases to abnormal cases in a side-by-side manner. Similarly, there is evidence for improved learning when comparing multiple different case examples of a similar abnormality [2].

2. Analyzing engagement: Incorporating analysis that directly records/measures forms of engagement on Instagram such as Hootsuite or Instract determine what types of posts stimulate the most engagement.

3. Utilizing follow-up posts to reinforce teaching points by spaced repetition learning techniques.

4. Exploring connections to Facebook, Twitter, and companion websites by maximizing the efficient use of the hashtag and biography page of Instagram.

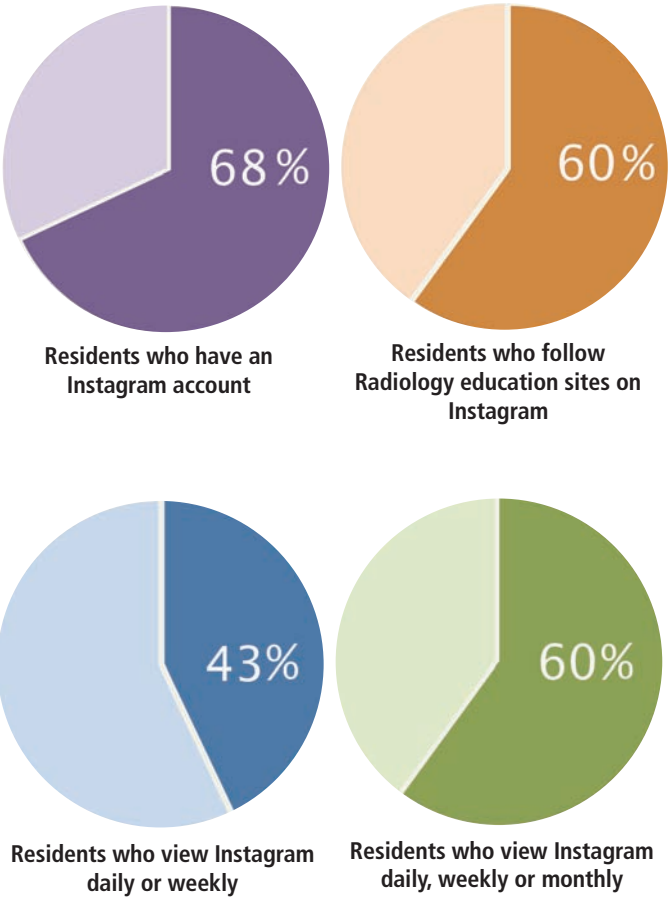
As we all know, social media already functions to distribute information on a large scale, potentially making it a useful and previously underutilized supplemental tool for educators. Instagram can be a means of providing case-based visual learning that is readily accessible by technology-savvy students, trainees and professionals. Hope to see you there!

References
1. Shah, V., Kotsenas, A. (2017). Social Media Tips to Enhance Medical Education https://doi.org/10.1016/j.acra.2016.12.023

2. Kok, E.M., de Bruin, A. B., Leppink, J., van Merrienboer, J. J. G., Robben, S.G.F. (2015). Case Comparisons: An Efficient Way of Learning Radiololgy. http://dx.doi.org/10.1016/j.acra.2015.04.012

To gain a greater understanding of the value of nuclear medicine education via the @nuclear_radiology Instagram page, we polled residents in the Diagnostic Radiology program at Wake Forest Baptist Health regarding their social media usage patterns.

Radiology resident and fellow usage patterns at Wake Forest University Health Sciences



Editor's note: This is part two of multiple articles exploring social media and healthcare. In the next issue: Practice development via social media.

LOOKING DEEPER INTO THE LUNGS WITH NUCLEAR MEDICINE

Dr. Andrew Ross, M.D. FRCP
Professor, Dalhousie University
Division Head, Nuclear Medicine Halifax, Nova Scotia, Canada

The strength of nuclear medicine lies in its ability to assess the body's physiologic processes and changes related to disease. Within the lungs, the most sensitive methods of looking at this function lie within nuclear medicine and utilization of tiny particles of carbon labelled with minute amounts of radioactivity which can mirror where air goes in the lungs. This radioactive tracer called Technegas is able to safely reach the tiny airways which are very difficult to assess with any other method.

This substance has been used for decades in a test to look for blood clots in the lungs. It is important in such assessment to know where the air reaches (ventilation) and assess that versus where the blood flow goes (perfusion). In areas where there is ventilation but no perfusion there is likely clot.

Over the last few years there has been increased interest in using Technegas to look at diseases other than blood clots that affect the lungs for which there is little sensitive testing currently available. The behavior of the agent like a gas provides the possibility to look more closely at the lung function differently and more sensitively. Our group in Halifax, led by the respiratory department with significant involvement of both biomedical engineering and nuclear medicine have undertaken a study to look at nuclear medicine ventilation in assessing an important disease of the lungs that occurs in patients having lung transplants or stem cell transplants. These patients are very prone to a condition called chronic lung allograft dysfunction (CLAD), which leads to pathology in the lungs called bronchiolitis obliterans. Although very complicated in name, it essentially is destruction of the tiny airways within the lungs with the resultant patient problems of difficulty breathing effectively.

Lung transplant and stem cell transplants are becoming more common and being utilized in a host of conditions. The lung complications discussed above are one of the significant longer term complications to this these procedures and lead to increased sickness and mortality. Early identification offers the potential for improved care, better quality of life and the potential for longer survival which will help better utilize scarce resources such as donor organs.

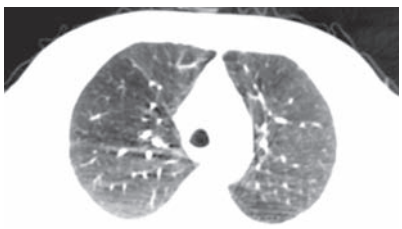
Current methods to assess these conditions involves lung function tests where the patient breathes into measuring devices, or another method called bronchial lavage, where through scope the doctor rinses the airways and the pathologist assesses these. Neither of these methods is particularly good at assessing for the disease, which at times can affect some areas of the lung worse than others.

"The hoped outcome is that by earlier detection, patients can receive treatment to mitigate against its progression and have a higher degree of function."

We have hypothesized that utilizing nuclear medicine ventilation, we can assess for changes in the small airways and how the lungs are being ventilated in patients after transplants. We are assessing the ventilation of these patients and comparing it to the current gold standards to assess for the appearance of changes within the lungs indicating the development of CLAD complications. The hoped outcome is that by earlier detection, patients can receive treatment to mitigate against its progression and have a higher degree of function.

Further, if the research demonstrates that nuclear ventilation is useful in assessing for early development and severity of small airway disease, expansion to other more common respiratory conditions that affect the small airways preferentially including COPD and asthma along with countless others will be of value.

In the study, 30 patients will be assessed over one year with several ventilation scans looking at ventilation patterns and quantitative measures for accurately assessing this and changes over time. These measures will include assessing overall variability in the ventilation pattern in the lung compared to functional tests. As well changes over time will be quantitatively assessed. ■



A: CT image of lungs

B: Technegas ventilation image

C: Quantitative assessment of overall heterogeneity of ventilation in a patient with red being uniform while the yellow/green shows heterogeneity

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甲状腺癌

甲状腺癌是内分泌系统和头颈部肿瘤中最常见的恶性肿瘤，其主要病理分型分为乳头状癌和滤泡状癌。近30年，除非洲地区因疾病诊断技术受限之外，世界大多数地区甲状腺癌发病率呈持续上升趋势。2016年，全球甲状腺癌新发病例数约为298 000例，死亡例数40 000例，虽有37%的新发病例来自欧美地区，但死亡主要发生在亚洲。我国甲状腺癌新发病例数占全球新发病例数的15.6%，死亡数占13.8%。2016中国肿瘤登记数据显示，2015年全国甲状腺癌发病率为4.12/10万，男性1.93/10万，女性6.42/10万；同期全国甲状腺癌死亡率为0.34/10万，男性0.23/10万，0.46/10万。近20年，我国甲状腺癌发病率一直呈上升趋势。中国肿瘤登记数据显示，2003-2012年甲状腺癌发病率逐年上升，死亡率较为稳定。

甲状腺癌大体分为分化型与未分化型，乳头状癌属分化型。分化型具有摄碘131功能，因此临床上用来治疗分化型甲状腺癌，特别是血行转移灶（肺、骨）。

碘-131治疗分化型甲状腺癌的指征推荐：
1、已知存在肺、骨等脏器的远处转移（M1），高危，强烈推荐进行碘-131治疗（提高疾病特异性生存率和无病生存率）；

2、术中肉眼可见肿瘤突破甲状腺包膜并侵犯皮下软组织、喉、气管、食管、喉返神经、椎前筋膜或包绕颈动脉和纵膈血管（无论肿瘤大小，T4），手术切除不完全，远处转移，高TG血症，个数不限但最大径大于或等于3厘米病理阳性的颈部淋巴结转移瘤，滤泡型甲状腺癌伴广泛血管侵犯（血管侵犯超过4处）。具备上述之一者即为高危，均强烈推荐进行碘-131治疗（提高疾病特异性生存率和无病生存率）；

3、原发肿瘤直径超过4厘米或镜下外侵（T3）、颈部淋巴结转移（N1），中危，应根据年龄、肿瘤外侵范围、淋巴结转移瘤数量和大小等选择性进行碘-131治疗；

4、虽然肿瘤没有突破甲状腺包膜且直径介于1—4厘米（T1b-2），低危，通常不建议行碘-131治疗，但若手术病理提示侵袭性组织学表现（如高细胞、柱状细胞、钉状细胞癌等）则可考虑进行碘-131治疗。

5、无外侵和转移的微灶癌（直径小于1厘米），无论单发还是多发病灶都应视为低危，不常规建议行碘-131治疗，除非有复发风险调整、疾病随访、患者意愿方面的考虑。

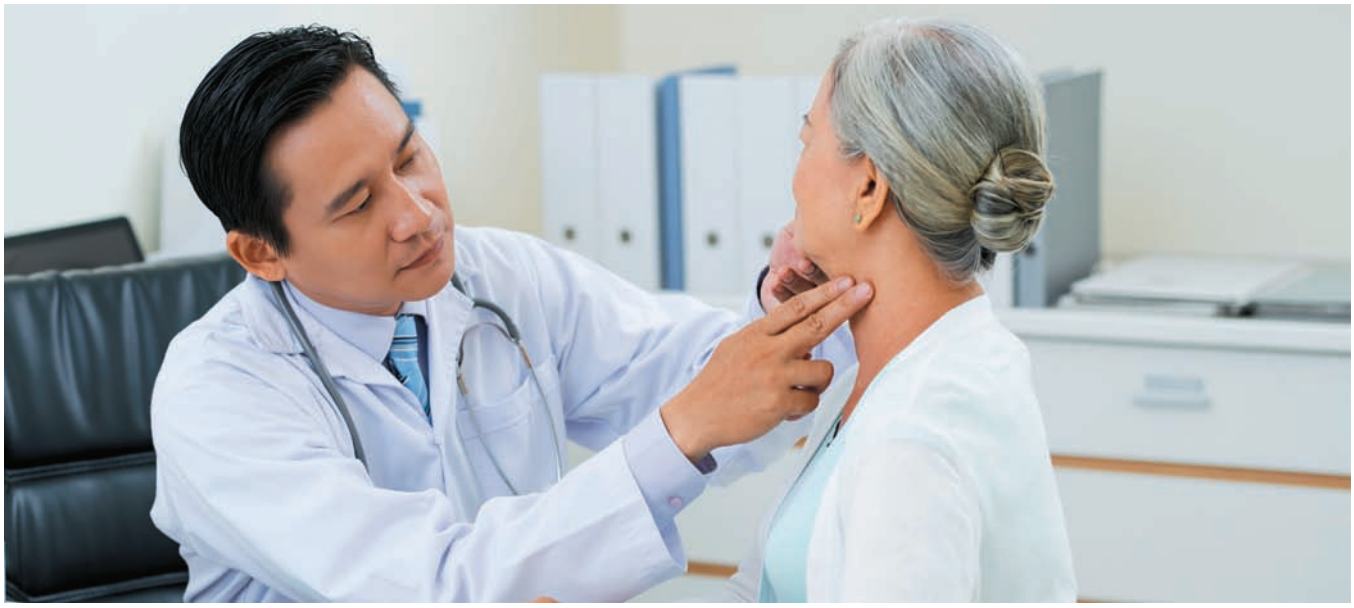
碘-131治疗分化型甲状腺癌的方法分类

严格来讲，广义的甲状腺癌术后碘-131治疗从实际方法和目的上可细分为三种具体情形，即残甲消融、碘-131辅助治疗和甲状腺癌碘-131治疗。

残甲消融，俗称“碘-131清甲”，是指通过口服碘-131的方法，使（术后残留）正常甲状腺组织受到靶向性电离辐射作用而坏死，充分实现甲状腺组织的去功能化。其作用在于降低术后甲状腺癌的复发、死亡风险并有利于进行疾病分期和随访（监测血清甲状腺球蛋白TG）。应该视残留甲状腺的大小和摄碘能力进行碘-131使用剂量决策，通常使用的碘-131剂量（活度）范围为30-150毫居里。

狭义的“甲状腺癌碘-131治疗”是指是指通过口服碘-131的方法，使甲状腺癌残留、复发、转移灶受到靶向性电离辐射作用而坏死，起到抑制甚至治愈甲状腺癌的作用。通常使用的碘-131剂量（活度）范围为150-250毫居里。

当然，在具体临床实践过程中，特别是首次收治时，部分患者同时存在残甲和潜在转移灶（或复发、残留）的可能。为了最大限度提高疗效、减少疗程数并降低辐射损害和医疗开支，在条件允许的情况下，可以使用碘-131治疗以同时起到残甲消融和辅助治疗甲状腺癌病灶的双重作用，此时就难以严格区分“消融”和“治疗”了，或者说两种情况可以同时进行，称为碘-131辅助治疗，通常使用的碘-131剂量（活度）范围为150-200毫居里。



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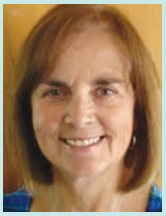

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President Canadian Association of Nuclear Medicine

The Canadian Association of Nuclear Medicine is more than honored to work closely with the International Associations or Societies of Nuclear medicine in the World. It is with all of us sharing our expertise that we will succeed in providing to our patients the best of what Nuclear Medicine can offer.

