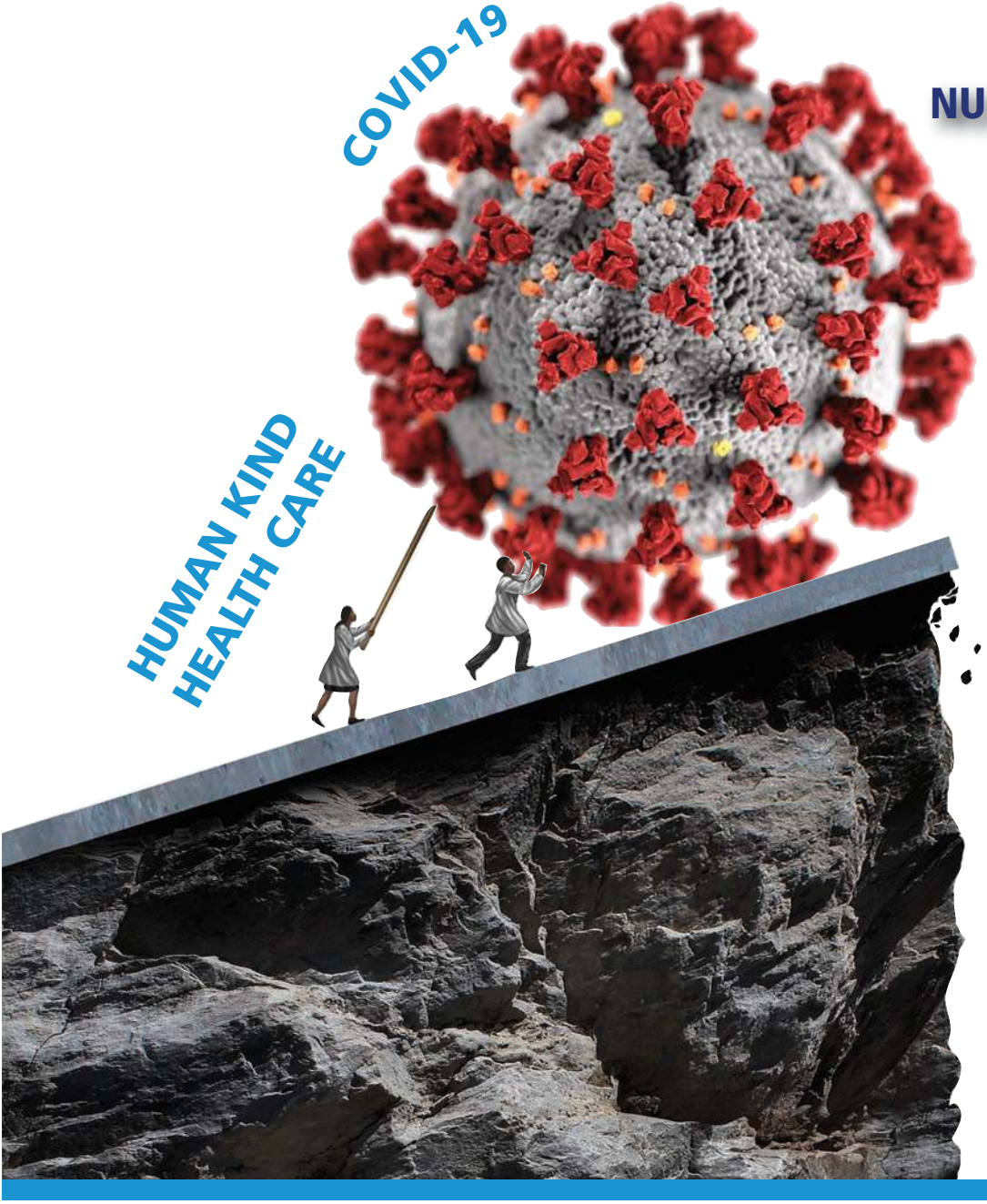
VOL 4 • NO 1

ePATIENT

NUCLEAR MEDICINE & MOLECULAR IMAGING

THE FREE NUCLEAR MEDICINE & MOLECULAR IMAGING EDUCATIONAL MAGAZINE AVAILABLE WORLDWIDE



NUCLEAR MEDICINE MADE SIMPLE

MÉDECINE NUCLÉAIRE SIMPLIFIÉE

MEDICINA NUCLEAR EN PALABRAS SENCILLAS

核醫學簡單

PANGEA PROJECT

PANGEA

CLINICAL RESEARCH OPPORTUNITY IN COVID-19

THE ADMINISTRATION OF TECHNEGAS™ IS NOT AN AGP

TECHNEGAS™
FUNCTIONAL LUNG IMAGING

Cyclomedica is seeking innovative clinical sites interested in researching the effectiveness of V/Q SPECT/CT scan using Technegas™ in COVID-19 and/or understanding the implication of the disease long-term.

In order to qualify for the research grants, the site must be a current Technegas™ user.
Register your interest here below via the QR code:

Technegas™ is not classified as an Aerosol Generating Procedure and, in more than 30 years of use, there have been no reported viral or other disease cross-contamination events associated with the use of the Technegas™ system.

For more information regarding the use of Ventilation/Perfusion procedures during the current pandemic, please refer to our company's guidance webpage on the COVID-19 situation
www.cyclomedica.com/covid19

NEWS APRIL 2020:

WE HAVE RECENTLY LODGED OUR NDA WITH THE USFDA FOR TECHNEGAS™

- Technegas™ is available in 59 countries worldwide with 4 million patient studies performed to date.
- Technegas™ as a diagnostic is innovative in seeding to expand its use beyond diagnosing Pulmonary Embolism.
- The administration of Technegas™ is not an AGP.

For more information about Technegas™ and how V/Q SPECT compares to CTPA in the diagnosis of Pulmonary Embolism, please refer to 2019 EANM guidelines and the 2018 CANM guidelines[1-2].

References: 1. Bajc M, et al. EANM guideline for ventilation/perfusion single photon-emission computed tomography (SPECT) for diagnosis of pulmonary embolism and beyond. Eur J Nucl Med Mol Imaging 2019; 46(12): 2429-245. 2 | 2. Leblanc M, et al. CANM guidelines for Ventilation/Perfusion (V/P SPECT) in Pulmonary Embolism. Nov 2018; available from https://canm-acmn.ca/guidelines

For more information, please visit **www.cyclomedica.com** or email **info@cyclomedica.com.au**
Cyclomedica Australia | Technegas™ is not yet available for sale in the USA.
Last revision (A4): v.1.0 - 29/Apr/2020

cyclomedica

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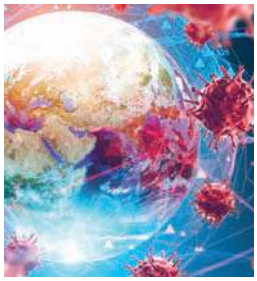

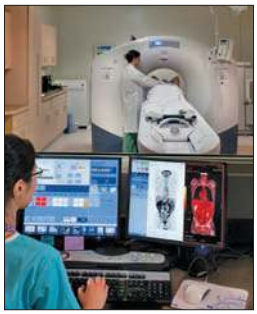

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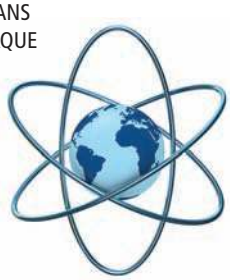

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Drs. Jean-Luc Urbain & François Lamoureux

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Dr. Natalie Keane Domeisen - Dr. Wei He -
Dr. Francois Lamoureux - Dr. Norman Laurin
Kristy Owen, NM technologist - Dr. Andrew Ross -
Dr. Raymond Taillefer - Dr. Jean Luc Urbain -
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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,
M.D.,M.Sc., FRCPSC,
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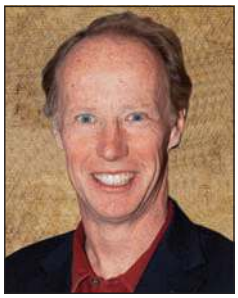

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Nuclear Cardiology, Rhode Island Hospital &
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INTRODUCTION

François Lamoureux
M.D.,M.Sc., FRCPSC
President, CANM

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

DEAR FRIEND AND COLLEAGUES.

Dr. Lamoureux and I are pleased to introduce the new version of your acclaimed ePatient magazine.

Who would have thought a year ago that there would be three articles on virus in a dedicated nuclear medicine magazine?

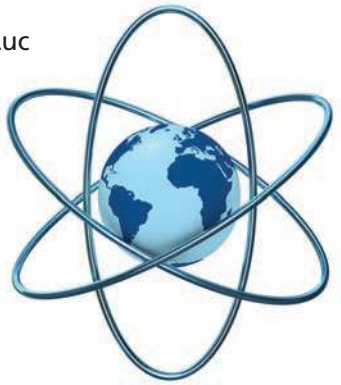
This past ten month have been quite challenging for the entire globe population around the globe. Ass off today October 26, 2020 more than 42 million cases have tested positive for covid-19 and more than 1 million people have died of complications of the infection by the virus. The Covid -19 pandemic has generated major challenges at all level of the health care system. Nuclear Medicine practices have not been spared. In this issue, Dr. Lamoureux describe the evil intentions of viruses and how it can seriously affect humans and the humanity with his notorious story telling gift. Dr. Zuckier from New York details the strategies and processes that have been placed in his medical center to mitigate the effect of the covid-19 pandemic on nuclear medicine practice. In his article, Dr. Blais describes the importance and contribution of telemedicine and tele-imaging to continue providing high level services to patients.

The other major topic in this issue relates to what I believe is part of what I call Cardiac Theranostics. Tc-99m labeled pyrophosphate is neither a strange or new molecule. Pyrophosphate is a ubiquitous metabolic byproduct of many intracellular processes found in most cells, and it also can be produced extracellularly. Pyrophosphate acts as a potent inhibitor of calcification; it antagonizes the ability of inorganic phosphate to crystallize with calcium to form hydroxyapatite, by occupying some of the inorganic phosphate sites on the surface of nascent growing hydroxyapatite crystals. Once used to diagnose myocardial infarction, technetium-99m pyrophosphate (Tc 99m PYP) imaging is now reborn as an alternative to biopsy for diagnosing cardiac transthyretin (ATTR) amyloidosis in some patients.

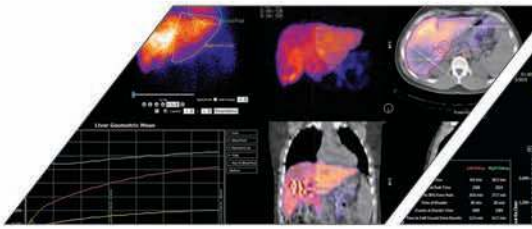
In their article, Drs. Blair and Taillefer describe and illustrate the significant contribution of nuclear medicine in the diagnosis of cardiac amyloid disease.