The future of Nuclear Medicine is so bright either in the diagnostic field as in the treatments that our biggest challenge at the moment is to train enough nuclear medicine specialists and technologists.

Nuclear Medicine is on a supersonic development.

The Canadian Association of Nuclear Medicine also believes that all of us should do more to make known the plus value of Nuclear Medicine to patients, to our governments and to the doctors as much to the specialists as to the general practitioners.

CANM is sincerely committed to this vision and his collaboration to the magazines LePatient or the Epatient are one of the examples of our implication.

www.lepatient.ca
www.nmpangea.com

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ALASBINM Lima Peru 13-16 November 2019
CANM Ottawa Canada 23-25 April 2020
SNMMI New Orleans USA 13-16 June 2020
EANM Vienna Austria 17-21 October 2020
WFNMB Kyoto Japan 7-11 September 2022

SISTER ORGANIZATIONS

SNMMI Society of Nuclear Medicine and Molecular Imaging
EANM European Association of Nuclear Medicine — Biomedical Imaging and Therapy for Personalized Healthcare
World Federation of Nuclear Medicine and Biology
AIPES
ARCENM
ASNC
AFNMB Asia Oceania Federation of Nuclear Medicine and Biology
IAEA International Atomic Energy Agency
alasbimn Asociación Latinoamericana de Sociedades de Biología y Medicina Nuclear
SFMN Société Française de Médecine Nucléaire et imagerie moléculaire
ARSNM Arab Society of Nuclear Medicine
South African Society of Nuclear Medicine

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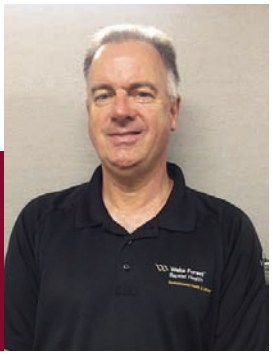


EFFECTIVELY MANAGING PATIENTS OR DECEDENTS THAT CONTAIN RADIOACTIVE MATERIALS

As of June 2018, there were 19,341 radioactive materials licensees in the United States; 16,545 (86%) regulated by 37 Agreement States and 2,796 (14%) regulated by the US Nuclear Regulatory Commission (USNRC). Through a formal arrangement with the USNRC, Agreement States have the authority to license and inspect byproduct, source, or special nuclear materials used or possessed within their borders. An Agreement State regulatory agency is typically a bureau, branch, section, or division in a department. Many of these radioactive materials licenses permit the receipt, possession, use, transfer and disposal of radioactive sources for biomedical research, diagnostic and therapeutic procedures.

About one-third of patients admitted to hospitals receive clinical treatment with ionizing radiation; each year 10-12 million nuclear medicine imaging and therapeutic procedures occur in the United States. About 100 different nuclear medicine imaging procedures exist; nationwide staffing is about 2,700 full-time Authorized Users (physicians) and 14,000 Certified Nuclear Medicine Technologists.

Guidance for release of patients that have been administered radiopharmaceuticals or permanent implants (i.e., prostate "seeds" using I-125, Au-198 or Pd-103) is contained in the April 1997 NRC Regulatory Guide 8.39, "RELEASE OF PATIENTS ADMINISTERED RADIOACTIVE MATERIALS." This guide provides an introduction, discussion, regulatory position, implementation, tables and sample calculations for release of a treated individual if the total effective dose equivalent to any other individual from exposure to the released individual is unlikely to exceed 500 mrem (5 mSv) based on administered activity, measured dose rate at one meter, or patient-specific dose calculations.

In accordance with the ALARA concept (As Low As Reasonably Achievable) for minimizing unnecessary radiation exposure to others, patient and family members should be informed at discharge, receive an instruction sheet and adhere to the principles of time, distance and shielding:

• Patient should reduce time spent in public places (stores, transportation hubs, theaters, restaurants, etc.)

• Patient should increase distance from others when possible (inverse square rule: doubling distance reduces exposure by 75%) and separate sleeping arrangements

• Patient should use any existing shielding (furniture, walls, car seats) to further reduce radiation exposure from patient

Disposable plates, cups and utensils will also help reduce any possible spread of radioactive contamination after dining. These actions are dependent on the particular isotope and activity

administered to the patient for determining how long to follow the precautions.

Security measures in certain high-risk areas (e.g., border crossing points, airports, docks, military installations, sporting/cultural events) may include the use of extremely sensitive radiation detectors. Patients treated with gamma-emitting radionuclides may trigger set point alarms, especially soon after discharge. If a radiation-emitting patient plans to fly soon (domestically or internationally) or lives near a secured area (e.g., Army base), he or she may be subject to radiation monitoring by security officials. The treating physician should provide the patient a wallet card/letter describing the treatment and contact information for the facility Radiation Safety Officer (RSO) in the event of an emergency or situation. The card/letter should indicate that patient received [x mCi] of [radioisotope] at [licensed facility] on [date] and is emitting radiation as the radioisotope decays.

If a radioactive patient triggers an alarm, it does not necessarily indicate hazardous levels of radiation. Modern digital radiation detectors meters can measure very low levels of radioactivity that pose no health concerns.

All security personnel should be trained and aware of possibly encountering a radiation-emitting patient and follow proper established protocols. For example, in March 2013, Chicago lawyer Jerry Jones was heading home on the train late in the afternoon. A TSA VIPR (Visible Intermodal Prevention and Response) team agent detected radiation from Mr. Jones and confronted him. Mr. Jones had undergone myocardial perfusion imaging that morning; he produced a card and doctor's note along with his ID attesting to the medical procedure. This satisfied the VIPR agent's request and Mr. Jones was free to travel.

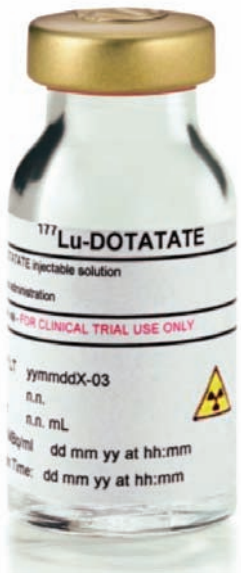
We can certainly keep doses to others low while the radioactive patient is alive, but what hazards exist if they expire soon after treatment? Each year, 55.3 million people die worldwide; in 2006, there were 40,000,000 treatments/exams using radioactive materials around the world.

What options exist for corpses?

- Donation: after embalming, for study at a medical school (eventually cremated)
- Inhumation: burial in Earth in a coffin or casket
- Immurement: permanent storage in an above-ground tomb/mausoleum
- Cremation: burned at right temperature and time for reduction to ashes
- Burial at sea: after suitable preparation and weighting before depositing into waters
- Ship burial: prepared and then set adrift on a boat at sea
- Cryogenics: prepared, frozen and stored upside down for (hopeful) eventual revival
- Alkaline hydrolysis: tissues are dissolved with chemicals and bones are pulverized
- Cryomation (aka promession): frozen and fractured into small particles for burial

The two most common, accepted and least controversial options are burial and cremation. There is a fair amount of controversy and conflict in religion, utilities, governments, science, commerce, special interest groups and public opinion regarding the last three options. What if the decedent was still radioactive and had requested one of these options prior to dying? It is not possible to change set characteristics of radioisotopes (emission, half-life, discrete energies) or otherwise render them non-radioactive. If one of these last three options

occurs, corpse may retain all, most, some or little of the originally administered radioisotope. What level of hazard do the remains then pose to anyone in close proximity to them?



In 2017, a 69-year-old male received lutathera treatment for pancreatic cancer at the Mayo Clinic in Arizona (typical administered dose is 200 mCi at each of four treatments). Two days later, he died unexpectedly at a different hospital; three days after his death he was cremated. Crematorium workers were unaware of his radioactive treatment until Mayo Clinic staff learned of his death and notified the Arizona Bureau of Radiation Control. Their survey on the oven, vacuum filter and bone crusher detected trace amounts of lutetium-177. A urine assay of one of the crematorium workers also exhibited trace quantities of technetium-99m, most likely inhaled from another corpse post-cremation.

Personnel protective equipment (PPE) should be in use whenever an activity involves exposure to hazardous materials. Level C protection (disposable coveralls, gloves, boots, goggles, and a half-mask N95 respirator with proper cartridges) is adequate for crematorium workers. This PPE will minimize their risks from external contamination, absorption, ingestion or inhalation of radioactive material from corpses pre- and post-cremation.

No federal regulations address cremation of radioactive corpses; it is left up to the individual states. In Florida, prior to cremation, removal of the radioactive organ(s) is required or the corpse is stored until the radioisotope has decayed to background levels (usually ten half-lives). This may pose an undue and unwanted emotional/financial burden on the affected family. Arizona has no law against cremating radioactive human remains.

Precautions for physicians and morgue personnel performing autopsies on radioactive corpses are listed in these NCRP (National Commission on Radiation Protection and Measurements) Reports:

• No. 155: Management of Radionuclide Therapy Patients (2006)

• No. 161: Management of Persons Contaminated with Radionuclides (2008)

A recent JAMA (Journal of the American Medical Association) letter concerning the 2017 Arizona cremation spurred media attention and some general public attention; this led the American Association of Physicists in Medicine (AAPM) and American College of Radiology (ACR) to release an announcement with these points:

• Radioactive materials are commonly used in medical practices (and have been for decades) to help improve overall health with little risk of harm;

• Risk of harm to crematorium operator is so small that it cannot be measured from exposure to trace amounts of volatilized radioisotopes;

• Consensus guidelines from the CDC and DOE, international radiation protection and public health organizations provide clear guidance on how to identify radioactivity in patient remains and appropriately deal with the body of the decedent;

These documents provide relevant information (available as .pdf downloads):

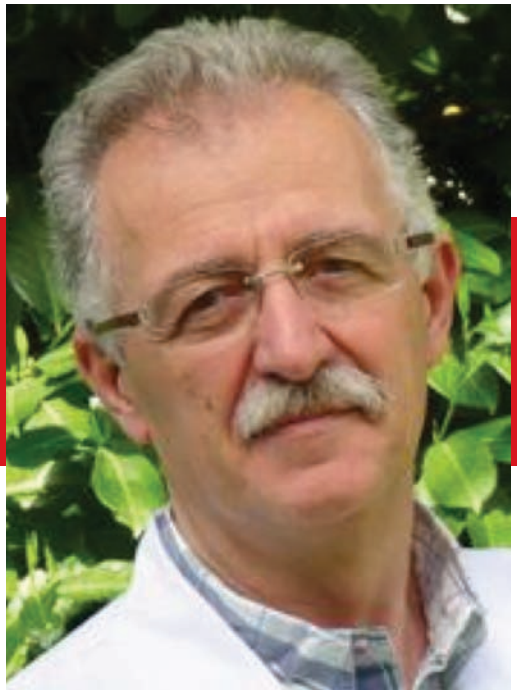
• CDC "Guidelines for Handling Decedents Contaminated with Radioactive Materials"

• DOE "Model Procedure for Medical Examiner/Coroner on the Handling of a Body/Human Remains that are Potentially Radiologically Contaminated"

• IAEA Safety Reports Series No. 63 "Release of Patients After Radionuclide Therapy"

• Canada REGDOC-2.7.3 "Radiation Protection Guidelines for Safe Handling of Decedents"

With the increased awareness that decedents may contain radioactive materials, a low-cost solution is installation and use of an appropriate radiation detector (i.e., alpha, beta, gamma) in morgues, funeral homes and crematories. Initial training, annual calibration, periodic testing and full-time detector use will alert facility personnel of the presence of radioactivity. A Radiation Safety Officer, health/medical physicist may be consulted to determine a 'safe' level of radiation exposure for corpse release to the coroner, medical examiner, or mortuary service. A policy and procedure regarding handling of radioactive corpses at the particular facility would ensure uniformity of practice in the future. ■



Patrick Bourguet,
Professeur émérite de médecine nucléaire, ancien directeur du Centre Eugène Marquis, ancien président de l'European association of nuclear medecine.

LA LÉGION D'HONNEUR RÉCOMPENSE LE PROFESSEUR, PATRICK BOURGUET

Dans un monde en perte de repères, la Légion d'honneur demeure un symbole fort et unificateur. Elle est profondément ancrée dans la société française. La Légion d'honneur est l'une des décorations les plus connues au monde. Elle a souvent servi de modèle dans de nombreux pays étrangers.

En mai dernier, le professeur, Patrick Bourguet, de la ville de Rennes en France, s'est vu décoré de la prestigieuse Légion D'honneur. Cette distinction, fort méritée, rejaillit également sur l'ensemble de la communauté nucléaire.

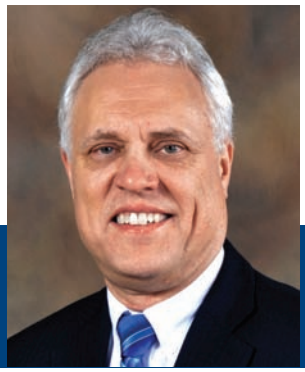
Patrick Bourguet, évoque l'exemple de ce que chacun d'entre nous voudrait représenter : un homme honnête, facile d'accès, d'une compagnie plus qu'agréable. Sa compétence exceptionnelle ainsi que son aptitude à partager ses connaissances avec les plus jeunes en font une personne d'exception.

Dans le domaine nucléaire, Patrick est reconnu et respecté de tous. En plus de son immense apport à la médecine nucléaire française, il a apporté une contribution inestimable sur la scène internationale. Ancien président des sociétés de médecine nucléaire de France ainsi que de toute l'Europe, il a su, par son expertise, apporter son talent au bénéfice du bien commun sur tous les continents.

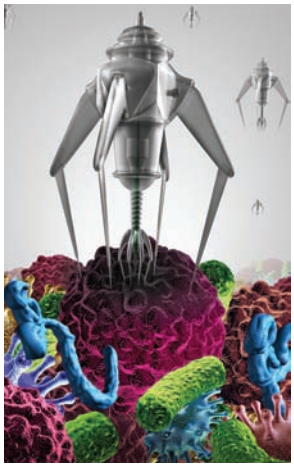
Patrick, au nom de tous les nucléistes du monde, MERCI !

Francois Lamoureux
et **Jean Luc Urbain**,
co-éditeurs ePatient.

Jean-Luc Urbain
M.D., Ph.D., CPE
Past President, CANM



THERANOSTICS: THE NEW HOLY GRAIL OF NUCLEAR MEDICINE



Theranostics, the new buzz word in medicine was coined in 1998 by John Funkhouser to describe a material that combines the modalities of therapy and diagnostic imaging and in the early 2000's by the CEO of PharmaNetics to define the vision for his company as a blend of therapeutics and diagnostics.

Theranostics are one of the significant outcomes of the Human Genome Project. In the medical era of the omics, it is directly related to, if not synonym to, precision medicine where diagnostic and therapeutic procedures are carved out for patients based on their genotype and phenotype. Most commonly, it refers to the use of a single agent/compound to diagnose and treat a specific disease.

Theranostics are not new to nuclear medicine practitioners. In fact, it has been intimately part of our day to day practice for a long time. Way before the sequencing of the sodium iodine symporter gene in 1996 which characterize the cellular membrane transporter for iodine, nuclear medicine had already used the an isotope of the physiologic iodine molecule (131 iodine) to diagnose and to treat patients with thyroid cancer for a few decades. To this day, the accumulation or lack of uptake of radioiodine by the thyroid gland represents a key non- invasive tool for the diagnosis and treatment of thyroid cancers.

The visualization, description and quantification of the molecular processes in normal and abnormal cells through molecular techniques has exploded since the late 1990s. Modern therapy of cancers, neurological and cardiac conditions now relies on the identification and targeting of specific cellular molecules. At the intersection of molecular biology and imaging, molecular imaging and nuclear medicine have grown exponentially as the complex biochemical and molecular secrets of the cell are being continuously unraveled. The amount of articles and references already published on the subject is striking: in less than 1 second a Google search for the word Theranostics yields more than 1.8 million hits.

Using specific probes and labeling them with diagnostic and/or killer medical isotopes, nuclear medicine offers the most attractive and quintessential tool in Theranostics medicine.

The modern landmark for Theranostics nuclear medicine originated in the seventies with the discovery of Somatostatin. Somatostatin, a 14-amino acid Cystin bridge-containing peptide, was first discovered in 1973. The elucidation of its three dimensional structure, its metabolism and biological activity site in the following years rapidly lead to the synthesis of a large number of analogs. Identified as the most stable and active in inhibiting the effect of the growth hormone, Octreotide, one of the derivatives, demonstrated enough in vivo stability to obtain regulatory approval in 1988 for the treatment of acromegaly and carcinoid tumors.

The coupling of Octreotide to gamma emitting isotopes in the late 80's and early 90's represented a major breakthrough to what we call now molecular targeted imaging. Furthermore its labeling with yttrium 90 and lutetium 177 in the early 2000's started the modern era of Theranostics nuclear medicine by introducing the fast growing field of peptide receptor radionuclide therapy (PRRT). In PRRT, specific receptors present at the surface of tumors can now be detected, imaged, treated and followed up with the same peptidomimetic labeled with either imaging or killer isotopes. Labeled with gallium 68, a positron emitter and lutetium 177 a gamma and beta emitter, the somatostatin analog dotatate has recently emerged as a prime tool to diagnose, treat and follow up the treatment efficacy of neuroendocrine tumors overexpressing the somatostatin receptor.

High throughput platforms such as phage, bacterial and aptamers display libraries, protein, RNA and DNA microarrays, fluorescence, spectroscopy are now routinely used to identify and to develop small molecular probes to image and potentially treat these specific receptors targets. Tagged with bifunctional chelating agents, native peptides, hormones, neurotransmitters and peptidomimetics are now emerging as suitable molecules for site-directed targeted imaging and therapy. Among the most promising of these compounds in nuclear medicine are the inhibitors of the prostate specific membrane antigen (PSMA).

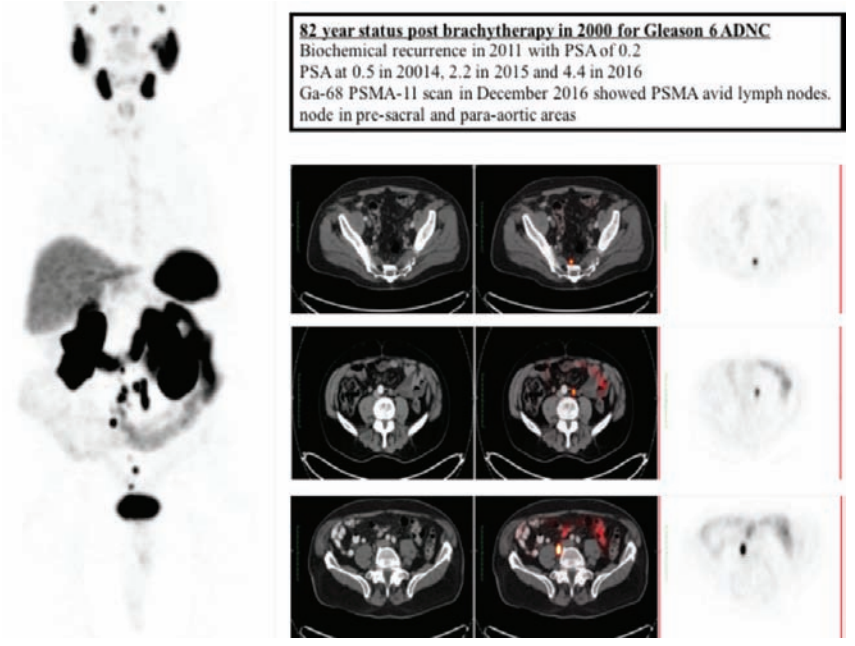
PSMA is a membrane glycoprotein with peptidase activity which is significantly over-expressed in prostate cancers. Its expression increases with tumor aggressiveness, androgen-independence, metastatic disease, and disease recurrence. Evidence suggests that PSMA may perform multiple physiological functions within the cell: a role in signal transduction,

cell migration, receptor function for an unidentified ligand and nutrient uptake such as glutamate and folate have been suggested.

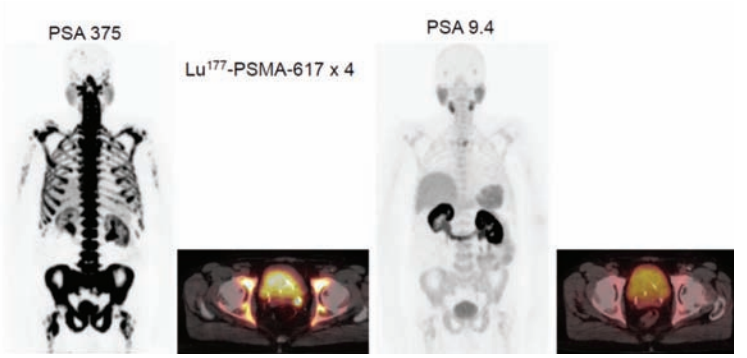
Having a sensitive and specific biomarker to localize primary and metastatic prostate cancer would greatly improve the algorithm for the diagnosis and management of prostate cancer. Other than skin cancer, prostate cancer is the most common cancer in North America. There area about 180,890 new cases of prostate cancer every year in the US. About one out of seven men will be diagnosed from prostate cancer during his lifetime.

Since 2012, the number of clinical studies using urea-based PSMA ligands, such as 123, 124,131 labeled IMIP-1072/-1095, 99mTc labeled MIP-1404/-1405, 68Ga labeled HBED-PSMA, 18F labeled DCFBC and DCFPyl, has exponentially increased. Among these agents, the 68 Ga- and 18F-labeled compounds have attracted the most attention, as these compounds can be used for PET/CT imaging. However, the availability of 123 Iodine or 99mTc also will allow SPECT/CT imaging in centers without facilities for PET. Based on these studies, the promising uses of imaging with labeled PSMA ligands in the management of prostate carcinoma include: the primary staging of high risk cancer disease, the biochemical recurrence with low PSA levels (as low as 0.2 ng/ml), identification of lesions for biopsy targeting after negative previous biopsy, the monitoring of systemic treatment in metastatic disease, the active surveillance and the treatment monitoring after 177 Lu-PSMA ligand therapy.

The following figure show the role that Ga68-PSMA played in a case of biochemical recurrence of prostate adenocarcinoma (Courtesy of Dr. Christiaan Schiepers from the Ahmanson Translational Imaging Division and Ronald Reagan UCLA Medical Center, Los Angeles, CA)



An example of the dramatic effect of 177 Lu-PSMA is illustrated on the next figure provided by Dr. Kalevi Karemo from Finland showing an extensive wide-spread strongly PSMA-positive skeletal disease. After 4 cycles of Lu 177 PSMA treatment, only one subtle uptake persisted at the level of T3 on the left. Concomitantly, PSA decreased from 375 ng/ml to 9.4 ng/ml.



Because of their ability to characterize cellular physiology and dysfunction, the radiopharmaceuticals used in nuclear medicine offer a very unique and specific window on disease that can exploited both for diagnostic and therapeutic purposes. During the past two decades, numerous ligands that bind to specific molecular targets, particularly in cancers, have been identified and characterized. Their labeling with single photon and positron emitters and alpha or beta particles has opened up a new era in nuclear medicine. While still in its infancy, nuclear diagnostic and therapeutic targeting (nuclear Theranostics) is rapidly becoming a cornerstone in precision oncology medicine.

A recent Theranostics market research analysis (MEDRaysintell) forecasted that the 4.8 billion global nuclear medicine market in 2017 in the US would become a 26 billion in 2030 confirming the trend that other market research companies have predicted. Their research also concluded that while radiotherapeutics represented 13% only of the global nuclear medicine market in 2017, nuclear therapy was expected to reach 60% by 2030.

The lack of concerted efforts in research and development of new radio-pharmaceuticals in the last part of the 20th century created a climate of uncertainty about the field of nuclear medicine at the eve of the 21st century. In a very interesting and remarkable turn of events, all credible indicators point towards Theranostics becoming the new holy grail of nuclear medicine.

Denise M Grandstaff, NP
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Theranostics Clinic
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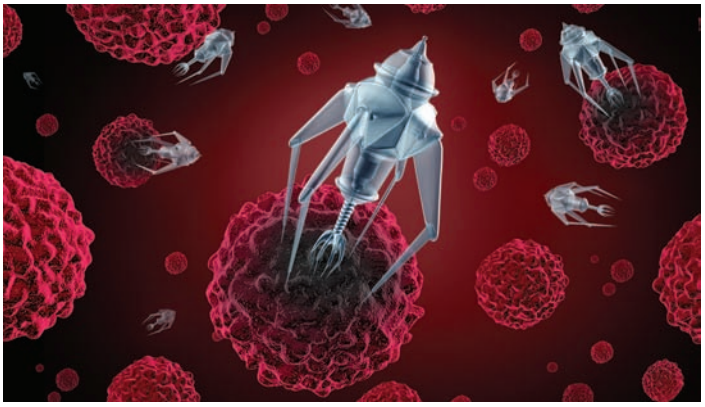
LUTATHERA THERONOSTICS TREATMENT



No patient wants to hear from a provider that there are no other treatment options to offer them at this time for neuroendocrine cancer. Lutathera is a Theronostic treatment for neuroendocrine cancer. Lutathera has been used successfully in Europe and has shown in studies to slow tumor growth and in some cases to reduce the size of the neuroendocrine tumor burden. Not only this, but Lutathera works directly with Theronostics, a series of diagnostic and therapeutic treatments that are individual for the patient. Although Lutathera is not a cure, it brings an improved quality of life and hope for the future for someone living with a terminal cancer diagnosis.

Wake Forest Baptist Medical Center (WFBMC) Nuclear Medicine Department has begun Lutathera treatments on patients with neuroendocrine cancer. If interested in pursuing Lutathera, patients must first conduct a consultation with a Nuclear Medicine Radiologist or Nurse Practitioner in order to discuss the treatment plan and the possible side effects. The treatment plan consists of four treatments of Lutathera over an eight month time period. After one Lutathera treatment, there is a four week consultation period with lab work including the Sandostatin injection, and a discussion about any side effects that may have occurred after treatment with Lutathera. These side effects may include fatigue and nausea among others, however, many patients describe having minimal side effects after receiving the Lutathera treatment as compared to those they had previously from their neuroendocrine cancer. After the four week follow up consultation visit, a decision will be made regarding the scheduling of a potential second Lutathera treatment. If the patient decides to go through with the treatment, this process will then be repeated four times over the course of eight months.