We sincerely hope that you will enjoy reading these contributions and the other articles published in this is issue of your ePatient magazine. Please take the time to share with us your comments to help improving the content and format of the magazine. Stay Safe. ■

François and Jean-Luc



HERMES MEDICAL SOLUTIONS

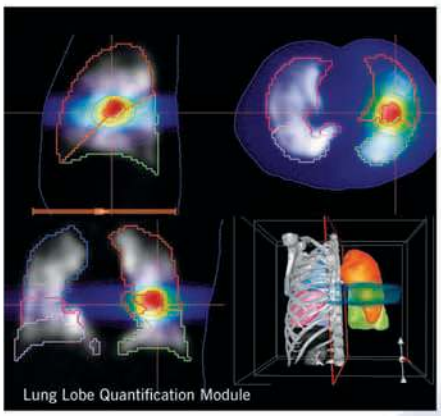


ENTERPRISE CLASS SOLUTIONS FOR MOLECULAR IMAGING

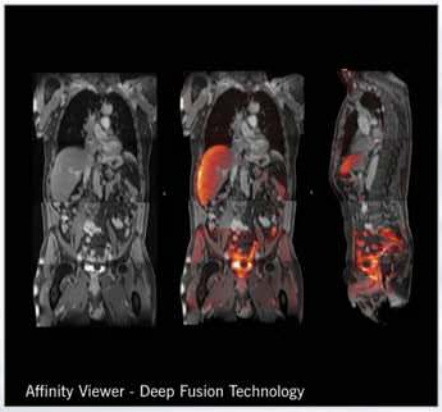
With more than 40 years of recognition for Clinical Excellence and innovation in Molecular Imaging, HERMES delivers Enterprise Class systems and software for integrating, visualizing, processing, reporting and archiving imaging data from different imaging modalities and devices within Molecular Imaging and Radiology. HERMES solutions are empowering physicians by enabling faster and more accurate diagnosis and treatment of patients, thereby improving patient outcomes and increasing efficiency. HERMES leadership within Molecular Imaging has been built on leading technological innovation, financial stability, and historical success. HERMES is committed to the continuous development of cutting-edge accessible software solutions for clinical environments, academic institutions and industry partners. HERMES will continue to offer its customers and proSPECTive clients, the most comprehensive Enterprise Molecular Imaging solutions available for diagnosis and treatment planning as healthcare moves into the new frontiers of Precision Medicine.

DISPLAYED BY HERMES™

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.



Lung Lobe Quantification Module



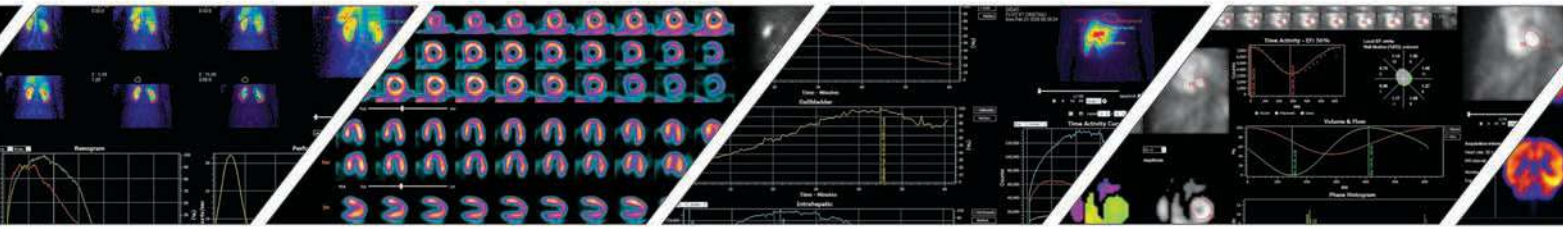
Affinity Viewer - Deep Fusion Technology

With crucial input from customers around the world, nuclear medicine pioneers, the HERMES R&D team has developed Hybrid Viewer PDR™ and Affinity Viewer: A unique and user-friendly software suite 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.

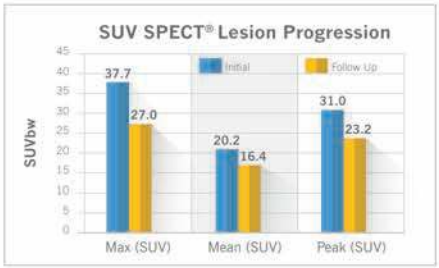
CONNECTED BY HERMES™

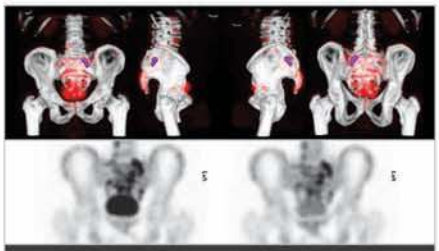
From the early days of nuclear medicine, quantification has been a key aspect; self-defining the practice and at the same time distinguishing from other imaging modalities. The arrival of Positron Emission Tomography (PET and its SUV scale) certainly contributed to advances in the field, but the essence of nuclear medicine still remains the 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.





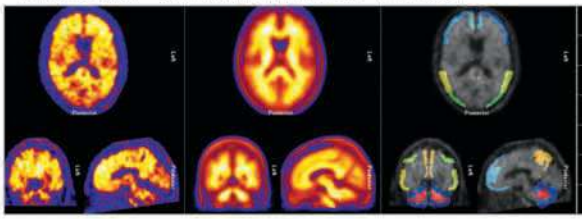
SUV presentation

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 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)

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.

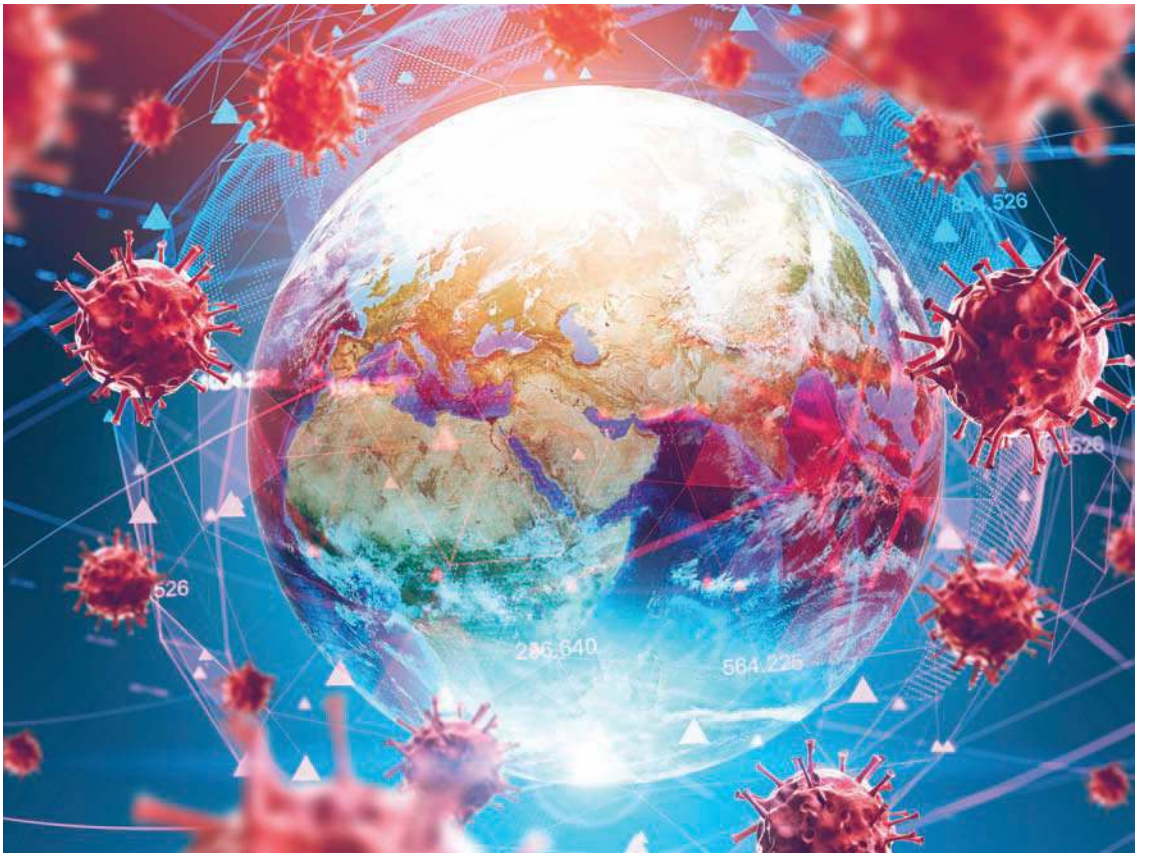
POWERED BY HERMES™

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.

François Lamoureux
M.D.,M.Sc., FRCPSC
President, CANM



LES AVANCÉES MÉDICO-PHARMACOLOGIQUES
MEDICAL AND PHARMACOLOGICAL ADVANCES

« Contre ces envahisseurs l'organisme humain n'a souvent qu'une seule possibilité de défense soit les anticorps. Ces anticorps c'est comme une CLEF DANS LA SERRURE (ici le virus), c'est spécifique au type de virus. »

LES VIRUS
CETTE CINQUIÈME COLONNE MALÉFIQUE

Les virus ces délétères mutants tentent continuellement de nous assaillir. Ce sont des spécialistes de la confusion, du furtif.

La cellule humaine se compose d'un noyau dépositaire de l'acide désoxyribonucléique ou ADN. Les messages du noyau de la cellule aux différents éléments du cytoplasme de la cellule sont convoyés par un vecteur l'acide nucléique ou ARN. Comme par exemple pour permettre a la cellule de se reproduire ou de se multiplier.

Les virus lorsqu'ils pénètrent dans une cellule ont la capacité de modifier ou de se substituer à l'ARN original de la cellule pour coder son propre message et amorcer rapidement une multiplication effrénée du virus. Une usine de multiplication extrêmement efficace de production exponentielle de virus est mise en marche. Beaucoup de ce type de virus souvent appelés RIBOVIRUS sont des experts de cette confusion. Par exemple les coronavirus sont de cette famille.

VIRUSES
THIS EVIL FIFTH COLUMN

Viruses, these deleterious mutants are constantly trying to attack us. They are stealthy and confusion.

The human cell consists of a nucleus that stores deoxyribonucleic acid or DNA. Messages from the nucleus of the cell to the different elements of the cell's cytoplasm are conveyed by a vector – nucleic acid or RNA. These messages allow the cell to reproduce or multiply.

Viruses, when they enter a cell, have the ability to modify or substitute the original RNA of the cell to encode its own message. Once the virus takes over, it sets in motion a highly efficient unbridled multiplication factory of exponential virus production. Many of the viruses often referred to as RIBOVIRUS are experts at this confusion. Coronaviruses are from this family.

Against these invaders the human body often has only one possibility of defense – antibodies. These antibodies are like a **KEY IN THE LOCK** and are specifically generated to combat each virus.

Contre ces envahisseurs l'organisme humain n'a souvent qu'une seule possibilité de défense soit les anticorps. Ces anticorps c'est comme une CLEF DANS LA SERRURE (ici le virus), c'est spécifique au type de virus.

Après un contact avec le virus les cellules lymphocytes T étudient le virus, l'identifie, le décode et commence a produire ses propres soldats, les anticorps spécifiques a l'envahisseur. Ce processus de défense atteint souvent son efficacité maximale qu'environ 2 mois ou 8 semaines après le premier contact. Pendant cette période ou les défenses sont limitées le virus lui se multiplie rapidement tentant éventuellement de submerger le déploiement des anticorps en production.

LES HUMAINS ONT SUBI A DE MULTIPLES REPRISES L'ASSAUT DE CES MALÉFIQUES ENVAHISSEURS VIRAUX ET DANS CHACUNE DE CES SITUATIONS ILS ONT RÉUSSI A LES VAINCRE.

Que ce soit la grippe espagnole (un coronarovirus), la poliomyélite, la variole, la grippe aviaire ou le SARS par exemple.

Certains autres virus peuvent subrepticement coloniser les cellules de l'être humain pour des années et même pour toute la vie de l'être infecté.

Par exemple après en jeune âge d'une attaque de varicelle le virus peut demeurer pour toute la vie du porteur et se remanifester en âge plus avancée sous forme d'une atteinte douloureuse de terminaisons nerveuses comme dans le ZONA.

D'autres virus pourront aussi demeurer à vie dans un être humain comme le virus de l'herpès labial et se remanifester à répétition. Certains autres, comme les papillomavirus, coloniseront à vie des cellules de l'épiderme et réapparaîtront de façon intermittente sur la peau sous forme de verrues. Le virus du SIDA probablement le plus furtif de ces mutants est particulièrement délétère. Il peut demeurer silencieux pendant plusieurs années et en profiter pour affaiblir et même complètement détruire les capacités des lymphocytes T, les producteurs d'anticorps, et ainsi annihiler la seule ligne de défense efficace . Éventuellement il n'y a plus de production de troupes d'assaut, LES ANTICORPS . Dans le cas du SIDA l'être infesté meure finalement de complications comme par une infection bactérienne ou encore par exemple de tuberculose.

La maladie la plus fréquente au monde c'est une maladie virale communément appelée la grippe. L'Organisation Mondiale de la Santé évalue a 650 000 le nombre annuel de décès dans le monde dû à la grippe saisonnière. On tente bien que mal de combattre ces agresseurs, ces mutants très sophistiqués, qui modifient continuellement leur codage génétique. C'est pourquoi à chaque année

After contact with the virus the T-cells study the virus, identify it, decode it and start to produce their own soldiers, the antibodies specific to the invader. This defense process often reaches its maximum effectiveness only about two months to eight weeks after the first contact. During this period when defenses are limited, the virus multiplies rapidly, eventually overwhelming the deployment of antibodies in production.

HUMANS HAVE BEEN REPEATEDLY ASSAULTED BY THESE EVIL VIRAL INVADERS AND IN EACH OF THESE SITUATIONS THEY HAVE SUCCEEDED IN DEFEATING THEM.

Whether it is the Spanish flu (a coronavirus), poliomyelitis, smallpox, avian flu or SARS for example, some other viruses can surreptitiously colonize the cells of the human being for years and even for the whole life of the infected person.

For example, after a chicken pox attack at a young age, the virus can remain for the entire life of the carrier and reappear in later life in the form of painful nerve endings as in Shingles.

Other viruses, such as the cold sore virus, can also remain in a human being for life and repeatedly re-occur. Some other viruses, called papillomaviruses, will colonize epidermal cells for life and reappear intermittently on the skin as warts. Probably the stealthiest of these mutants, the AIDS virus, is particularly deleterious. It can remain silent for several years and take advantage of its concealment to weaken and even completely destroy the capacities of the T-lymphocytes, the producers of antibodies, and thus annihilate the only effective line of defense. Eventually there is no more production of assault troops, THE ANTIBODY. In the case of AIDS, the infected person finally dies of complications such as bacterial infection or tuberculosis.

The most abundant viral disease in the world is commonly called influenza. According to the World Health Organisation the seasonal influenza kill 650 000 persons in the world annually. There is little attempt by the body to fight these aggressors, very sophisticated mutants that are constantly changing

" Against these invaders the human body often has only one possibility of defense – antibodies. These antibodies are like a KEY IN THE LOCK and are specifically generated to combat each virus. "

« Mais ces experts de la mutation tenteront toujours de nous envahir pour assurer leur multiplication. L'être humain est un hôte idéal pour assurer leur survie et se multiplier. Car un virus seul sans coloniser une cellule ne peut survivre. »

" However, these mutation experts will always try to invade us to ensure their existence. Humans are an ideal host to ensure their survival and multiplication. After all, a virus alone without colonizing a cell cannot survive. "

on doit étudier attentivement le génome du virus et y adapter un nouveau vaccin qui permettra par les lymphocytes T la production d'anticorps spécifiques, LA CLEF, et seulement ceux-ci seront efficaces. Mais les lymphocytes T ont besoin de temps pour produire efficacement ces anticorps.

C'est pourquoi lorsqu'une attaque de grande envergure survient, la période de 2 mois ou 8 semaines peut expliquer un type de courbe à surveiller.

D'autres virus s'attaquent également à l'être humain que l'on pense aux virus responsable de l'hépatite A ou B ou encore de la fièvre hémorragique, l'ÉBOLA.

L'humanité a eu, a et aura toujours à subir périodiquement l'assaut de ces envahisseurs mutants maléfiques. Certaines batailles ont été gagnées par l'homme. Certaines mesures de protection sont régulièrement mises en place comme les VACCINS.

Mais ces experts de la mutation tenteront toujours de nous envahir pour assurer leur multiplication. L'être humain est un hôte idéal pour assurer leur survie et se multiplier. Car un virus seul sans coloniser une cellule ne peut survivre.

VOILA LE VRAI ENNEMI DE L'HOMME PAS SES CONGÉNÈRES HUMAINS.

Bien sûr on vit presqu'en symbiose avec ces méchants mais certains virus peuvent devenir nos amis et nos alliés.

Comme les virus bactériophages qui eux attaquent de façon très efficace des bactéries comme par exemple les escherichia coli qui chez certains individus peuvent provoquer des diarrhées mortelles.

On vaincra cette attaque virale sans précédent. Pour la première fois l'ensemble de l'humanité réalise que l'être humain sera toujours en guerre contre cet envahisseur. Seulement une attention continuelle, actuelle et future permettra à l'homme de sortir vainqueur contre chacun de ces assauts viraux. ■

their genetic coding. This is why every year the genome of the virus must be carefully studied. Each year a new vaccine must be adapted to it, which will allow the T-lymphocytes to produce specific antibodies (THE KEY) that is specific only to that virus. The challenge for the human organism is that the T-lymphocytes need time to produce these antibodies efficiently.

This delay is why when a large-scale attack occurs, we must observe the infection curve over a period of two months or eight weeks.

Other viruses also attack humans, such as the viruses responsible for hepatitis A or B or the hemorrhagic fever, EBOLA.

Humanity has, and always will have, to suffer periodically from these evil mutant invaders. Some battles have been won by mankind. Humanity may attempt to intervene by placing certain protective measures in place such as the VACCINES.

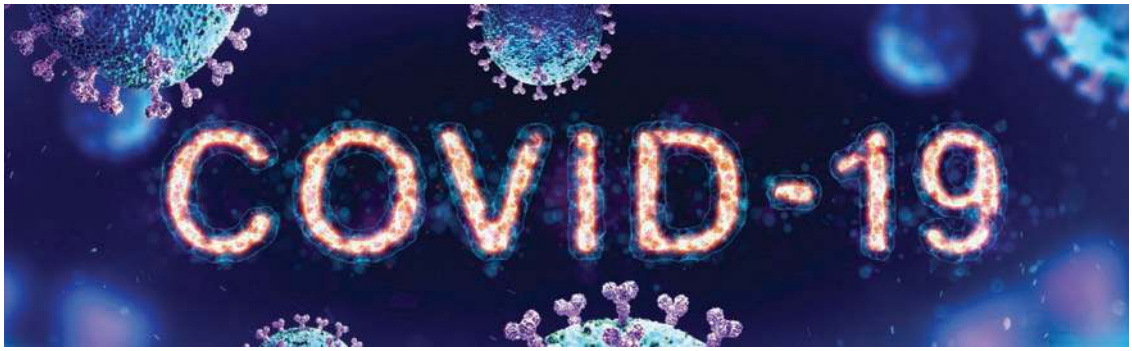
However, these mutation experts will always try to invade us to ensure their existence. Humans are an ideal host to ensure their survival and multiplication. After all, a virus alone without colonizing a cell cannot survive.

THIS IS MAN'S REAL ENEMY, NOT HIS FELLOW HUMANS.

Of course, whilst we live as hosts to these parasitic these villains we also symbiotically live with others as both friends and allies.

An example of one of these friendly viruses to humanity are the bacteriophage viruses that attack bacteria in a very efficient and helpful way; for example, bacteriophages viruses help our body attack the Escherichia Coli that in some individuals can cause deadly diarrhea.

We will defeat this unprecedented viral attack of COVID-19. For the first time the whole of humanity realizes that human beings will always be at war with this invader. Only continuous attention, present and future, will enable mankind to emerge victorious against each and every one of these viral assaults. ■



Message du Président de la CANM

Message from the CANM President

François Lamoureux
M.D.,M.Sc., FRCPSC
President, CANM

En ces jours difficiles, l'Association canadienne de médecine nucléaire poursuit ses efforts pour promouvoir la valeur ajoutée de la médecine nucléaire aux niveaux canadien et international. La médecine nucléaire est un domaine restreint mais très dynamique.

Sur la scène canadienne, l'ACMN poursuit son implication aux niveaux des gouvernements fédéral et provinciaux. L'Association se concentre sur la réglementation et la nécessité d'investissements pour mettre à la disposition des patients canadiens de nouveaux radiotraceurs et équipements en TEMP-TDM et en TEP-TDM. Nous appuyons la position selon laquelle chaque unité de médecine nucléaire canadienne devrait avoir au moins une caméra TEMP-TDM et une caméra TEP-TDM.

Ces technologies sont devenues incontournables pour le diagnostic et le suivi de plusieurs maladies, que ce soit pour le cancer, les maladies neuro-dégénératives ou les maladies cardiaques et infectieuses, par exemple. Le succès du Québec dans ces développements est remarquable et est devenu un point de référence pour d'autres provinces au Canada.

L'ACMN est également impliquée dans la proposition de modification du programme de formation de nos résidents au Collège royal du Canada pour mieux refléter les nouveaux défis de la pratique de la médecine nucléaire en technologie hybride et en théranostique.

Face à tous ces développements, le besoin de plus de spécialistes et de technologues en médecine nucléaire augmente d'année en année. L'ACMN participe activement à la promotion du recrutement de ces collègues.

Notre partenariat avec nos collègues industriels est crucial pour le développement et l'avancement de nouveaux tests et traitements pouvant être proposés aux patients.

Nous produisons également, de temps en temps, des vidéos éducatives destinées au grand public afin d'aider à mieux comprendre à l'avance les tests à subir en médecine nucléaire comme le TEP-TDM au FDG, l'Étude cardiaque, l'Étude pulmonaire ou l'Étude osseuse. Le tout est disponible gratuitement sur notre site Web (www.canm-acmn.ca). De plus, l'Association continue de travailler en étroite collaboration avec les magazines Le Patient (www.lepatient.ca) et Epatient (www.nmpangea.com) pour sensibiliser les prescripteurs, le grand public et les décideurs gouvernementaux à la médecine nucléaire. Des lignes directrices sont également en cours d'élaboration sur divers sujets tels que les Études de ventilation et de perfusion dans l'embolie pulmonaire, l'Imagerie du système de transport Dopamine dans l'évaluation des troubles du mouvement et la Théranostique cardiaque.

En ces jours difficiles, l'ACMN est rapidement passée à des réunions scientifiques virtuelles et à des webinaires, tous reconnus par le Collège des médecins du Québec et par le Collège royal du Canada pour les crédits en formation médicale continue.