The request for new consultations for Lutathera treatments has dramatically increased for the Nuclear Medicine Department and has opened the door for Nurse Practitioners to be utilized in Nuclear Medicine. Traditionally, Nurse Practitioners (NP) were not utilized in this department, but the treatment process for Lutathera has introduced new unforeseen opportunities. Nurse Practitioners will also be directly involved in the initial consultations for potential Luthathera patients being referred for Lutathera treatment and follow up visits. Reviewing lab results and discussing any possible side effects will be completed at the follow up visits by the NP. The total eight month treatment cycle of patients receiving Lutathera will be conducted as a clinic setting within the Nuclear Medicine Department.

Wake Forest Baptist Medical Center (WFBMC) is on the leading frontier with modern and precision medical treatments for neuroendocrine cancer and patients can travel great distances to be treated at WFMBC. Upon arriving, the patient is immediately welcomed by the Nuclear Medicine treatment team consisting of the provider, technologist, and registered nurse. This close knit team specializes in helping assist the patient during their eight month treatment course and ensures with utmost responsibility that they are personally cared for at the Nuclear Medicine clinic. Many patients have explained they actually look forward to their treatments here at WFBMC because they are made to feel special, important, and above all, completely supported. WFBMC focuses on a positive patient experience and prides itself in its ability to provide superior medical care.

Theronostics with Lutathera has the potential to slow the growth of neuroendocrine tumors for patients with no other treatment options. It has not only led to an advance in this aspect, but has also opened the door to new opportunities for Nurse Practitioners to be used in the field of Nuclear Medicine in a clinical setting. This cutting edge therapy and treatments for cancer have given yet another advantage to work at Wake Forest Baptist Medical Center. ■

TECHNEGAS™

FUNCTIONAL LUNG IMAGING

BENEFITS IN USING TECHNEGAS V/Q SPECT/CT

DIAGNOSTIC TOOL

Technegas has the ability to allow the clinician to assess regional airflow and lung function with SPECT or SPECT/CT imaging[1].

It provides a physiological assessment by scintigraphy of alveolar spaces for:

- **Pulmonary embolism**
- **CTEPH**
- **COPD**
- **Asthma**
- **Emphysema**
- **Pre-operative quantification**
- **Radiotherapy treatment planning**

FAST & SIMPLE

A few breaths of Technegas are sufficient to achieve excellent quality images[2]

LOW DOSE BURDEN

V/Q SPECT with Technegas has a low radiation burden as compared with CTPA[3].

QUANTITATIVE TOOL

Advanced quantitative V/Q SPECT/CT with Technegas could be used as a tool for pre-operative evaluation, monitoring disease progression and following-up treatment response[4-5].

> ***" With the advent of SPECT and SPECT/CT technology, significant improvements in ventilation-perfusion imaging have been made not only in our ability to resolve subtle heterogeneity in ventilation and perfusion distributions but also in providing relative quantitation of ventilation and perfusion[1] "***

DIAGNOSTIC ACCURACY

Clinical studies have shown that V/Q SPECT with Technegas has high sensitivity and specificy in diagnosing PE[6] and CTEPH[7] with a very high negative predictive value.

> ***" We consider V/Q SPECT/CT to be superior in most clinical settings with better overall diagnostic performance[6] "***

WHAT IS TECHNEGAS

Technegas is a hydrophobic nanoparticle dispersion of carbon-labelled ^{99m}Technetium[8].

The nanoparticle size and hydrophobic properties of Technegas provide ideal characteristics for gaseous behaviour and alveoli deposition into the lungs[8-9]. This provides for a represention on imaging of peripheral penetration of Technegas to the lungs[9].

According to the Canadian Associaion of Nuclear Medicine (CANM) and the European Association of Nuclear Medicine (EANM) guidelines, Technegas is the preferred ventilation agent for ventilation-perfusion (V/Q) functional lung imaging studies[10-12]. In a few breaths and following SPECT or SPECT/CT, the clinician can produced 3D images providing information on lung function and pulmonary physiology[2,12].

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THE EXPANDING SPECTRUM OF NEUROENDOCRINE TUMORS (NETS)

Glossary of abbreviations.
CgA, chromogranin A, NEN, neuroendocrine neoplasm; NET, neuroendocrine tumor; 5-HIAA, 5-hydroxyindoleacetic acid,

OVERVIEW

Endocrine cells have the capacity to convert substrates into specific hormones that they store for secretion on specific demand. Endocrine cells are divided into three types based on their structure and function (1). Thyroid follicular cells produce thyroid hormone; these epithelial cells are derived from the oral endodern and their products are iodinated tyrosine-based hormones. Steroid hormones, which are manufactured based on cholesterol uptake followed by specific modifications, include glucocorticoids, mineralocorticoids and the sex steroids estrogen, progesterone and testosterone as well as DHEAS and others; these are produced by a family of cells that are of mesodermal origin including adrenal cortex and gonadal stromal cells. The most numerous hormones are polypeptide hormones, which are synthesized from amino acids, in a highly regulated manner in dedicated endocrine glands, which classically include the pituitary, thyroid, parathyroid, and pancreatic islets, but also include endocrine cells scattered throughout the respiratory and gastrintestinal tracts, as well as the numerous paraganglia of the sympathetic and parasympathetic nervous system including the adrenal medulla. Tumors arising from peptide hormone-producing endocrine cells, regardless of their anatomical location, have been collectively referred to as neuroendocrine tumors (NETs).

The classification of NETs has been complex, with terms such as carcinoid tumor, islet cell tumor, and adenoma in pituitary and parathyroid to indicate low grade lesions, neuroendocrine carcinoma to signify aggressive cancers, and small cell carcinoma to characterize the most lethal of these tumors. The features applied for grading of these lesions vary from organ to organ. Recently, the WHO has proposed to bring this large family of neuroendocrine neoplasms (NENs) under a single umbrella in an attempt to streamline and apply appropriate terminologies (2). The proposal is to classify all well differentiated epithelial tumors as NETs, with three grades based on their proliferation rates, and to separate the high grade, less well differentiated epithelial neoplasms as neuroendocrine carcinomas (NECs). This proposal is supported by molecular data that have shown distinct genetic alterations in these two different types of tumors that can arise from the same cells. Paragangliomas that are not epithelial are a third category of NEN. The term « carcinoid » is restricted to a syndrome that is caused by serotonin excess.

In this article, we will review the expanding spectrum of differentiated NETs, their presentations, and advances in their diagnosis and management.

HOW COMMON ARE NEUROENDOCRINE TUMORS (NETS)?

NETs are being recognized with increasing frequency. The incidence of gastro-entero-pancreatic NETs has increased dramatically over the last decade, with

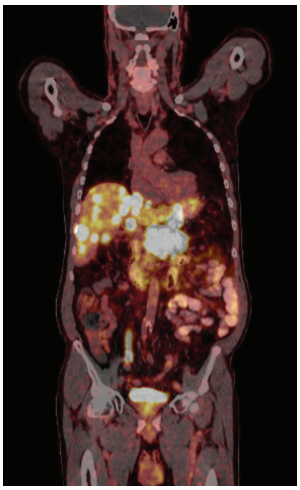

Figure 1. Innumerable lesions of metastatic NET within the abdomen show Gallium 68 avidity on PET imaging.

recent annual incidence estimates at 4-5/100,000 both in United States (3) and Ontario Canada (source: Ontario Cancer Registry). One of the National Cancer Institute largest databases on the subject included 13,715 cases of neuroendocrine tumors covering five decades from 1950 to 1999 (4). The most frequently involved anatomical sites were the gastrointestinal tract (67.5%) and the bronchopulmonary system (25.3%). Within the gastrointestinal tract, neuroendocrine tumors were diagnosed most frequently in the small bowel (42%) but also the rectum (27%) and stomach (9%). Five-year survival rates of 88%, 74% and 71%, respectively, were recorded for patients with the most frequent forms of NETs. Of these tumours, 4%, 28%, and 40%, respectively, demonstrated invasive growth or metastatic spread. However, it is critical to note that in nearly 13% of patients with gastrointestinal NETs, distant metastases can be detected at the time of diagnosis, highlighting the importance of increased awareness and early detection.

Other NETS are also being diagnosed more often. Pituitary NETs (PitNETs), which were one thought to be rare, are now known to be common tumors (5).

HOW SERIOUS CAN THEY BE?

NETs span the spectrum from indolent tumors to aggressive malignancies. Their proliferative activity is one of the most accepted biological markers of clinically relevant aggresive behaviour; this is determined by the Ki-67 labeling index, a feature identified by quantification of an immunohistochemical stain that detects a nuclear antigen expressed in dividing cells. Tumors with low proliferation are classified as grade 1 on the World Health Organization (WHO) grading system. Intermediate or grade 2 tumors have higher proliferative activity. The most aggressive or grade 3 tumors are the least common but also carry the worst prognosis with survival measured in months compared to years for the lower grade tumors. Neuroendocrine carcinomas, in contrast, are usually highly aggressive malignancies (Figures 1-3).

Paragangliomas have traditionally been considered benign with rare malignancy (Fig. 2b). The function and location of these tumors can have significant consequences and recently, the WHO has revised their classification; they are no longer classified as benign or malignant but all are considered to have have malignant potential and they are only distinguished as metastatic when spread is documented (6).

An important issue for all NETs is the high degree of familial predisposition. Patients with epithelial NETs may have multiple endocrine neoplasia (MEN) syndromes such as MEN1, MEN2 or MEN4. Paragangliomas have the highest incidence of causative germline genetic events at approximately 40%; these include succinate dehydrogenase (SDH)-related disease, von Hippel Lindau disease, MEN2 and mutations in more than 15 other genes (7).

HOW CONSISTENT ARE THE SYMPTOMS OF NETS?

The symptoms arising from NETs can be divided into two major categories. The first category is hormonal, which depends largely on the cell of origin. For example, lung and small bowel NETs frequently manufacture serotonin, resulting in flushing, wheezing, and diarrhea, the constellation of symptoms and signs known as the carcinoid syndrome. However, most other NETs do not manufacture serotonin. Instead, they produce dedicated hormones that are the normal products of their cell and organ of origin. In the endocrine pancreas this can include inappropriate insulin secretion with resultant hypoglycemia, gastrin overproduction leading to recurrent peptic ulcerations, glucagon hypersecretion contributing to diabetes and skin rashes, and vasoactive intestinal peptide (VIP) presenting with severe watery diarrhea. There are also other hormones such as somatostatin, pancreatic polypeptide, and cholecystokinin (CCK) with poorly defined common symptoms that often go without specific diagnosis. Thyroid NETs, known as medullary thyroid carcinomas, produce calcitonin. Parathyroid NETs cause hypercalcemia, PitNETs produce a number of hormones, some of which cause acromegaly or Cushing disease, others affect thyroid and gonadal function and fertility. Some NETs produce hormonal products usually secreted by other NETs, a phenomenon known as ectopic hormone production; the most common of these is ectopic ACTH, giving rise to Cushing syndrome that can be associated with NETs at various sites.

It is important to consider paragangliomas in the NET family since they can produce symptoms that mimic carcinoid syndrome but they do not produce serotonin; the production of catecholamines is relevant in this context.

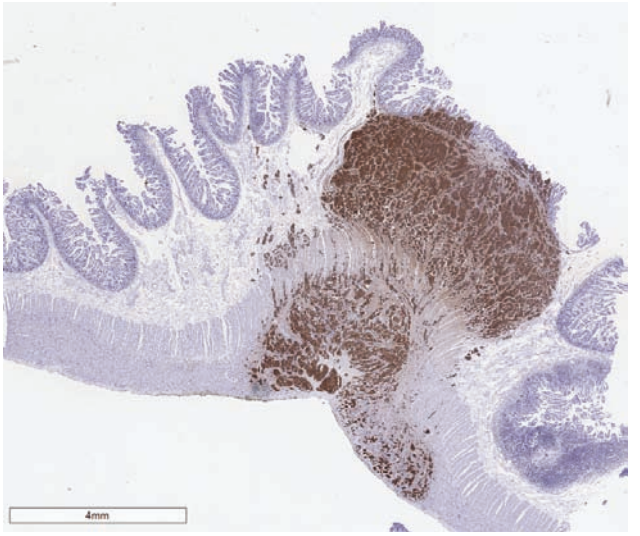

Figure 2. A NET of small bowel is seen infiltrating from its origin in the mucosa of the ileum (top right) through the bowel wall to the serosal surface; the tumor is highlighted by this immunostain for serotonin.

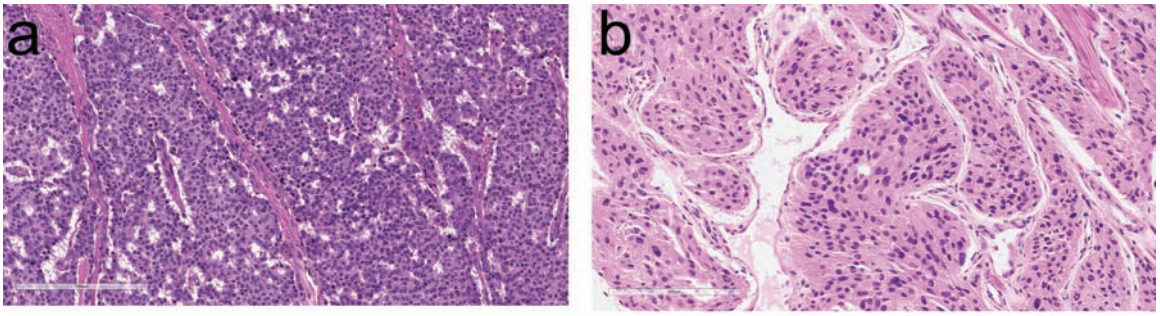

Figure 3. Histology of NETs. NETs usually are composed of solid nests, sheets, cords and small acini within a highly vascular stroma. (a) Epithelial NETs are characterized by round cells with relatively bland nuclei. (b) Paragangliomas often have larger and more polygonal cells with abundant amphophilic cytoplasm.