Finalement, nous aimerions mentionner que l'un de nos anciens Présidents, le Dr Jean-Luc Urbain, assumera la présidence de la Fédération mondiale de médecine nucléaire et de biologie WFNMB en 2021-2022. ■

In these challenging days, the Canadian Association of Nuclear medicine continues its efforts to promote the added value of nuclear medicine both at the Canadian and International levels. Nuclear medicine is a small field but very dynamic.

On the Canadian scene, the CANM continues its involvement at the federal and provincial levels of government. The Association focuses on regulation and the need for investments to make available to Canadian patients, new radiotracers and equipment, in both SPECT-CT and PET-CT. We support the position that each Canadian nuclear medicine unit should have at least one SPECT-CT camera and one PET-CT camera.

These technologies have become essential for the diagnosis and follow-up of several diseases whether in cancer, neuro-degenerative diseases or cardiac and infectious diseases, for example. Quebec's success in these developments is remarkable and has become a reference point for other provinces in Canada.

The CANM is also involved with the proposal to amend the training program for our residents at the Royal College to better reflect the new challenges of practicing nuclear medicine in both hybrid technology and theranostics. In the face of all these developments, the need for more nuclear medicine specialists and technologists grows year after year. The CANM is actively involved in promoting the recruitment of these colleagues. Our partnership with our industrial colleagues is crucial to the development and advancement of new tests and treatments that can be offered to patients.

We also from time to time produce educational videos for the general public to help better understand in advance the test they could have in nuclear medicine, like FDG PET-CT, Cardiac Study, Pulmonary Study or Bone Study, for example. All are free and available on our Website (www.canm-acmn.ca)

In addition, the CANM continues to work closely with Le Patient (www.lepatient.ca) and the Epatient (www.nmpangea.com) magazines to raise awareness of nuclear medicine among prescribers, the general public and our government decision-makers. Guidelines are also being developed on various topics like V/Q, Imaging of the DOPAMINE transportation system in the assessment of movement disorders and Cardiac Theranostics.

In these challenging days, the CANM has rapidly moved to virtual scientific meetings and webinars, all recognised by le Collège des médecins du Québec and the Royal College for medical education credits.

Finally, we would like to mention that one of our past President, Dr. Jean -Luc Urbain, will assume the presidency of the World Federation of Nuclear Medicine and Biology for the years 2021-2022. ■

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 16,000 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.

For Healthcare Providers

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.

PET PROS Documents
SNMMI offers numerous resources for physicians ordering PET/CT imaging, including:

- The SNMMI Coding Corner, offering answers to a variety of nuclear medicine coding questions
- *Elements of PET/CT Reporting*, a comprehensive guide to help physicians create accurate, useful patient reports (includes sample reports)
- Educational brochures on diagnosis and treatment plans
- Charts and diagrams for use in physician offices on the topics of liver segments, neck nodes, and small lung nodules

For more information, visit www.snmmi.org/PETPROSResources.

Appropriate Use Criteria

The SNMMI, working with numerous medical societies including the American Society of Clinical Oncology, the North American Neuroendocrine Tumor Society, the Society for Pediatric Radiology, the Society of Thoracic Surgeons, the Society of Interventional Oncology, the 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, individual and group ratings of the scenarios using a formal consensus process, and document drafting based on final group ratings and discussions.

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

The AUCs, including charts offering ratings-at-a-glance, can be found at www.snmmi.org/auc.Factsheets offering overviews of the AUCs a well as the charts are available for physician office use; to learn more, email outreach@snmmi.org.

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" and "Nuclear Medicine and Radiation Safety." Many factsheets are available both in English and Spanish. To view and download, visit www.snmmi.org/factsheets.

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 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 will be held June 23 at the Anaheim Convention Center and Arena in Anaheim, California. The program for this free event will be available in spring 2019 at www.discovermi.org.

SNMMI 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 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
- Lung Cancer Alliance
- 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.

PAAB members Theresa Wickerham (ThyCa), Josh Mailman (NorCal CarciNET), Stephen Schwartz (LRF), Rosemary Ciotti (FORCE), and Jeri Francoeur (Susan G. Komen) participated in a 2018 U.S. Capitol Hill Day to educate legislators on issues regarding patient access to diagnostic radiopharmaceuticals.

Photo courtesy of Josh Mailman

THE ROLE OF NUCLEAR MEDICINE IN DETECTION OF CARDIAC AMYLOIDOSIS

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CISSS-Montérégie centre

Amyloidosis is a rare systemic disorder that is classified into several types. This is a group of diseases that are a consequence of abnormal protein deposits, called amyloid, in various tissues of the body. There are several types of amyloid proteins produced by the bone marrow. Depending on the structure of the particular amyloid, the abnormal protein can accumulate in an isolated tissue (localized amyloidosis) or can affect many organs or tissues (systemic amyloidosis). While the localized form of the disease can be less harmful, the systemic form can cause serious changes in almost every organs of the body. The most frequently involved organs are the kidneys, heart, skin, lungs, liver, spleen, nerves, tongue and digestive tract.

1- TYPES OF AMYLOIDOSIS

Systemic amyloidosis is usually classified into three major types that significantly differ from each other.

A- The most common type of systemic amyloidosis is **AL** amyloidosis (immunoglobulin **light** chain). The annual incidence of this for mis approximately 8-10 cases per million in North America. This form of amyloidosis results from an abnormality of the plasma cells in the bone marrow and is closely related to multiple myeloma. Although earlier onset may occur, the higher incidence is seen between the ages of 60 to 70 with nearly 70% being male patients.

B- AA amyloidosis, usually known as secondary amyloidosis is derived from an inflammatory protein serum **amyloid A** which occurs in association with chronic inflammatory disease such as chronic inflammatory bowel disease or rheumatic diseases.

C- Hereditary amyloidosis is caused by an abnormal gene. Although many genes can cause the disease, the most common type of hereditary amyloidosis is called **ATTR**. This form is caused by mutations in the transthyretin (**TTR**) gene. Transthyretin, a prealbumin, is an abundant protein produced by the liver and is a **trans**porter of **thy**roxine and **retin**ol. In its monomeric form, transthyretin is prone to misfold and gradually concentrate as amyloid deposits. The two main subtypes of ATTR amyloidosis are the mutant ATTR (ATTRm) and the wild-type ATTR (ATTRwt), previously described as senile amyloidosis.

2- CARDIAC AMYLOIDOSIS

The vast majority of cardiac amyloidosis is caused by one of the two proteins: light chain (AL) or transthyretin (ATTR). Age related amyloidosis (in which amyloid is derived from wild-type normal transthyretin) is a slowly progressive disease that affect the heart of elderly men.

" Cardiac amyloidosis is frequently misdiagnosed initially since its clinical presentation is similar to that of many other cardiac diseases. "

Cardiac amyloidosis is frequently misdiagnosed initially since its clinical presentation is similar to that of many other cardiac diseases. Cardiac manifestations of amyloidosis include heart failure and cardiac arrhythmias. Ventricular hypertrophy with inappropriately low electrical voltages on the electrocardiogram is clues to diagnosis. The AL amyloidosis is usually seen between the ages of 40 to 80 with an incidence in men and women almost equal and shows mild left ventricular hypertrophy. However, left ventricular hypertrophy can be significant in both ATTRwt and ATTRm amyloidosis. In these two forms, men are significantly more affected than women and the age of occurrence is between 65 to 95 years. for ATTRwt and 55 to 75 years. for ATTRm. ATTRwt form is quite underestimated since almost a quarter of elderly patients at autopsy has some degree of cardiac amyloid deposits. Approximately 3-4% among US African Americans have a common inherited mutation of the TTR gene.

3- PROGNOSIS AND DIAGNOSIS OF CARDIAC AMYLOIDOSIS

Mortality from amyloidosis remains high for patients with advanced cardiac involvement. Early detection with appropriate classification is crucial for a better treatment and prognosis. This is very important since the treatment will differ according to the type of amyloidosis. Prognosis in amyloidosis is mainly dependent on the degree of cardiac involvement. Although the prognosis is generally better in the ATTR form than in the AL form of the disease, both forms still show a high annual mortality rate. The treatment of AL amyloidosis has two goals: attempting to slow the progression of the disease by eliminating the clonal plasma cells and their production of abnormal light chains with chemotherapy and treating the organ dysfunction. On the contrary, chemotherapy has no role in the treatment of ATTR amyloidosis as it is not a malignant process. Several agents have been and are currently under investigation for the treatment of amyloidosis such as nonsteroidal anti-inflammatory drug (however anti-inflammatory drugs are relatively contraindicated in heart failure) or RNA interference medications which help reducing the production of transthyretin by the liver. In May 2019 the US Food and Drug Administration (FDA) approved Pfizer Inc's oral drug, Tafamidis, for ATTR amyloid cardiomyopathy. This agent has been previously approved in Europe and Japan for treatment of ATTRm amyloidosis polyneuropathy.

Definitive diagnosis of amyloidosis requires a tissue biopsy of the clinically involved organ. For cardiac amyloidosis an endomyocardial biopsy with special stainings will reveal the amyloid deposits and confirm the diagnosis. Other adjunctive laboratory tests will be also helpful to confirm the type of amyloidosis and monitor the disease response to treatment. Due to the rather "aggressive" nature of the myocardial biopsy, researches have been focused on non-invasive imaging methods to detect and differentiate the different types of amyloidosis. Echocardiography and MRI (magnetic resonance imaging) are very useful in identifying the morphological and functional status of the heart but cannot always make the distinction between the two types of cardiac amyloidosis. Recent scientific data showed that a nuclear medicine procedure could help to improve and differentiate the non-invasive diagnosis of cardiac amyloidosis: myocardial scintigraphy with 99mTc-Pyrophosphate.

4- MYOCARDIAL SCINTIGRAPHY

Recent scientific awareness about cardiac amyloidosis and its possible treatment renewed the interest in a nuclear medicine diagnostic test which is used since more than 50 years, bone scintigraphy. It is known since several decades that the radiotracers used in bone scintigraphy, 99mTc-Methylene Diphosphonate (99mTc-MDP) or 99mTc-Pyrophosphate (99mTc-PYP) show a high affinity for amyloid protein resulting in a diffuse myocardial uptake of the radiotracer in patients with cardiac amyloidosis. 99mTC-PYP has been shown to be the best agent in that purpose. Although myocardial increased uptake of 99mTC-PYP can be seen in different conditions such as an acute myocardial infarction or pericarditis, these conditions can be relatively easily differentiated from amyloidosis with simple clinical tests. Many studies have shown that 99mTc-PYP accumulate at various degrees in the heart of patients with ATTR amyloidosis but not in those with the AL type. Although the exact mechanisms of 99mTc-PYP uptake in ATTR cardiac amyloidosis (and the lower or no uptake in AL amyloidosis) are currently unknown, it is thought that this increased radiotracer uptake is related to the high calcium levels in the amyloid deposits of patients with ATTR cardiac amyloidosis. A distinct advantage of 99mTc-PYP myocardial imaging is its ability to specifically identify ATTR cardiac amyloidosis non-invasively.

No specific test preparation is required. This procedure is available in every department of nuclear medicine. This non-invasive procedure requires a single

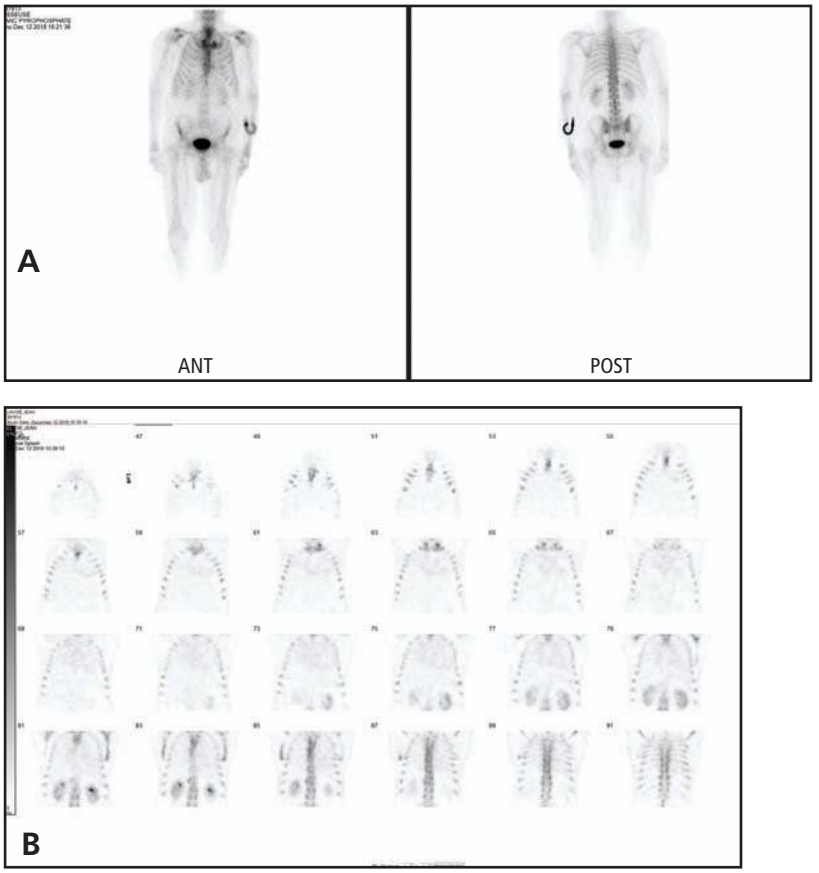

Figure 1
99mTc-PYP whole-body planar images (A) and SPECT images (B) in a patient with cardiac AL type of amyloidosis. There is no focalized increased cardiac uptake of the radiotracer and thus represents a normal finding. This study is interpreted as normal.

" Mortality from amyloidosis remains high for patients with advanced cardiac involvement. Early detection with appropriate classification is crucial for a better treatment and prognosis. "

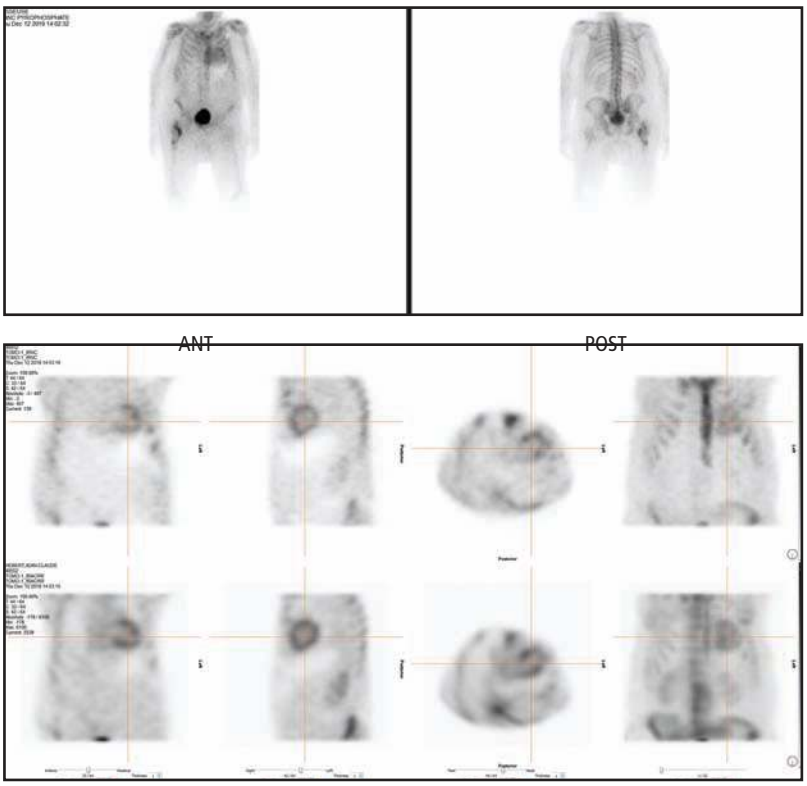

Figure 2
99mTc-PYP whole-body planar images (A) and SPECT images (B) in a patient with cardiac ATTR type of amyloidosis. Note the intense myocardial increased uptake which is well delineated in the SPECT study slices (arrows). This is a typical finding in ATTR cardiac amyloidosis.

" Recent scientific awareness about cardiac amyloidosis and its possible treatment renewed the interest in a nuclear medicine diagnostic test which is used since more than 50 years, bone scintigraphy. "

intravenous injection of the radiotracer with no side effect. Three to four hours after the injection, planar whole-body images and SPECT study (Single Photon Emission Tomography) which consists of a gamma camera detecting the gamma rays emitted by the radiotracer from the heart and rotating around the patient (allowing for more precise localization of the radiotracer uptake) are obtained. The entire procedure lasts for approximately 45 minutes. SPECT imaging can help to evaluate the uptake of the radiotracer at the apex of the heart which is usually spared until the disease is very advanced. Quantitative or semi-quantitative analysis can be obtained from computer image analysis. This serves to categorize more objectively the degree of myocardial uptake which can be proportional to the degree of amyloid deposits into the myocardium.

99mTc-PYP myocardial imaging is indicated in patients with heart failure and unexplained increase in left ventricular thickness, especially over the age of 60 years with preserved left ventricular ejection fraction. Other indications include the evaluation of cardiac involvement in individuals with known or suspected familial amyloidosis, diagnosis of cardiac ATTR in patients with MRI or echocardiography consistent with cardiac amyloidosis or in patients with suspected cardiac ATTR amyloidosis and contraindications to MRI such as renal insufficiency or implantable cardiac devices.

Other radiotracers are used in the non-invasive diagnosis of cardiac amyloidosis. European countries currently used in clinical practice a new radiotracer, 99mTc-DPD (99mTc-3,3-diphosphono-1,2-propan-odicarboxylic acid) with very good results. Some authors have reported the use of 123 Iodine-mIBG (**m**eta **i**odobenzyl **g**uanidine). This radiotracer is used to evaluate the degree of innervation of the heart. Patients in the early stages of cardiac amyloidosis, especially those with ATTR type, show some degree of denervation and can be detected with 123Iodine-mIBG scintigraphy. It is hoped that more generalized use of this test would help identifying patients in the early stages of the disease, potentially improving the prognosis.

CONCLUSION

The paradigm of cardiac amyloidosis has markedly changed in the last decade. Better understanding of the disease, increased awareness of its incidence, marked improvements in both treatment and in diagnostic tools are modifying the actual medical approach of cardiac amyloidosis. Although 99mTc-PYP imaging is considered as an "old" procedure, its high sensitivity in diagnosing cardiac amyloidosis and its unique ability to differentiate ATTR and AL cardiac amyloidosis is recognized as an important tool in guiding patient management. Nuclear medicine can play a key role in this underdiagnosed disease. ■

L'APPORT DE LA MÉDECINE NUCLÉAIRE DANS LA DÉTECTION DE L'AMYLOÏDOSE CARDIAQUE

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L'amyloïdose cardiaque est une maladie systémique rare qui est classifiée en plusieurs types. Il s'agit d'un groupe de maladies qui résultent de dépôts d'une protéine anormale appelée amyloïde, dans différents tissus du corps. Il existe plusieurs types de protéines amyloïdes produites par la moelle osseuse. Selon la structure de l'amyloïde en question, la protéine anormale peut s'accumuler dans un tissus isolé (amyloïdose localisée) ou peut affecter plusieurs organes ou tissus (amyloïdose systémique). Tandis que la forme localisée peut être moins nocive, la forme systémique peut causer de sérieux changements dans presque tous les organes du corps. Les organes les plus souvent atteints sont les reins, le cœur, la peau, les poumons, le foie, la rate, les nerfs, la langue et le tractus digestif.

1- TYPES D'AMYLOÏDOSE

L'amyloïdose systémique est habituellement classifiée en trois types principaux qui sont très différents les uns des autres.

A- Le type le plus commun d'amyloïdose systémique est l'amyloïdose **AL** (immunoglobuline à chaine **légère**). L'incidence annuelle de cette forme est d'environ 8-10 cas par million en Amérique du Nord. Cette forme d'amyloïdose est le résultat d'une anomalie des cellules plasmatiques de la moelle osseuse et est intimement reliée au myélome multiple. L'incidence la plus élevée survient entre les âges de 60-70 ans, même si elle peut parfois survenir à un âge plus jeune et environ 70% des patients atteints sont des hommes.

B- L'amyloïdose **AA**, habituellement connue sous le nom d'amyloïdose secondaire est dérivée d'une protéine inflammatoire sérique anormale, l'**amyloïde A**, qui survient en association avec une maladie inflammatoire chronique telle une maladie intestinale inflammatoire chronique ou une maladie rhumatismale.

C- L'amyloïdose héréditaire est causée par un gène anormal. Même si plusieurs gènes peuvent causer la maladie, le type le plus commun d'amyloïdose héréditaire est appelée **ATTR**. Cette forme est causée par des mutations du gène transthyrétine (**TTR**). La transthyrétine, une préalbumine, est une protéine abondante produite par le foie et agit comme **trans**porteur de la **thyr**oxine et du **rétin**ol. Dans sa forme monomérique, la transthyrétine a tendance à se replier et se concentrer progressivement en dépôts d'amyloïde. Les deux principaux sous-types d'amyloïdose ATTR sont l'ATTR mutant (ATTRm) et le ATTR « wild-type » (ATTRwt) aussi décrite sous le nom d'amyloïdose sénile (ou la transthyrétine est normale mais plus abondante).

2- L'AMYLOÏDOSE CARDIAQUE

La grande majorité des cas d'amyloïdose cardiaque sont causés par une des deux protéines : la chaine légère (AL) ou la transthyrétine (ATTR). L'amyloïdose reliée à l'âge (dans laquelle l'amyloïde provient de la transthyrétine « wild-type » normale est une maladie lentement progressive qui affecte le cœur surtout des hommes plus âgés.

Le diagnostic d'amyloïdose cardiaque est fréquemment manqué ou sous-évalué car sa présentation clinique est souvent similaire à plusieurs autres maladies cardiaques. Les manifestations cardiaques de l'amyloïdose incluent principalement l'insuffisance cardiaque et les arythmies cardiaques. L'hypertrophie ventriculaire avec un voltage électrique anormalement faible à l'électrocardiogramme (ECG) sont des indices de la présence de la maladie. L'amyloïdose AL survient habituellement entre l'âge de 40-80 ans avec une incidence presque égale entre les hommes et les femmes et montre une légère hypertrophie. Cependant, l'hypertrophie des ventricules est plus significative dans les deux formes ATTRwt et ATTRm. Dans ces deux formes d'amyloïdose les hommes sont beaucoup plus fréquemment atteints que les femmes et l'âge de l'incidence varie entre 65-95 ans pour

« Le diagnostic d'amyloïdose cardiaque est fréquemment manqué ou sous-évalué car sa présentation clinique est souvent similaire à plusieurs autres maladies cardiaques. »

l'ATTRwt et de 55 à 75 ans pour l'ATTRm. La forme ATTRm est très sous-estimée puisque presque un quart des patients âgés ont un certain degré de dépôts d'amyloïde dans le cœur à l'autopsie. De plus, environ 3-4 % des afro-américains ont une mutation commune héréditaire du gène TTR.