The second category of symptoms is structural or compressive in nature. These depend on the anatomical site of the disease and its metastases. For example, in the lungs, compressive lesions can result in recurrent pneumonias and/or hemoptysis. Around the biliary duct, growing NETs and their associated lymphadenopathy can result in significant cholestasis with or without pancreatitis. In the pituitary, the sequelae of NETs includes headaches and visual field defects.

HOW ARE NETS DIAGNOSED?

Incidental findings

NETs are increasingly diagnosed as an incidental finding during routine CT, ultrasound, or MR imaging. Incidental detection of gastric and rectal NETs at the time of endoscopy is also becoming increasingly common. While the appearance of NETs is sometimes characteristic, a tissue diagnosis is required for confirmation. In most locations, this can be in the form of a needle biopsy; ideally, a core biopsy is preferred over the more common fine needle aspirate. It is important to keep in mind that while a biopsy can establish the NET identity based on the detection of classic markers including synaptophysin and chromogranin, site-specific transcription factors and hormones (8), prediction of tumor behaviour is difficult to determine on a biopsy sample, since it requires complete staging and accurate proliferation assessment for grading, a feature that can be misleading on a biopsy due to tumor heterogeneity that is well documented in these lesions. The diagnosis of paragangliomas by a pathologist requires a high index of suspicion and special immunostains (8).

Biochemical testing

In instances where the clinical presentation provides a clue to the diagnosis of NET, specific blood and/or urine tests represent the cornerstone of laboratory diagnosis. Such biomarkers fall into two major categories. The generic biomarker for NETs is the peptide chromogranin A which has emerged as the single most useful general marker of neuroendocrine neoplasia. However, many precautions are required for specific application of this test. Of these, fasting conditions in the absence of medications which can falsely elevate serum chromogranin A are essential for reliable interpretation. The more specific markers include serum insulin, gastrin, somatostatin, vasoactive intestinal peptide (VIP), and/or pancreatic polypeptide, and 24 hr urinary 5-hydroxyindoleacetic acid (5-HIAA) that is a metabolite of serotonin. Again, such markers should be requested on the basis of specific symptoms and clinical suspicion as well as the results of pathology testing to enhance the yield and avoid misuse of laboratory resources. The diagnosis of paraganglioma must also be considered and in this setting, biochemical testing involves measuring the N-metabolites of catecholamines: methoxytyramine, normetane-phrine and metanephrine.

Functional imaging

Functional imaging using a variety of radioiostopes has long been recognized as a useful modality in detecting endocrine tumors. Earlier studies relied on metaiodobenzyl guanidine (MIBG) for the detection of catecholamine producing pheochromocytomas and paragangliomas. Subsequently, various groups around the world noted the ability of MIBG to also detect other NETs. However, this technique has now

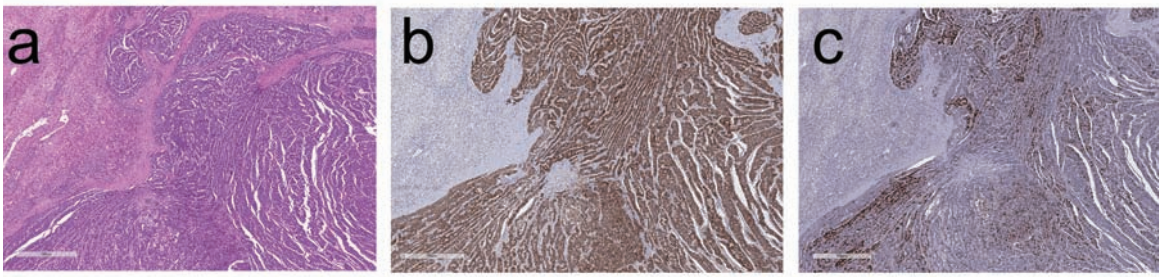

Figure 4. A metastatic NET in liver (a) stains for chromogranin A (b) and gastrin (c).

been largely superseded by somatostatin receptor scintigraphy (SRS). These technologies are based on the inherent abundance of somatostatin receptors expressed by NETs. The earliest generation of SRS relied on Indium^{111} as the tracer resulting in the traditional octreoscan. Subsequent studies, however, have demonstrated the overwhelming advantage of positron emission tomography/computed tomography (PET/CT) with ^{68}Ga-labelled peptides such as ^{68}Ga-[DOTA,Tyr3]-octreotate (Figure 4), also known as DOTATATE.

TREATMENT OF NETS

Surgery

Whenever possible, complete surgical resection of the suspected NET is the most desirable and successful therapeutic option. Unfortunately, this is not always possible given that a considerable fraction of patients present with metastatic disease at the time of diagnosis. Nevertheless, cytoreductive surgery coupled with detection and excision of the primary tumor is of proven benefit in impacting disease outcome.

Medical options

From a medical perspective, somatostatin analogues represent the cornerstone of most regimens for their ability to control hormone hypersecretion and arrest tumor progression (8). When insufficient, mTOR inhibition and tyrosine kinase inhibitors such as sunitinib represent the next options for intermediate grade tumors (8). For even more rapidly growing, high grade NETs, oral combination chemotherapy with capecetabine and temozolomide has gained wide popularity for its efficacy and relative tolerability (8).

Radiopharmaceuticals

The principle of somatostatin receptor overexpression in NETs has also been exploited and extended for radiotherapeutic applications. Currently, peptide receptor radionuclide therapy (PRRT) using particle-emitting radionuclides is emerging as one of the most promising radiopharmaceuticals with proven objective response rates, survival benefit compared to historical controls, and possibly enhanced quality of life (QOL) (9). It is anticipated that newer methods of PRRT application based on various internal dosimetry paradigms will represent the cornerstone of managrment of a sizable portion of the NET patient population.

Minimally invasive approaches

Complemented by surgery and radiopharmaceuticals are a host of new interventional approaches (10) including radiofrequency ablation, chemo- and bland-embolization, and nanoknife electroporation.

SUMMARY

Neuroendocrine neoplasms represent a large spectrum of tumors that occur from the base of the brain to the rectum. They are among the few tumors that are increasing in incidence. Their diagnosis requires clinical acumen based on recognition of their subtle features, and is confirmed by appropriate structural and functional imaging, biochemistry and pathology. Their diagnosis implies consideration of potential familial predisposition. A number of treatment modalities are available including surgery, medical and radiotherapeutic targeting. ■

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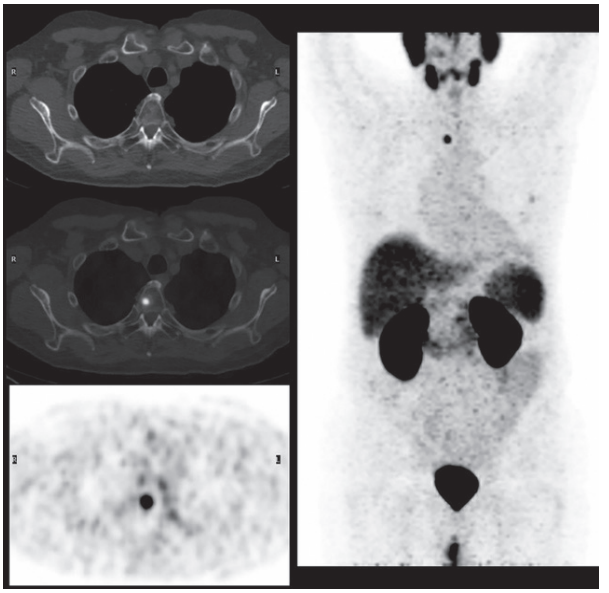
PSMA DIAGNOSTICS AND THERAPEUTICS FOR PROSTATE CANCER

PROSTATE CANCER AND PSMA

Prostate cancer is the most common cancer and the second most common cause of cancer death in North American men. For reasons only partly understood, positron emission tomography (PET) with ^{18}F-fludeoxyglucose (FDG) never showed adequate diagnostic performance in the prostate cancer indications where it mattered most – effectively shutting out these patients from the most advanced oncologic imaging in current clinical practice. Prostate specific membrane antigen (PSMA) PET is finally unlocking the potential of PET for prostate cancer patients.

PSMA is an enzyme and cell surface protein of the prostate which is highly upregulated in prostate cancer. Early antibody-based attempts to target PSMA such as ProstaScint® suffered from many drawbacks such as low count rates due to ^{111}In labelling, pairing with less precise SPECT imaging, slow blood clearance and very poor target-to-background ratios – needless to say this radiopharmaceutical was a clinical failure.



Novel urea-based small molecule PSMA PET ligands such as ^{68}Ga-PSMA and ^{18}F-DCFPyL do not suffer from these drawbacks and the clinical significance of these discoveries soon became apparent. For the major prostate cancer body imaging indications, namely staging of high risk disease and restaging of post-treatment biochemical failure, PSMA PET widely exceeds the sensitivity, specificity and accuracy of conventional imaging modalities such as CT + bone scan and significantly outperforms the prior gold-standard ^{18}F-fluorocholine PET.

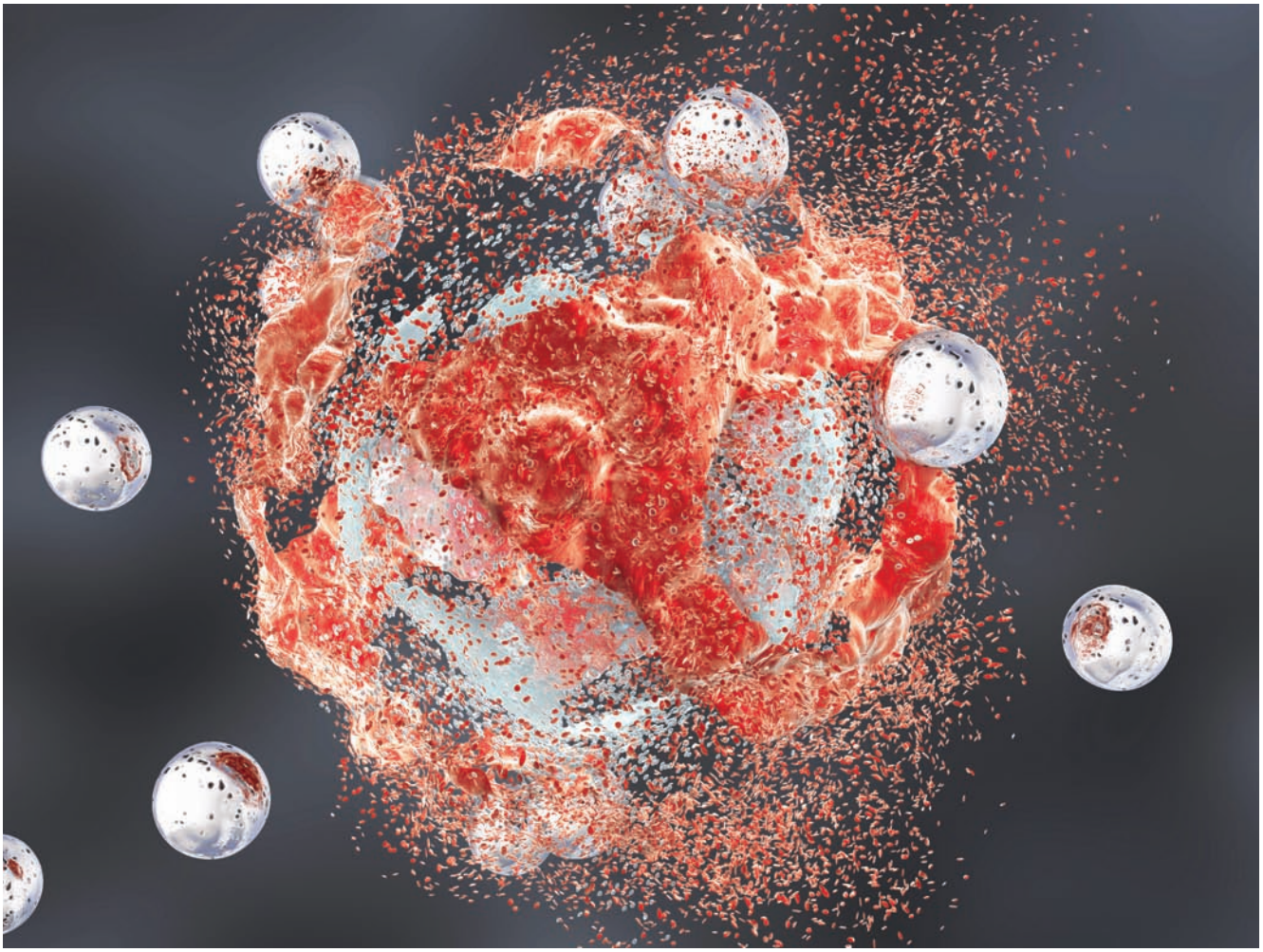
PSMA PET FOR STAGING OF HIGH RISK PROSTATE CANCER

In the setting of high risk prostate cancer (such as those with high Gleason scores, high PSA or advanced clinical T stages), up to 10–20% have extra-prostatic disease not detected by conventional imaging. In patients with nodal disease amenable to surgical excision or pelvic radiation, this allows physicians to adapt and personalize therapy. Patients with distant metastases at diagnosis are offered systemic therapy and spared invasive surgery or the side effects of radiation which would not be beneficial to their disease.

PSMA PET FOR RESTAGING OF BIOCHEMICALLY RECURRENT PROSTATE CANCER

Anywhere from 20–40% of patients undergoing radical prostatectomy and 30–50% of patients undergoing radiation therapy will experience biochemical recurrence, or PSA relapse) within 10 years. Because conventional imaging such as CT + bone scan are almost invariably negative in early biochemical recurrence, local therapies depending on disease localization were rarely possible, however PSMA PET promises to change this paradigm.

The advantage of PSMA PET is especially evident in patients with ultra-low PSA biochemical recurrence; detection rates of almost 60% have been reported in biochemical recurrence



after radical prostatectomy in a PSA-range 0.2–0.5 ng/ml. In such early stages of recurrence, curative-intent salvage procedures such as secondary lymphadenectomy and targeted radiation therapy become a reality.

PSMA THERANOSTICS FOR METASTATIC PROSTATE CANCER

Theranostics (a portmanteau of therapeutics and diagnostics) is a new field of medicine which combines targeted therapy based on similarly-targeted diagnostic tests. In addition to the progress made with the PSMA PET imaging agents described above, radionuclide therapy for men with metastatic prostate cancer is another highly promising development in the prostate cancer landscape. This targeted therapy for prostate cancer uses injectable lutetium-177 (^{177}Lu) labelled PSMA peptides which seek and destroy prostate cancer cells with radiation, wherever they are in the body. Human studies evaluating the safety and efficacy of ^{177}Lu-PSMA therapy have demonstrated promising results with a majority of men with metastatic prostate cancer, who have already failed other therapies, responding clinically to ^{177}Lu-PSMA.

PSMA CANADIAN LANDSCAPE

Despite very promising results, none of the above molecules are currently Health Canada approved, however the PET agents are available under research protocol at a few Canadian centers. Approval of ^{18}F-DCFPyL is expected in 2020 and widespread adoption should not be far behind. The phase-III registration trial which should lead to FDA and Health Canada approval and widespread availability of ^{177}Lu-PSMA therapy is currently enrolling at over 70 sites world-wide including the Jewish General Hospital and CHUM in Montreal, Hotel Dieu Hospital in Quebec City, Odette Cancer Centre in Toronto and BC Cancer in Vancouver.

CONCLUSION

The discovery of PSMA PET and PSMA therapy have brought the age of theranostics and molecular personalized medicine upon us. Nuclear medicine physicians, urologists and medical oncologists have powerful new tools at their disposal. Although much work remains to be done to bring these discoveries to Canadian prostate cancer patients, the future is promising. ■

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NEW FRONTIERS ACCESSIBLE, SOMATOSTATIN RECEPTOR IMAGING

HISTORY

Somatostatin is a hormone discovered in 1972 by Professors Brazeau and Guillemin (Salk Institute), also known as growth hormone–inhibiting hormone. It is a peptide regulating the endocrine system (exocrine and glandular secretion), which acts on the absorption of nutrients, plays a role in neurotransmission, smooth muscle tissue contractility and cell proliferation. This hormone is composed of a set of peptides that can be found in two forms. The first is composed of a sequence of 28 amino acids and is found mostly in the nervous system. The second, called efficient somatostatin, is a derivative of the first, possessing only 14 amino acids. The latter is mainly found in the digestive system.

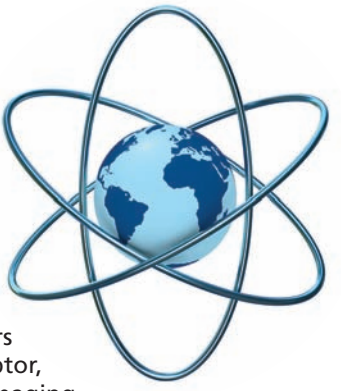
Somatostatin has a very short biological half-life, ranging from two to three minutes. It binds to one of the five somatostatin receptor subtypes (SSTR1-5) found on the cell surface to activate a cascade of interactions via the G-protein and inhibit the release of multiple secondary hormones. The concentration of these different receptors varies according to the tissues as well as the histological type of the tumors. The SSTR-2 receptor is the most physiologically expressed.

Research has promptly suggested that somatostatin could have tremendous therapeutic potential, thus creating a substantial hope for the treatment of growth hormone hypersecretion in diabetes as well as for the control of gastroenteropancreatic secreting tumors. Due to its very short biological half-life, several somatostatin analogues have been developed to circumvent this limitation. This work led to the discovery of octreotide in 1979, a somatostatin analogue with a half-life of approximately 90 minutes. Octreotide is a synthetic eight amino acid sequence that has more potent inhibitory effects than somatostatin on the secretion of growth hormone, glucagon, or insulin. Nowadays, it is frequently used in the treatment of certain pituitary hormone disorders such as acromegaly and very frequently in patients with neuroendocrine gastroenteropancreatic tumors to reduce symptoms and slow tumor progression.

NEUROENDOCRINE TUMORS

Although neuroendocrine tumors (NETs) are thought to be rare, national and global statistics show that their incidence is increasing (five cases per 100,000). This growth is mainly due to the fact that doctors are more familiar with the clinical manifestations caused by the hormonal activity of NETs and not by an increase in the number of cases. The major advances in biochemical and imaging diagnostic tools also explain the improved diagnosis of these types of tumors. The prognosis depends on the location, grade and and the rapidity of detection from the time of onset. A specific hormonal secretion will be sought in case of evocative symptoms. Chromogranin A (a glycoprotein produced in the secretory granules of neuroendocrine cells) is one of these commonly used markers, and the value will be high in 85% of patients with digestive NET. On the other hand, its specificity is only 68% because several conditions can cause its elevation. Of these, chronic use of proton pump inhibitors is the most common indication. Other causes include chronic lung disease, inflammatory joint and digestive diseases, renal failure, several non-digestive cancers, heart failure and even acute coronary syndrome.

The diagnosis of NETs is made using endoscopic, radiological and nuclear medicine techniques. Many of these tumors will be visible by CT and MRI with a sensitivity ranging between 30 and 40%. The ability to accurately determine the location and extent of the tumor is of paramount importance because the only curative action available is surgical resection. In the wave of specialist medicine, nuclear medicine has distinguished itself by offering an imaging test aimed at a biological characteristic of NETs, that is, the expression of the somatostatin receptor. The concept of somatostatin receptor imaging was introduced in 1994 by the introduction of a nuclear medicine agent called Octreoscan (Mallinckrodt Pharmaceuticals). This agent marked the beginning of a revolution in receptor imaging to identify, by non-invasive testing, the extent of tumors overexpressing the somatostatin receptor, almost undetectable by other imaging modalities.



OCTREOSCAN

Octreoscan (Indium-111 pentetreotide) has been available for several years in all nuclear medicine centers in Quebec and elsewhere in the world. It offers a sensitivity ranging from 52-92% and a specificity of 92% for the detection of NETs. It is a sequence of eight amino acids similar to octreotide to which a chelating group has been added in order to insert a radioactive isotope, indium-111. This isotope is essential for monitoring the distribution of the radiopeptide which, once injected intravenously, will specifically target the expression of the somatostatin receptor on the cell surface. Of the five known subtypes of somatostatin receptors, the Octreoscan preferentially targets SSTR-2, 3 and 5 receptors. At the level of gastroenteropancreatic NETs, the STR-2 receptor is the most frequently expressed compared to the SSTR-4, which is only very rarely expressed. All the NETs express differently the five receptor subtypes and the expression of the receptor is not specific to the NETs since benign lesions (e.g. pituitary adenoma, meningioma, hemangiomas) and neoplasia (e.g. breast, lung, lymphoma) can also express the receptor. Also, during the progression of a tumor from a

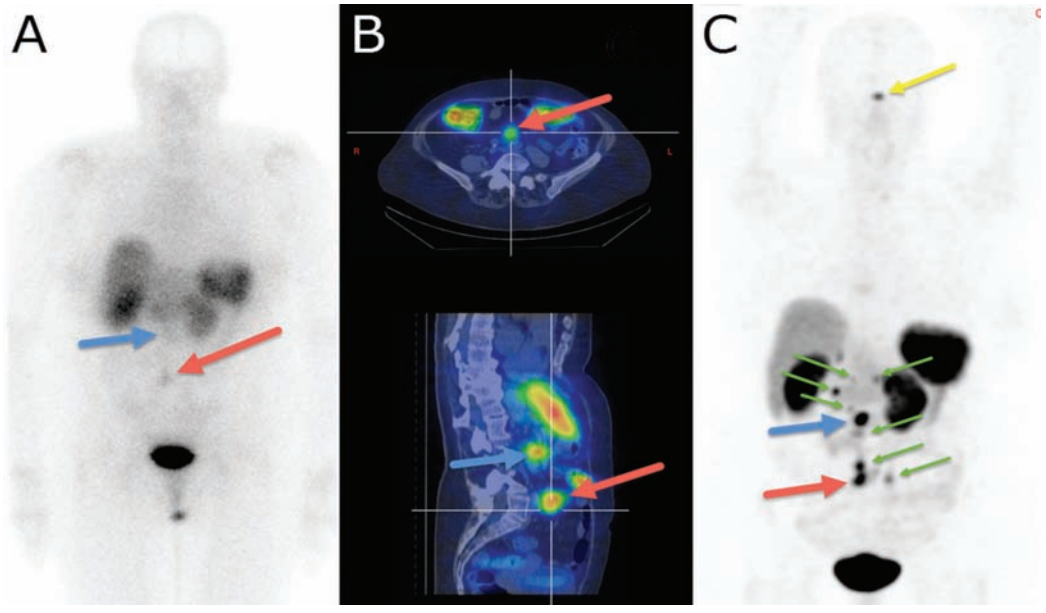


Figure 1.
Images obtained at Octreoscan (A and B) and Octreotate (C) in the same patient at an interval of one month. Octreoscan scintigraphy (A): the red arrow points to a somatostatin receptor overexpressing lesion and the blue arrow indicates an abdominal equivocal lesion. SPECT-TDM with Octreoscan (B): two lesions clearly visible (arrows red and blue). PET-Octreotate (C): confirms that both lesions visible to Octreoscan over-express somatostatin receptors in addition to seven other lesions (green arrows). Physiological pituitary uptake (yellow arrow).

Table 1.

Advantages and disadvantages of PET-Octreotate imaging compared to Octreoscan

Advantages

- It takes 25 minutes in one day instead of two to three days.
- Lower dosimetry, advantageous for the pediatric population (2.1mSv / 100MBq vs 8mSv / 100MBq).
- 5 mm resolution compared to 1-1.5 cm, more sensitive.
  - Locates more unsuspected lesions.
  - Change in management in > 50% of patients.
- Cost-effective, lower than the cost of Octreoscan for high-speed imaging installations.
- Available every day. Octreoscan must be ordered one week before use.

Disadvantages

- The half-life of the radiotracer (68 minutes) makes exporting impossible.
  - Patients must move to the imaging center.
- Must be synthesized on site, a few minutes before use.
  - Requires an experienced and available team.
  - Only one possible synthesis per six-hour period.
- False positives also more visible: hepatic hemangioma and bone.

differentiated to undifferentiated state, the expression of the receptor decreases until it disappears. These factors must therefore be considered to ensure the effectiveness of somatostatin receptor imaging.

Moreover, this type of imaging requires a gamma-camera type device which is nowadays present in the form of hybrid apparatuses combining both a gamma detector and an axial computed tomography (CT) scan. This combination considerably increases the sensitivity and specificity of the examination, but remains ineffective in imaging tumors less than 1 cm (Figure 1, A and B). To increase the ability to image smaller lesions, the examination should take two to three days, requiring great flexibility from the patients.

EVOLUTION TOWARDS POSITRON EMISSION TOMOGRAPHY

Today, several departments of nuclear medicine in Quebec have been upgraded to integrate a positron emission tomograph (PET) into their equipment fleet. These ultra-high-tech devices, which are more sensitive and quicker than conventional nuclear medicine devices, offer great advantages by opening the door to customized molecular imaging. The advantages of fluorodeoxyglucose imaging (FDG) are now well known in oncology for a very high proportion of neoplasias. However, for NETs, FDG-PET is not indicated for the majority of low-cell-proliferation NETs (less than 20%). FDG-PET sensitivity becomes higher for NETs with a more aggressive biology and an unfavorable prognosis. Due to the inability to properly image well-differentiated NETs with FDG, an imaging similar to Octreoscan has been developed, commonly called DOTATOC, DOTANOC or DOTATATE PET/CT.