3- PRONOSTIC ET DIAGNOSTIC DE L'AMYLOÏDOSE CARDIAQUE.

La mortalité secondaire à l'amyloïdose demeure élevée chez les patients avec une atteinte cardiaque avancée. La détection précoce avec une classification appropriée est primordiale pour un meilleur traitement et un meilleur pronostic. Ceci est d'autant plus important que le traitement va être différent selon le type d'amyloïdose. Le pronostic de l'amyloïdose est intimement relié au degré de l'atteinte cardiaque. Même si le pronostic est habituellement meilleur avec la forme ATTR que la forme AL de la maladie, les deux formes montrent un taux de mortalité annuelle élevé.

Le traitement de la forme AL a deux buts principaux : premièrement, tenter de ralentir la progression de la maladie en éliminant les cellules clonales plasmatiques et leur progression de chaines légères anormales à l'aide de la chimiothérapie et deuxièmement de traiter l'atteinte de la fonction de l'organe. Contrairement à la forme AL, la chimiothérapie n'a aucun rôle dans le traitement de l'amyloïdose ATTR car cette forme de maladie n'est pas maligne. Plusieurs agents ont été ou sont en investigation actuellement pour le traitement de l'amyloïdose tels les anti-inflammatoires non stéroïdiens (toutefois, les anti-inflammatoires sont relativement contre-indiqués en présence d'une insuffisance cardiaque) ou les médicaments interférant avec le RNA qui aident à réduire la production de la transthyrétine par le foie. En mai 2019, la compagnie Pfizer a reçu l'aval du Food and Drug Américain (FDA) pour commercialiser le Tafamidis, un médicament prometteur dans les cas de cardiomyopathie amyloïde de la forme ATTR. Cet agent était déjà approuvé en Europe et au Japon dans le traitement de la polyneuropathie reliée à l'amyloïdose ATTRm.

Le diagnostic définitif de l'amyloïdose requiert une biopsie tissulaire de l'organe cliniquement atteint. Pour l'amyloïdose cardiaque, une biopsie endomyocardique avec coloration spéciales vont révéler la présence de dépôts d'amyloïde dans les cellules cardiaques et confirmer le diagnostic. D'autres tests de laboratoire peuvent aussi être utiles afin de confirmer le type d'amyloïdose et de monitorer la réponse de la maladie au traitement. Compte tenu de la nature plus effractive de la biopsie cardiaque, les recherches se sont penchées sur des méthodes d'imagerie non effractives afin de détecter et de différentier les types d'amyloïdose. L'échocardiographie et la résonnance magnétique (MRI) sont très utiles pour identifier l'état fonctionnel et morphologique mais ne peuvent pas facilement faire la distinction entre les deux types d'amyloïdose cardiaque. De récentes données scientifiques ont démontré que la médecine nucléaire pouvait être utile afin d'améliorer et de différentier le diagnostic non effractif de l'amyloïdose cardiaque : la scintigraphie myocardique au 99mTc-Pyrophosphate.

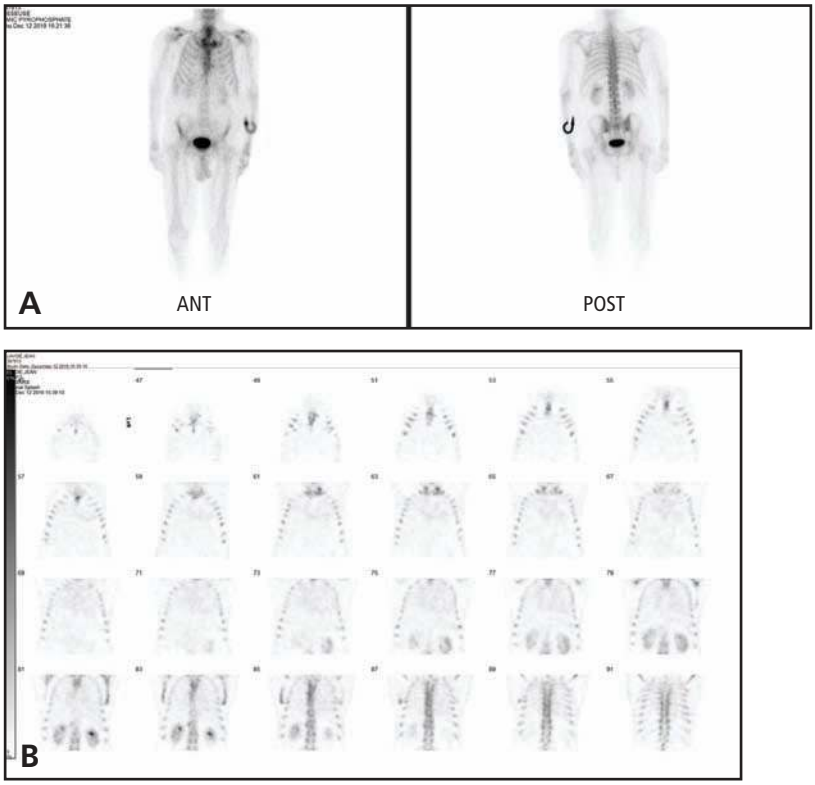

Figure 1
Scintigraphie pancorporelle au 99mTc-PYP en mode planaire (A) et en mode tomoscintigraphique (B) chez un patient avec une amyloïdose cardiaque de type AL. Il n'y a aucune captation anormale du radiotraceur au niveau du muscle cardiaque, ce qui est normal pour ce type de pathologie. L'étude est interprétée comme étant normale.

4- LA SCINTIGRAPHIE MYOCARDIQUE

Les études scientifiques récentes au sujet de l'amyloïdose cardiaque et son traitement possible ont renouvelé l'intérêt pour une technique de médecine nucléaire qui existe depuis plus de cinquante ans, soit la scintigraphie osseuse. Il est connu depuis des décennies que les radiotraceurs utilisés pour obtenir des scintigraphies osseuses tels le 99mTc-Methylene Diphosphonate (99mTc-MDP) ou le 99mTc-Pyrophosphate (99mTc-PYP) montrent une affinité élevée pour la protéine amyloïde, ce qui se traduit par une hypercaptation cardiaque du radiotraceur chez les patients atteints d'amyloïdose cardiaque alors que le radiotraceur ne se fixe pas dans un cœur normal. Il a été démontré que le 99mTc-PYP était le meilleur agent à cet égard. Même si une captation anormale du 99mTc-PYP peut être décelée dans certaines pathologies telles l'infarctus aigu du myocarde ou la péricardite, ces conditions peuvent être reconnues relativement facilement de l'amyloïdose à l'aide de simples test cliniques. Plusieurs études ont démontré que le 99mTc-PYP s'accumulait à différents degrés dans le cœur des patients avec l'amyloïdose ATTR mais non chez les patients avec le type AL. Même si les

« La mortalité secondaire à l'amyloïdose demeure élevée chez les patients avec une atteinte cardiaque avancée. La détection précoce avec une classification appropriée est primordiale pour un meilleur traitement et un meilleur pronostic. »

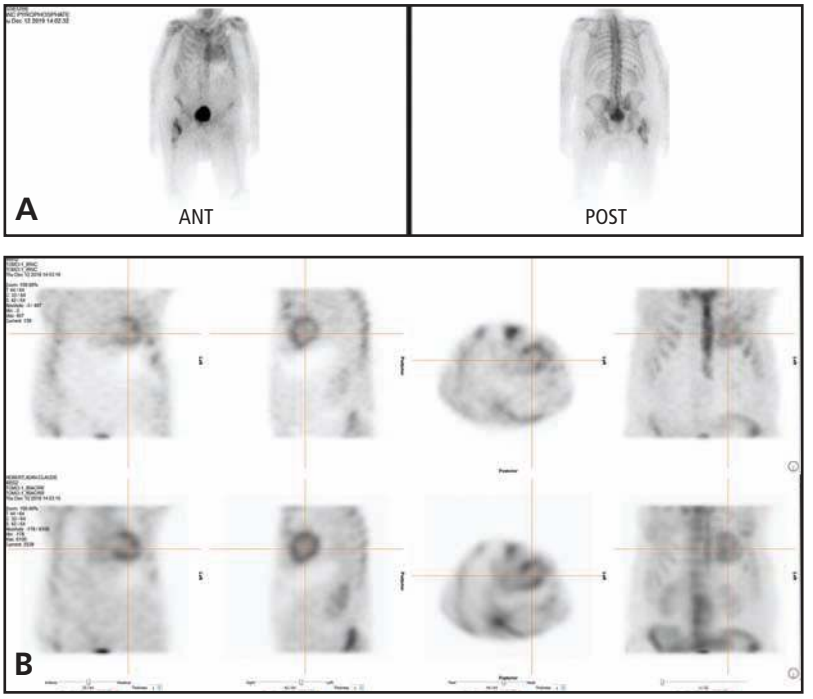

Figure 2
Scintigraphie pancorporelle au 99mTc-PYP en mode planaire (A) et en mode tomoscintigraphique (B) chez un patient avec une amyloïdose cardiaque de type ATTR. Il y a une importante captation anormale du radiotraceur au niveau du muscle cardiaque, bien délimitée sur les études tomographiques (flèches). Ceci représente un cas typique d'amyloïdose cardiaque de type ATTR.

« Les études scientifiques récentes au sujet de l'amyloïdose cardiaque et son traitement possible ont renouvelé l'intérêt pour une technique de médecine nucléaire qui existe depuis plus de cinquante ans, soit la scintigraphie osseuse. »

mécanismes exacts de la captation cardiaque du 99mTc-PYP dans les cas d'amyloïdose ATTR (et l'absence ou le peu de captation dans les cas d'amyloïdose AL) sont actuellement inconnus, les hypothèses sont à l'effet que la captation accrue des radiotraceurs est reliée aux niveaux de calcium élevés dans les dépôts d'amyloïde chez les patients avec l'amyloïdose cardiaque ATTR. Un avantage distinct de la scintigraphie cardiaque au 99mTc-PYP est sa capacité d'identifier spécifiquement l'amyloïdose cardiaque ATTR de façon non effractive.

Il n'y a pas de préparation spéciale pour la scintigraphie myocardiaque au 99mTc-PYP. Cette technique est disponible dans tous les départements de médecine nucléaire. Cette technique non-effractive et sans effet secondaire ne requiert qu'une simple injection intraveineuse du 99mTc-PYP. Trois à quatre heures après l'injection, des images planaires pancorporelles de même qu'une tomoscintigraphie SPECT (**S**ingle **P**hoton **E**mission **T**omography) du cœur, qui consiste à faire tourner autour du patient une gamma caméra qui détecte les rayons gammas provenant du radiotraceur dans le cœur, seront obtenues. La technique entière prend environ 45 minutes. La tomoscintigraphie permet d'obtenir de fines images de la région cardiaque et permet d'évaluer la captation du 99mTc-PYP au niveau de l'apex du cœur qui est habituellement épargnée jusqu'à un stade avancé de la maladie.