Similarly to Octreoscan, Octreotate (DOTATATE) is an eight amino acid sequence associated with a chelator that will allow a PET isotope, Gallium-68, to be inserted into the peptide. However, the amino acid sequence is different from octreotide. Minimally, PET-Octreotate imaging has the same advantages and indications as Octreoscan, making it a replacement. But compared to Octreoscan, PET-Octreotate (Figure 1 C) has a higher sensitivity, ranging 81-94% and a specificity of 82-90%. This increase in accuracy compared to Octreoscan is explained by a 12-fold higher affinity of the Octreotate for SSTR-

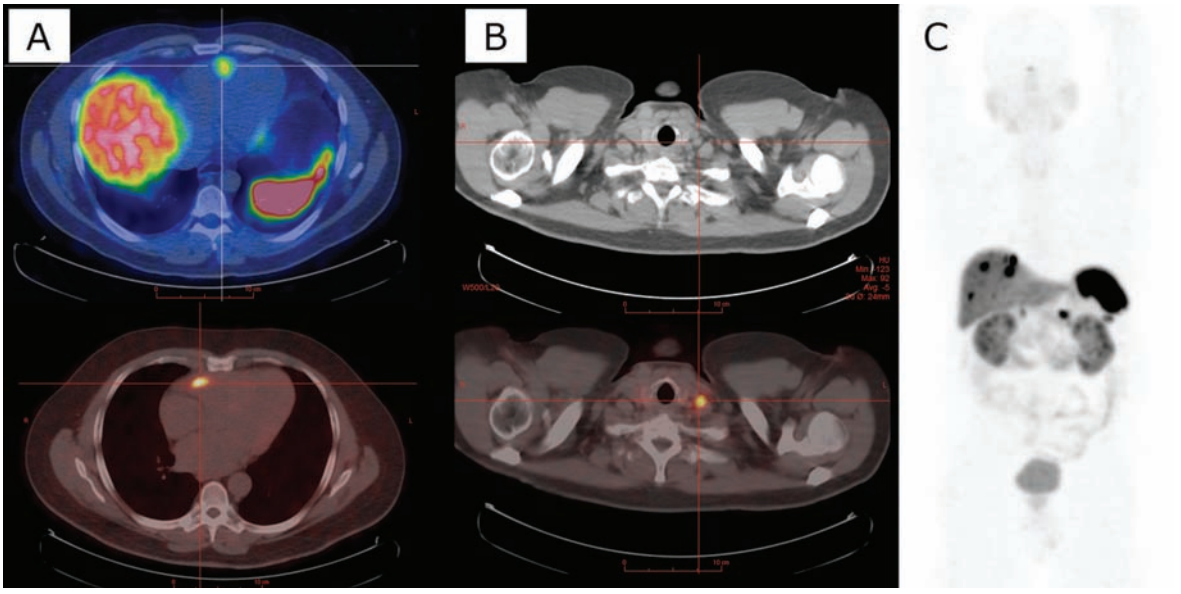


Figure 2. PET-Octreoscan imaging showing unsuspected lesions. Image A (top and bottom): NET cardiac metastasis in two patients. Image B (High CT, Low Fusion PET-CT): 3 mm cervical metastasis of a small bowel tail. Image C (PET): NET of the pancreas with multiple liver metastases.

2 somatostatin receptors and a sensitivity gain of PET devices capable of imaging lesions as small as 5 mm. This increase in sensitivity results in a modification of the therapeutic approach in more than 50% of patients who previously had a conventional negative imaging with the Octreoscan. Octreotate PET imaging has considerable benefits for the patient as imaging takes place in a single day and takes only 25 minutes. The examination is also less irradiating, making it the exam of choice for the pediatric population.

The main disadvantage of Octreotate is its availability due to its physical half-life of 68 minutes compared to the Octreoscan of 2.8 days. This limitation is a consequence only because of the use of Gallium-68 as an isotope, which cannot be replaced. Consequently, the Octreotate must be synthesized on site by an experienced team, can be transported only a short distance and must be used within minutes of its synthesis. No place for error is allowed, as only one synthesis can be obtained per six-hour period and each synthesis makes it possible to image a patient, for a maximum of two patients per synthesis if two PET devices are available. Table 1 summarizes the advantages and disadvantages for the patient and the clinician of PET-Octreotate versus conventional Octreoscan imaging.

Since the summer of 2016, a Canadian center (CIUSSS de l'Estrie CHUS, Sherbrooke Molecular Imaging Center - CIMS) offers PET-Octreotate as a replacement for conventional Octreoscan for both adult and pediatric population. Since this is an imaging test not approved by Health Canada, patients must first consent to the injection of the Octreotate. In case of refusal, conventional Octreoscan imaging will be offered. Less than six months after its implementation, more than 100 studies have been conducted with Octreotate for patients from British Columbia, Ontario and Quebec. The most common findings are the extension of the NET (Figure 2, ABC), determine the degree of somatostatin receptor expression in anticipation of radiopeptide therapy (Lutetium-Octreotate), measure the response to treatment and characterization of brain lesions (meningioma).

Given the growing popularity of PET-Octreotate, the imaging center expects to reach a pace of 150-200 exams for 2017. Due to the presence of two PET devices, it is estimated that a maximum of 280 examinations could be performed annually. Table 2 summarizes the indications for PET-Octreotate. ■

If you feel that any of your patients may benefit from this examination, please contact us at:

Email: e.turcotte@usherbrooke.ca
Phone: 819-346-1110 x11887
Fax: 819-820-6490

Table 2:

Indications for which the Octreotate replaces the Octreoscan

- Locate a NET or tumor expressing the receptor to somatostatin and its metastases:
  - Gastroenteropancreatic tumors: carcinoid, gastrinoma, insulinoma (50%), glucagonoma, VIPoma, bronchial, small cell carcinoma.
  - Tumors of the sympathetic and parasympathetic system (pheochromocytom, paraganglioma, neuroblastoma, ganglioneuroma, glomus).
  - Medulloblastoma.
  - Oncogenic osteomalacia.
  - Merkel-cell carcinoma.
  - Medullary carcinoma of the thyroid
  - Other tumors: breast (Figure 3), lymphoma, hypernephroma, hepatoma, pituitary adenoma, meningioma
- Select patients for whom the tumor is progressing and may benefit from radiopeptide therapy (Lutetium or Yttrium)
- Measure response to treatments.
- Locate recurrence sites in symptomatic patients or in the progression of tumor markers.
- Determine the degree of expression of somatostatin receptors in order to characterize a lesion that is difficult to biopsy.
- Characterization of a suspicious meningioma brain lesion, impossible to biopsy, in anticipation of radiotherapy.

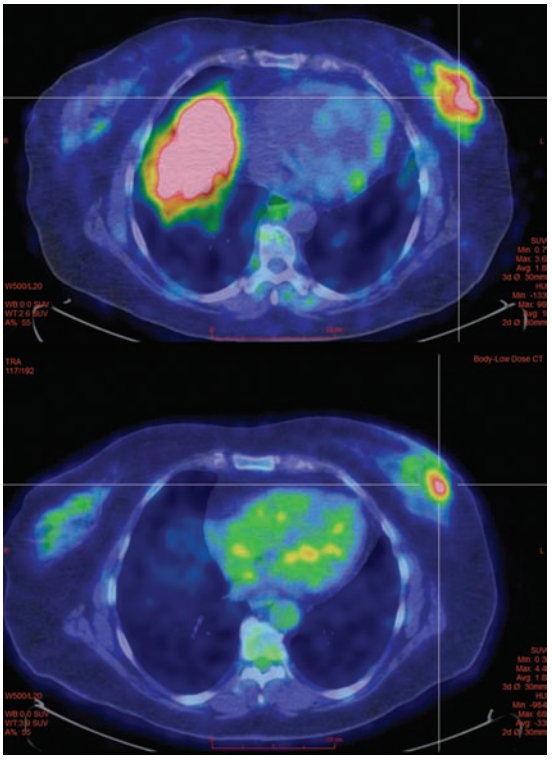


Figure 3.
Octreotate imaging (top) and FDG (low) within one week in a patient with a left breast infiltrating canal neoplasia. The octreotate allows to better visualize and delimit the local extension.

CANM ACMN
The Canadian Association of Nuclear Medicine
Association canadienne de médecine nucléaire

CANM GUIDELINES FOR VENTILATION/PERFUSION (V/P SPECT) IN PULMONARY EMBOLISM

Executive Summary

Document prepared by
Drs. Michel Leblanc, Michel Tessier, Glenn Ollenberger, Christopher O'Brien

November 2018

1. Diagnostic approach for PE.
Generally, predictive models based on clinical data for PE are poor.

D-dimer has high NPV but low specificity for PE, and is not needed if the pretest probability for PE is other than low.

V/P SPECT has at least the same or better accuracy for PE as CTPA, but much lower radiation dose especially regarding breast exposure. Also, there have been little or no reported adverse reactions.

2. Methodology
V/P SPECT should be used instead of planar acquisition when available. Multidetector gamma-cameras with large FOV are preferred for V/P SPECT. A one-day ventilation and perfusion protocol where the ventilation precedes the perfusion is the norm.

For ventilation, ^{99m}Tc-Technegas is the best radio-aerosol, particularly in patients with COPD. Liquid aerosols produced in nebulizers such as ^{99m}Tc-DTPA are inferior for SPECT and should not be used unless Technegas is not available.

Lung perfusion is performed using ^{99m}Tc-macroaggregated albumin (MAA). Suggested administered doses and acquisition parameters are presented in **table 1** of attached document. Appropriate iterative reconstruction and display of transverse, sagittal and coronal projections are essential for interpretation.

3. Interpretation criteria and reporting
Interpretation in probabilistic terms is not appropriate and must be avoided. Accordingly, all exams should be interpreted as either "PE present" or "PE absent" or other similar clear affirmative terms.

Affirmative diagnosis of PE requires the presence of vascular type mismatches. **PE is considered excluded** if perfusion is normal, if there are only matched defects, non-vascular type mismatches or reverse mismatches. See document for explanations.

Findings other than PE may be clinically pertinent, especially if symptoms include dyspnea or desaturation.

All PEs should have a final control 3 months after diagnosis to assess final reperfusion and to benefit from the availability of a baseline exam in case of recurrent symptoms.

4. Other considerations
In the **pediatric population and during pregnancy**, one should consider V/P SPECT as the first investigation for suspected PE due to better sensitivity, lower radiation, and no adverse reactions.

As ventilation co-morbidities are unlikely, a perfusion-only study might suffice, with an optional ventilation study the next day if needed. However, V/P SPECT should be used in pregnant women with co-morbidities or a history of smoking.

Due to a higher sensitivity and no adverse reactions, V/P SPECT should be the first investigation for the assessment of **Chronic PE**.

Although we do not recommend performing **SPECT-CT** on a regular basis, it could be appropriate in more challenging and selected cases.

CANM Endorsement of the 2009 EANM Guidelines for Ventilation / Perfusion Scintigraphy

1) Diagnostic approach to pulmonary embolism (PE)

Key Points:

1. **Predictive models for PE are generally inaccurate**
2. **D-dimer has high sensitivity but low specificity for PE**
3. **Negative D-dimer has a high NPV**
4. **High quantitative value of D-Dimer increases likelihood for PE**
5. **D-dimer is not needed if pretest probability for PE other than low**
6. **V/P SPECT has at least the same or better accuracy for PE as MDCT**
7. **Availability is the main determinant of use for MDCT vs V/P SPECT**
8. **Fetal dose is roughly equivalent for both V/P SPECT and MD-CTPA**
9. **Breast dose is much higher with MD-CTPA as compared to V/P SPECT**
10. **V/P SPECT carries less risk of allergic reaction associated with contrast agent injection**
11. **99% of patients referred for V/P can undergo the exam.**

Referral criteria and assessment of clinical probability

For the diagnosis of PE the patient's clinical factors are non-specific. The clinical probability of PE can be accomplished empirically or by means of a prediction rule. Wells model is most frequently used. PISA model may be a more precise predictor of PE. Combining clinical probability with objective testing for PE can rule in or out PE. The measurement of D-dimer is widely used in the investigative work-up of patients with suspected venous thromboembolism. D-dimer features a low specificity (40%). Accordingly, a negative quantitative D-dimer test has a high negative predictive value for venous thromboembolism. High quantitative value of D-Dimer increases likelihood for PE

CANM endorses Fig. 1 and 2 - **Clinical algorithms for investigation of patients with suspected PE** as published in *Eur J Nucl Med Mol Imaging* (2009) 36:1528–1538.

Imaging studies in PE

The diagnosis of PE relies upon imaging tests, notably V/P scan and MDCT. In many clinical studies, including recent ones, comparisons between V/P scan and MDCT have been based upon obsolete scintigraphic techniques and interpretation criteria. The lack of a satisfactory gold standard for the diagnosis of PE poses difficulties for the assessment of sensitivity, specificity and accuracy of all diagnostic methods for PE. V/P SPECT has at least the same or equal accuracy for PE as MDCT. Additional diagnoses found on V/P SPECT include COPD, left heart failure and pneumonia. MDCT provides valuable information about diagnoses other than PE, such as aortic aneurysm, tumour, pleural effusion and pneumonia. A high number of patients are ineligible for MDCT due to kidney failure, allergy, ventilator support, recent MI and critical illness. 99% of patients referred for V/P can undergo the exam. CTPA is more readily available on a 24/7 basis and thus may be used more often.

Radiation Doses

The effective radiation dose from V/P SPECT is 1.2–2 mSv. The absorbed dose to the female breast is estimated as 0.8 mGy. During the first trimester, the estimated dose for perfusion study (50 MBq) gives a fetal absorbed dose of 0.1–0.2 mGy [47].

For MDCT during the first trimester the absorbed fetal dose was estimated as 0.24–0.66 mGy and significantly higher later during gestation. Recent studies have shown that MDCT is often technically suboptimal during pregnancy. The rate of nondiagnostic MDCT studies was 27.5% during pregnancy, versus 7.5% in nonpregnant women.

Based upon data from ICRP reports, the effective dose for V/P SPECT with the recommended protocol is about 35–40% of the dose from MDCT. The dose to the female breast for V/P SPECT is only 4% of the dose from MDCT. During the first trimester of pregnancy the fetal dose from MDCT is greater than or equivalent to that of V/P SCAN. The advantage of V/P SPECT increases after the first trimester.

Follow-up

V/P SPECT is ideally suited for use in the follow-up of PE because small and large emboli are recognized so that regression or progression of thrombotic disease can be studied in detail. Furthermore, the low radiation exposure allows repeated studies. It can be applied **in all patients**. Using the same method for diagnosis and for follow-up has great advantages. Perfusion-only scintigraphy may be chosen for control during the initial phase of treatment

CANM endorses Fig. 3 - **Algorithms for diagnostic imaging for acute PE suspected** as published in *Eur J Nucl Med Mol Imaging* (2009) 36:1528–1538.

2) Methodology

Introduction

Planar ventilation/perfusion technique with probabilistic interpretation suffered disrepute since the PIOPED I study showed that 65% of scans were nondiagnostic for PE. Consequently, it has become an inferior technique for most clinicians and should be replaced by more advanced nuclear medicine imaging using SPECT acquisition whenever available. The following recommendations regarding the choice of radiopharmaceuticals and imaging strategies for V/P studies are based on the 2009 EANM guidelines, updated with the more recent literature.

Radiopharmaceuticals

Ventilation

^{81m}Kr (krypton) is currently the only gas appropriate for V/P SPECT. However, because of high costs and limited distribution, it is not readily available in Canada. The best widely available agent for ventilation is ^{99m}Tc-Technegas, an aerosol of carbon nanoparticles (5-200 nm) generated in a high temperature furnace (Technegas Generator, Cyclomedica). Because of the very small particle size, this agent is distributed in the lungs almost like a gas and deposited in alveoli by diffusion, where they remain stable, thus providing the best possible images for ventilation SPECT. In practice, between 400-900 MBq (1025 mCi) of $^{99m}TcO_4$ in 0.15ml NS is vaporized in a graphite crucible at 2750 °C in an argon atmosphere. The resulting ^{99m}Tc-Technegas is inhaled as soon as possible (<5 minutes) by the patient in a supine position, over the course of 2 to 5 inspirations. Activity over the lungs should be monitored, and administered activity should be around 30-50 MBq (0.8-1.4 mCi).

Liquid aerosols produced in nebulizers, such as ^{99m}Tc-DTPA, are inferior for SPECT, and should not be used unless technegas is not available. Overall, technegas remains the best radio-aerosol, particularly in patients with obstructive lung disease. Another advantage is that only a few breaths are sufficient to achieve an adequate amount of activity in the lungs, reducing time and personnel exposure to radiation.

Perfusion

Lung perfusion is performed using ^{99m}Tc-macroaggregated albumin (MAA). These albumin particles average 10–90 um in size, which allows them to lodge in the pulmonary capillaries and properly define lung perfusion. Normally, about 400,000 particles are injected, but a reduction to between 100,000 and 200,000 is recommended in patients with severe pulmonary hypertension or after a single lung transplantation. A minimum of 60,000 particles is needed to obtain a uniform distribution.

The suspension containing ^{99m}Tc-MAA should be gently shaken immediately before use and then administered by slow i.v. bolus injection over several respiratory cycles while the supine patient breathes at normal tidal volumes. Withdrawal of blood into the syringe must be avoided to prevent aggregation artefacts. The administered dose is typically between 120–240 MBq (3-6 mCi) but actually depends on the count rate of the ventilation agent. The activity ratio between perfusion and ventilation should be at least 4:1. The EANM guidelines recommend doses at the low end of the range to keep radiation exposure low (< 2.5 mSv).

Equipment and imaging protocols

A one-day ventilation and perfusion protocol where the ventilation precedes the perfusion is the norm. Ventilation is essential to maximize specificity and may help recognize alternate pathologies. A perfusion only protocol might be considered during pregnancy (with an optional day-after ventilation study if needed) or in the context of massive PE.

Planar acquisition should not be used anymore, unless SPECT is not feasible for some reason. In this case, six to eight projections are recommended for both ventilation and perfusion. The recommended matrix size is 256x256 in combination with a LEHR collimator, and acquisition time should be long enough to yield 500–1,000 kcounts per view.

Multidetector dual or triple head γ-cameras with large FOV are preferred for V/P SPECT. LEHR parallel collimators with 128 x 128 matrix size represents a good combination, but LEAP collimators with a 64 x 64 matrix are also adequate especially if one aims for lower doses and/or shorter acquisition times. It is important that the patient remains in the

same supine position, carefully maintained between ventilation and perfusion acquisitions. A total acquisition time of 20–30 minutes (excluding dead time) is usually sufficient to complete both the ventilation and the perfusion SPECT scans. Ranges of acceptable doses and acquisition parameters are shown in Table 1 below. Ultimately the doses to be administered should be determined by each institution on the basis of the image quality obtained in a reasonable time, which is influenced by factors such as camera sensitivity, collimator choice, acquisition matrix size, processing parameters and local radiation protection guidelines. The added benefit of SPECT-CT is still debated, but the SPECT part acquisition parameters are similar, if there is a need to acquire CT data in selected cases.

Table 1: Suggested doses and acquisition parameters for V/P SPECT

Parameter	Value range
Administered dose Ventilation	30 - 50 MBq
Administered dose Perfusion	120 - 240 MBq
Collimator and Matrix size	LEHR (128 x 128), LEAP (64 x 64)
# steps / 360°	64 - 128 (32 - 64 / detector)
Step time for Ventilation	10 - 25 seconds
Step time for Perfusion	5 - 15 seconds
P/V activity (count rate) ratio	at least 4:1

Reconstruction and display
Transverse, sagittal and coronal projections are generated using an OSEM (ordered-subset expectation maximization) or equivalent iterative reconstruction algorithm. The number of iterations, subsets and other parameters may vary according to the manufacturer's software used to this end, but overly noisy images should be avoided as they do not promote reproducible interpretations. A 3D post reconstruction filter is usually applied, and the final images can be reviewed in each of the orthogonal planes, preferably on a workstation with dedicated software. Pseudo-planar images can be generated using an angular summing technique and other methods. More advanced data processing can also be performed. Defect contrast on perfusion SPECT can be further enhanced by subtracting the background activity remaining from the preceding ventilation scan. Further, by examining the pixelbased V/P ratio, quotient images can be generated from the SPECT data. These parametric images can facilitate reporting and improve the demonstration of defect location and extent.

3) Interpretation criteria and reporting

- **Basic criteria**
- **Affirmative or negative w/r to PE**
- **Other possible diagnoses**
- **Follow-up recommendations**

Interpretation
Interpretation in probabilistic terms is not appropriate with VQ SPECT and should be abandoned. All images should be interpreted as either "PE present" or "PE absent" or other similar clear affirmative terms. A small number of "non-diagnostic or equivocal studies" is inevitable for various reasons but should not exceed 5% of the case load.

Affirmative diagnosis of PE requires the presence of vascular type mismatches. Vascular type perfusion defects have the following characteristics: moderate to severe defects, with clear borders, which are pleural based, wider at pleura than centrally, with an orientation compatible with pulmonary vascular anatomy. At the sub-segmental level, the shape is usually triangular.

PE present: PE is diagnosed if there is at least one lobar or segmental vascular type mismatched defect (perfusion defect with preserved ventilation), or two sub-segmental vascular mismatches, regardless of other findings.

PE absent: PE is considered excluded if perfusion is normal, if there are only matched defects (regardless of morphology), non-vascular type mismatches or reverse mismatches (perfusion preserved but ventilation absent).

A frequent cause of non-vascular mismatches is physiologically compressed lung. Typical locations are posterior para-mediastinal lung, costophrenic angles, the top of the great fissures and shallow posterior lung surfaces in cases of gravity dependant atelectasis. Other causes include penetration of ventilation agent in emphysema bullae or cystic space in severe fibrosis.

False positives interpretation may occur mainly in extrinsic vascular compression, pulmonary vein stenosis and rare cases of vasculitis.

The interpretation of an isolated vascular-type defect that is matched on ventilation and congruent with a radiographic opacity of similar size remains controversial because an isolated pulmonary infarct is a possibility (albeit not a frequent one). If symptoms are not acute (more than a few days), partial reperfusion of embolic disease can give atypical perfusion patterns. In difficult cases, consultation with the clinician is suggested.

Other diagnoses
Other findings than PE may be clinically pertinent, especially if symptoms include dyspnea or desaturation.

- Cardiac failure: redistribution of perfusion to superior and anterior portions of the lungs (inversion of the normal gradient) associated with preserved normal ventilation gradient is highly suggestive of early cardiac failure and can be observed earlier than on chest X-ray. This redistribution of perfusion is often lost with more advanced failure and typical X-ray change of edema.

- COPD: The magnitude of changes observed on VQ SPECT correlates with COPD severity, which can be underestimated clinically. Changes are typically more severe on ventilation, which include varying degrees of heterogeneity, ventilation defects and aerosol deposition at various bronchi levels indicating turbulence.

- Reverse mismatch: indicates failure of the physiological pulmonary vasoconstriction in the presence of a ventilation defect. May contribute to hypoxemia because of right-to-left shunt effect. Frequent association with pneumonia and may also be seen in atelectasis, mucous plug or other causes of bronchi obstruction.

Follow up
All PEs should have a final control 3 months after diagnosis to assess final reperfusion and benefit from the availability of a baseline exam in case of recurrent symptoms. Once a diagnosis of PE is made, a follow up exam is necessary to evaluate the degree of reperfusion. This has 2 purposes. First, incomplete reperfusion of a moderate to extensive PE is associated with the development of chronic pulmonary hypertension. Second, if there is a suspicion of new PE on follow up, it may be impossible to distinguish new PE from unresolved prior PE.

If PE is extensive, routine early control 7-10 days after diagnosis is advisable since a substantial part of reperfusion may occur in the first week. If there is early suspicion of new PE, this early control may be invaluable for correct diagnosis in this group.

Interpretation of new defects on control VQ SPECT has some known pitfalls. Sometimes, a partially occluding proximal defect may dissolve in several distal severe defects. Although those defects may seem impressive, they are not new. Also, clots located close to branching arteries may dissolve proximally and part of the clot may be drawn in the adjacent artery.

4) Additional considerations

CHART 1: ACUTE PE

	V/P SPECT	V/P SPECT/ low dose CT
SENS	93-97	93-97
SPEC	91-96	98
NPV	97-99	97-99
Inconclusive	1-3	~1
Nephrotoxicity	none	none
Mortality	none	none
Allergy	none	none

COMMENT: low dose non-contrast CT improves specificity and reduces inconclusive findings in selected patients. SPECT/CT is not recommended as a routine procedure in the diagnosis of PE.

CHART 2: RADIATION EXPOSURE

V/P SPECT	V/P SPECT/ low dose CT	CTPA (4 to 16 slice)	CTPA (64 slice)
~ 2.1 mSv	~ 3.1 mSv	~ 5.4 mSv	~ 20 mSv

COMMENT: exposure from CTPA is difficult to assess as many variables influence exposure: these include patient BMI, mAs, pitch, and radiation reduction protocols to name a few. As the number of slices increase with CTPA exposure does increase.

CHART 3: CHRONIC PE

	SENS	SPEC
CTPA	51	
V/P SPECT	93-97	90

CHART 4: PREGNANCY

	CTPA	V/P SPECT
Breast Exposure	10-70 mGy	less than 1.5 mGy
Fetal Exposure	less than 1.0 mGy	less than 1.0 mGy
Adverse reactions	Possible	None

Conclusions

In situations of Acute PE, Chronic PE, Pregnancy, Pediatrics, and the COPD population one can consider V/P SPECT, with or without low dose CT, as a first line investigation due to high sensitivity and specificity, low radiation, and no adverse reactions.

In situations of Pregnancy and Pediatrics due to the low likelihood of ventilation co-morbidities one could consider Perfusion only SPECT as a first line investigation. If co-morbidities exist then a full V/P SPECT should be performed. Also, V/P SPECT is not influenced by vascular volume changes during pregnancy as is CTPA.

In situations of COPD up to 31% of patients may have PE and up to 10% may die. Even those patients who have abnormal Chest X ray can still undergo V/P SPECT and in selected patients, V/P SPECT with low dose non-contrast CT could be considered. Technegas is considered the agent of choice in this population as there is less central airway deposition, better peripheral penetration, and it does not wash out as quickly as traditional aerosols.

List of Acronyms Used In The Present Document

COPD	Chronic Obstructive Pulmonary Disease
EANM	European Association of Nuclear Medicine
FOV	Field of View
ICRP	International Commission on Radiological Protection
LEAP	Low Energy All-Purpose
LEHR	Low Energy High Resolution
MDCT	Multi-Detector Computed Tomography
MD-CTPA	Multirow-Detector Computed Tomographic Pulmonary Angiography
OSEM	Ordered-Subset Expectation Maximization
PE	Pulmonary Embolism
PIOPED	Prospective Investigation of Pulmonary Embolism Diagnosis
SPECT	Single Photon Emission Computed Tomography
SPECT-CT	Single Photon Emission Computed Tomography—X-ray Computed Tomography
V/P SPECT	Ventilation/Perfusion Single Photon Emission Computed Tomography

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LINKS TO EANM 2009 GUIDELINES FOR VENTILATION/PERFUSION SCINTIGRAPHY

https://eanm.org/publications/guidelines/gl_pulm_embolism_part1.pdf

https://eanm.org/publications/guidelines/gl_pulm_embolism_part2.pdf

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DaTscan (Ioflupane (123I) Injection) is a radiopharmaceutical indicated for visualization of functional striatal dopamine transporter using single-photon emission computed tomography (SPECT) brain imaging. In adult patients with suspected parkinsonian syndromes (PSs), DaTscan SPECT imaging may be used as an adjunct to other established evaluations to help differentiate essential tremor from tremor due to PS related to idiopathic Parkinson's disease (PD), multiple system atrophy (MSA) and progressive supranuclear palsy (PSP). DaTscan is unable to discriminate between PD, MSA and PSP.

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Report:

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- By calling 1-866-234-2345 (toll-free);
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  - Mail to: Canada Vigilance Program Health Canada, Postal Locator 0701E Ottawa, ON K1A 0K9

Postage paid labels and the Consumer Side Effect Reporting Form are available at MedEffect.

For more information please consult the product monograph at http://www3.gehealthcare.com/~/media/Documents/MarketoPDFsnogating/ProductMonographCanadaControlNo201481December72017.

The DaTscan product monograph is also available by calling 1-800-654-0118 (option 2, then option 3).

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PARKINSON'S DISEASE

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It causes a progressive loss of dopamine in the brain, which can cause symptoms that include resting tremor, slowness of movement, stiffness or rigidity of muscles, difficulty with balance and walking, difficulty with fine motor movements.

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