Des analyses quantitatives et semi-quantitatives sont obtenues par la suite. Cette analyse permet de classifier plus objectivement le degré de captation cardiaque qui peut être proportionnel au degré des dépôts d'amyloïdose dans le cœur.

La scintigraphie cardiaque au 99mTc-PYP est indiquée chez les patients avec une insuffisance cardiaque et une augmentation inexpliquée de l'épaisseur du ventricule gauche, spécialement chez les patients âgés de plus de 60 ans ayant une fraction d'éjection ventriculaire gauche normale. D'autres indications incluent l'évaluation de l'atteinte cardiaque chez les individus avec une amyloïdose familiale connue ou suspectée, dans le diagnostic d'amyloïdose cardiaque ATTR chez les patients avec une échocardiographie ou une MRI compatibles avec une amyloïdose cardiaque ou chez les patients chez qui une amyloïdose cardiaque ATTR est suspectée mais qui présentent des contre-indications à la MRI telles une insuffisance rénale ou la présence d'implants métalliques.

D'autres radiotraceurs peuvent être utilisés dans le diagnostic non effractif de l'amyloïdose cardiaque. Les pays européens utilisent en clinique un nouveau radiotraceur, le 99mTc-DPD (99mTc-3,3-diphosphono-1,2-propanodicarboxylic acid) avec de très bons résultats. Certains auteurs ont rapporté également l'utilisation du 123 Iode-mIBG (**m**eta **i**odo**b**enzyl **g**uanidine). Ce radiotraceur est utilisé afin d'évaluer le degré d'innervation du cœur. Les patients au stade précoce d'amyloïdose cardiaque, spécialement ceux du type ATTR, démontrent un certain degré de dénervation et peut être détecté à l'aide de la scintigraphie cardiaque au 123 Iode-mIBG. Il est possible que l'utilisation plus répandue de ce test pourrait aider à identifier les patients à un stade plus précoce de la maladie, pouvant ainsi améliorer le pronostic.

CONCLUSION

Le paradigme de l'amyloïdose cardiaque s'est significativement modifié au cours de la dernière décennie. Une meilleure compréhension de la maladie, une reconnaissance accrue de son incidence, une amélioration significative à la fois dans le traitement et les outils diagnostiques ont modifié l'approche médicale de l'amyloïdose cardiaque. Même si la scintigraphie cardiaque au 99mTc-PYP est considérée comme une « vielle » technique, sa haute sensibilité dans le diagnostic de l'amyloïdose cardiaque et son potentiel unique de différentier les formes ATTR et AL, elle est reconnue comme étant un outil diagnostique important pouvant aider à guider la prise en charge de ces patients. La médecine nucléaire peut donc jouer un rôle important dans cette maladie souvent sous-diagnostiquée. ■

CANM ACMN

The Canadian Association of Nuclear Medicine

Association canadienne de médecine nucléaire

Message from the CANM President

On behalf of all members of the Canadian Association of Nuclear Medicine (CANM), I would like to wish you a great success for the 52th Annual Conference of the Society of Nuclear Medicine-India that will take place virtually December 11-13, 2020.

India, on the world scene, brings an exceptional contribution to the added value of nuclear medicine to our patients.

This conference, virtually accessible to all, will allow fellow Canadians and others to benefit from an update from our colleagues from India and others from various countries.

We encourage our members to participate via our regular communications and by posting the information on our website (www.canm-acmn.ca). The conference announcement will also be published in the magazine Epatient (www.nmpangea.com).

The CANM is proud of its good relations with the SNM-India. Together, we can offer more to our patients.

Again, we wish you the best for your 2020 conference.

François Lamoureux, MD
President, CANM
canm@canm-acmn.ca
www.canm-acmn.ca

SOCIETY OF NUCLEAR MEDICINE (INDIA)

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Nuclear Medicine Re-defining Precision Oncology

Message from Chairman, SNMICON 2020 Virtual

On behalf of organising committee, it is my pleasure to invite all of the great scientists, academicians, young researchers, Business delegates and students from all over the world to attend the 52nd Annual Conference of Society of Nuclear Medicine India, (SNMICON 2020) from 11th – 13th December 2020 on a virtual platform.

Goal of this meeting is to bring together, a multi-disciplinary group of scientists, physicians and technologists from all over the world to present and exchange break-through ideas relating to the nuclear medicine.

Since this conference covers the global aspects on nuclear medicine from very fundamental issues to practical applications of the principle of nuclear medicine, anyone interested in the future progress of nuclear medicine should not miss.

We're looking forward to an excellent meeting with great scientists from different countries around the world sharing new and exciting results in nuclear medicine.
With my best and warm regards!

Prof. Dr. Karan Peepre
Organising chairman
SNMICON 2020

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RTNM

WHY MY JOB IN NUCLEAR MEDICINE IS LIKE THAT FAVORITE VACATION SPOT YOU WANT TO KEEP SECRET...

Have you ever stumbled on the most gorgeous vacation spot? Perfectly serene, optimal weather, private, not overcrowded, perfect price, and just happened to be available at the ideal time? So coveted you hesitate to tell your friends on the off chance they might steal it? That is how I feel about my career in Nuclear Medicine. A career I must admit, I was lucky to find. With just a little research I was intrigued: a blend of patient care, cutting edge technology, radiation science, physics and laboratory work. What I didn't realize was how exciting a day in the life of a Nuclear Medicine Technologist is, how much radiation science knowledge I would gain, how fascinating the future is for detection and treatment of diseases, how this directly impacts patient outcome, how many diverse jobs there are and how connected the community is. A community that I will forever be a part of. I didn't predict that years later, I would still feel fulfilled and proud of my personal and professional growth. So let me share my secret with you…

Nuclear Medicine Technologists typically start their day in the "hot (radioactive) lab" where they make radiopharmaceuticals (radioactive pharmaceuticals), test them for quality, and prepare them to be administered to patients. The immense variety of studies performed in a nuclear medicine department can be attributed to the fact that the functional aspect of every body system can be imaged to detect a variety of diseases such as infection, inflammation, or cancer. As the patients arrive throughout the day, a technologist will administer a specific radioactive tracer intravenously, subcutaneously, orally, or via inhalation. Each tracer is chosen and chemically created to highlight a specific function of the patients' body and is then visualized using a fusion camera. Fusion cameras, such as Single Photon Emission Computed Tomography/Computed Tomography (SPECT/CT) and Positron Emission Tomography (PET/CT) create highly sensitive and specific images that are evaluated and scrutinized for thoroughness and quality by the meticulous eye of a technologist. Technologists are the experts of this trade and can often recognize subtle changes in an image in advance of a physicians consult. This means the technologist has a direct and crucial impact on the outcome of each patient's health. Excellent patient care skills and a high level of attention to detail is mandatory as patients can potentially be in critical condition. To further optimize patient outcome, Nuclear Medicine Technologists are an essential part of the healthcare team and work in an interprofessional environment with other imaging modalities, physicians, nurses and many more healthcare professionals.

The physics of radiation sciences is a significant part of the Nuclear Medicine Technologists skillset. Ionizing radiation, historically associated with fear and hesitation, is explored in depth in their training. Knowledge is power in this subject and technologists are masters at the safety procedures required to protect themselves and their patients. During their exhaustive training, myths are debunked and the truth about the benefits and risks associated with different types of radiation is clarified. Personal radiation measurement

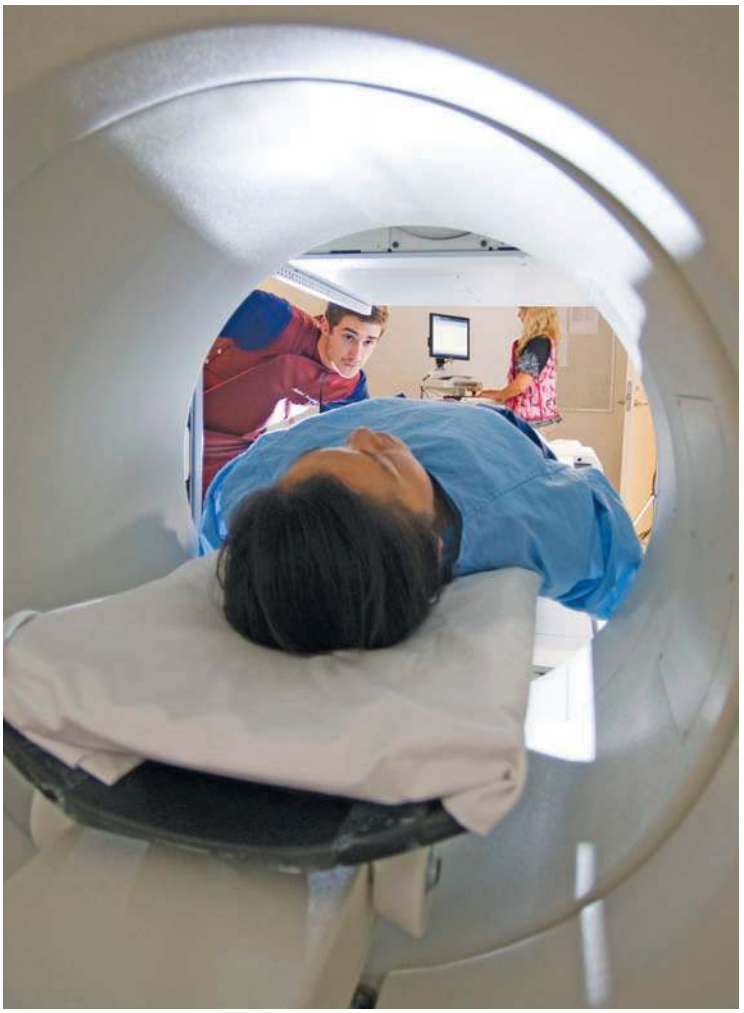
devices are worn to verify their diligence when manipulating ionizing radiation. Patient safety, in all aspects, is their responsibility and they are perpetually accountable for this. Radiation in nuclear medicine is essential and is saving lives daily!

Nuclear Medicine is moving forward at an incredible rate with the advancement of technological equipment and the development of new radiotracers. Fusion cameras have brought the ability to perfectly localize cellular-level functional changes in the body, detecting disease early, accurately and consistently. Specifically, PET/CT technology, focused mostly in oncology, has greatly impacted the outcome of millions of cancer patients. New PET radiotracers can evaluate breast and prostate cancer as well as new PET neurological tracers can diagnose and treat Parkinson's, Alzheimer's and CTE (Chronic Traumatic Encephalopathy). Theranostics is the fastest growing vertical in Nuclear Medicine and is influencing and paving new paths for targeted cancer diagnoses and treatments. Research in these areas is continual and abundant. PET/CT and SPECT/CT cameras are popping up all over Canada with a desperate need for technologists to operate them.

Upon graduation from an accredited school and passing a certification exam, you become a Registered Nuclear Medicine Technologist. While many retire in this same role, the opportunity for a variety of careers await you. Just within my humble network, fellow technologists have been cross-trained to perform other diagnostic imaging procedures like CT, MRI and Ultrasound. Some have moved to industry and work for equipment and software vendors, accreditation companies or regulatory bodies. Others have become managers, practice leads, teachers, deans, cyclotron operators or radiation safety officers. Some have left Canada to work internationally. Interestingly, technologists trained in Canada are recognized and highly sought after globally for their elite level of training. Finding a niche in this industry that captivates you is not only gratifying, but also quite obtainable.

What causes so many to stay in the field of Nuclear Medicine? Well in my heart I believe it is the community we have created. Provincially, nationally and internationally there is a sense of inclusivity and connection linking nuclear medicine graduates of all levels together. I have witnessed firsthand the passion, outreach, promotion and pride of our discipline at events all over the globe. As an instructor in the Nuclear Medicine Program at British Columbia Institute of Technology (BCIT) and a board director for Canadian Association of Medical Radiation Technologists (CAMRT), engaging the newest members of this growing field and thriving community is something I take immense pride in. Attracting future graduates early on by introducing them to key partners and stakeholders provides them advanced opportunities to connect. Whether it is volunteering, attending national/international conferences or just sharing in the excitement around new Nuclear Medicine developments, these fresh graduates are already invested in our community. In this industry, people feel connected, and when they feel connected to something bigger, it gives them a sense of belonging. I believe it is this sense of belonging that creates such high job satisfaction.

Whether you are just starting out as a fresh graduate, or you have been in the field for decades, Nuclear Medicine offers unlimited opportunities to learn and explore. Find that perfect niche. Connect to others. Make that difference. While no career can replace the most impeccable, beautiful and perfect vacation spot, I can assure you this one is so valuable to be a part of. Fascinating science, impressive technology, optimization of patient care and treatment outcomes, working in a multidisciplinary, ever-changing setting are only a few of the reasons I have found this career to bring such personal satisfaction. ■



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Nuclear Radiology & Theranostics Fellowship Program

The Section of Nuclear Medicine of the Department of Radiology at Wake Forest School of Medicine offers an ACGME accredited one-year fellowship program in nuclear radiology. The training program includes classroom, training and experience in nuclear medicine, nuclear cardiology, positron emission tomography (PET/CT) as well as in Theranostics.

The fellowship is designed to provide the trainees an in-depth experience in all areas of clinical nuclear medicine, both diagnostic and therapeutic. The fellow is taught the basic principles upon which the field of nuclear medicine is founded, including: Radiation physics, Radiobiology, Health physics, Instrumentation, Radio-pharmacy. Successful completion of the training program and requirements provides the fellow a certificate in Nuclear Theranostics.

The Wake Forest Nuclear Radiology fellowship program strives to offer the radiology fellow a great learning environment in diagnostic (single photons-regular Nuclear Medicine and positrons-PET studies) and therapeutic Nuclear Medicine (Theranostics) while providing excellence in clinical service to patients and referring clinicians. Additionally, the program facilitates research and publications endeavors in Nuclear Medicine, molecular & hybrid imaging and Theranostics. Nuclear Radiology fellows are intimately part of the success of the Nuclear Medicine section.

The training provides the necessary knowledge in Nuclear Medicine to prepare for certification by the American Board of Nuclear Medicine and Nuclear Cardiology and the full clinical practice of Nuclear Medicine, including eligibility for Authorized User status by the Nuclear Regulatory Commission (NRC) or Agreement State. A Theranostics certificate is also given to the fellows who successfully complete all necessary requirements.

Ultimately, the twelve months Nuclear Radiology Fellowship Core Curriculum (combined with the Cardiology Nuclear Curriculum and Theranostics certificate) is designed to provide the Nuclear Radiology fellow with the necessary skills to become competent in all aspects of clinical Nuclear Medicine, Nuclear Cardiology and Theranostics and to become leaders in their field.

An MD or MD/PhD degree is required. Applicants should also have completed the USMLE Steps 1, 2 and 3, an ACGME accredited radiology residency with 4 months of nuclear medicine rotation and be eligible to obtain a Medical License in North Carolina.

Interested applicants should submit a Personal Statement, Current CV, Copy of USMLE Scores, ABR Examination Results – if applicable and 3 Letters of Recommendation to:

Katie Holbrook, Nuclear Radiology Fellowship Program Coordinator, krholbro@wakehealth.edu

Leadership and Faculty

Four clinicians staff the nuclear medicine service at Wake Forest University/Baptist Medical Center. The nuclear radiology fellow provides supervision for the radiology residents under the ultimate guidance of the nuclear medicine faculty.

Jean-Luc C Urbain, MD, PhD, CPE, FASNC
Professor of Radiology,
Nuclear Medicine & Cardiology
Cheif & Medical Director Nuclear Medicine

Anita J Thomas
Associate Professor of Radiology
& Nuclear Medicine

A Paige Bennett, MD
Professor of Radiology & Nuclear Medicine

Jennifer A Schroeder, MD
Assistant Professor of Radiology
& Nuclear Medicin

Natalie Keane Domeisen, MD
St. Joseph Mercy Health Ann Arbor

THERA-WHAT?! A GUIDE TO NUCLEAR MEDICINE MEDICAL STUDENT EDUCATION

"Do you know what the field of 'Theranostics' is?"

I was a fourth-year medical student who had just submitted my Diagnostic Radiology residency applications. I had done all the things an applicant was supposed to do: lead the Radiology Interest Group, start a radiology medical education program for first year medical students, perform research, shadow all the subspecialties, dabble with the prospect of IR, and get excited listening in on the inter-provider banter surrounding mysterious cases. Yet I found myself sitting in the Nuclear Medicine reading room shaking my head. No. I had never heard of Theranostics. It wasn't on our USMLE boards, no radiologists had lectured to the medical students about the topic, and I never saw the reference in any patient charts on the clinical wards.

The provider went on to explain the breadth of Nuclear Medicine. How within Theranostics, the patient care is circumferential, starting with the diagnosis of disease, leading to clinic visits, disease targeted intervention, and ending in follow up. The provider explained to me the financial implications of this ever-popularizing trend in practice. I don't know the number, but it was significant.

Medical student education regarding radiology has been a long-established difficulty in the field, however it remains critical to institute. Medical students are future residents, who are future attendings, who are then future healthcare leaders and influencers. Ill-equipping future leaders in healthcare with knowledge pertaining to the diagnosis and treatment of disease is antithetical to the practice of medicine and the primary goal of medical education.

Early exposure to the field of radiology has been identified as one of the key solutions to this problem; early exposure has been proven to improve students' impression of radiology and increase interest in radiology as a career.[1] It has also been established that the most preferable method of teaching radiology is live instruction.[2] When compared to web-based medical student radiology curriculum, students greatly prefer live instruction despite the ease of use of web-based tools for administrators.[2] Therefore, exposing students to fields of medicine they are not routinely exposed to, such as Nuclear Medicine and Theranostics, is proven to be efficacious and necessary.

In-person introductory lectures aimed at increasing student understand of the field only cost one hour of a provider's time, are administratively easy to coordinate, and importantly, at our institution, have demonstrated student interest. An introductory lecture entitled "Nuclear Medicine, Theranostics, and Clinical Radiology" was offered to 84 students who participate in a radiology certificate program at our institution. At the time of this article, 72 of the 84 participants signed up for the one-hour lecture, indicating an interest on the student's behalf in learning about this field.

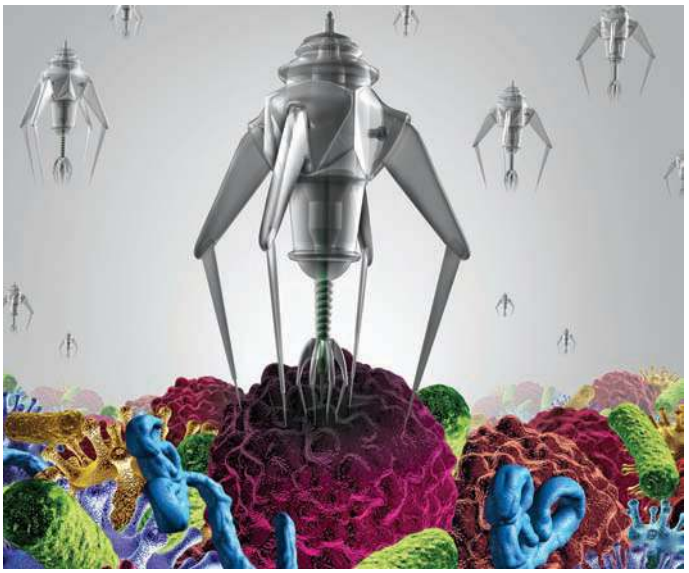
Improving the prominence of radiology in medical education will promote the usage of more accurate diagnostic imaging modalities, improve referral relationships between future radiologists and clinicians, and improve patient care. Radiology is cornerstone in the practice of clinical medicine[3], thus it is the responsibility of leaders in the field to educate medical students in all aspects of the specialty, including Nuclear Medicine.

Works Cited:

1. Branstetter IV, Barton F., et al. "Preclinical medical student training in radiology: the effect of early exposure." American Journal of Roentgenology 188.1 (2007): W9-W14.

2. Chew, Felix S., and Annemarie Relyea-Chew. "Distributed Web-supported radiology clerkship for the required clinical clerkship year of medical school: development, implementation, and evaluation." Academic radiology 9.6 (2002): 713-720.

3.Squire LF, Novelline RA. Radiology should be a required part of the medical school curriculum. Radiology 1985; 156:243–244.



CANM ACMN

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L'Association canadienne de Médecine nucléaire continue de travailler en étroite collaboration avec les différentes Associations et Sociétés de Médecine nucléaire dans le monde. La survenue de la crise du COVID-19 nous oblige a continuellement nous adapter a la situation.

MERCI À VOUS TOUS

Collègues, technologues, physiciens, ingénieurs, radiochimistes, industriels, préposés a nos patients, personnel du secrétariat, les employés de l'entretien ménagé, les gardiens de sécurité, les bénévoles et beaucoup nos patients pour leur compréhension et leurs escortes, ambulanciers et infirmières, autorités hospitalières.

On ne peut également que remercier nos confrères spécialistes et omnipraticiens et résidents pour leur indéfectible support et disponibilité. L'ACMN continuera de collaborer aux magazines LePatient et le Epatient mais pour le moment seulement en version électronique. Les versions magazine suivront aussitôt que possible. **www.lepatient.ca • www.nmpangea.com**

François Lamoureux, Président

The Canadian Association of Nuclear Medicine continues to work in close collaboration with the various Associations and Societies of Nuclear Medicine in the world. The onset of the COVID-19 crisis forces us to continually adapt to the ongoing situation.

TO ALL OF YOU, THANK YOU !

Colleagues, technologists, physicists, engineers, radio-chemists, industrialists, patient attendants, secretarial staff, housekeeping staff, security guards, volunteers, paramedics, nurses and hospital authorities.

We also cannot thank our fellow specialists, general practitioners, and residents enough for your unwavering support and availability. CANN will continue to collaborate with the magazine ThePatient and e-Patient, but for now the electronic format only will be available. The magazine version will follow as soon as possible. **www.lepatient.ca • www.nmpangea.com**

François Lamoureux, President

SAVE IMPORTANT DATES - Virtual Sessions

The Canadian Association of Nuclear Medicine (CANM) is proud to announce a series of Webinars as well as a one-day virtual conference this Fall. Please mark your calendar for the following:

Wednesday, November 25, 7-8 pm ET - Webinar: Diagnosing Alzheimer

Wednesday, January 27, 7-8 pm ET - Webinar: Parkinson: Differential & Diagnosis

Wednesday, February 24, 7-8 pm ET - Webinar: Theranostics

All virtual sessions mentioned above will be offered to all CANM members and sponsors free-of-charge. More information to come about content, registration, and technicalities to be able to join the sessions. In the meantime, please mark your calendar!

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Lionel S. Zuckier, MD, MBA, FRCPC and Edgar Zamora, MD
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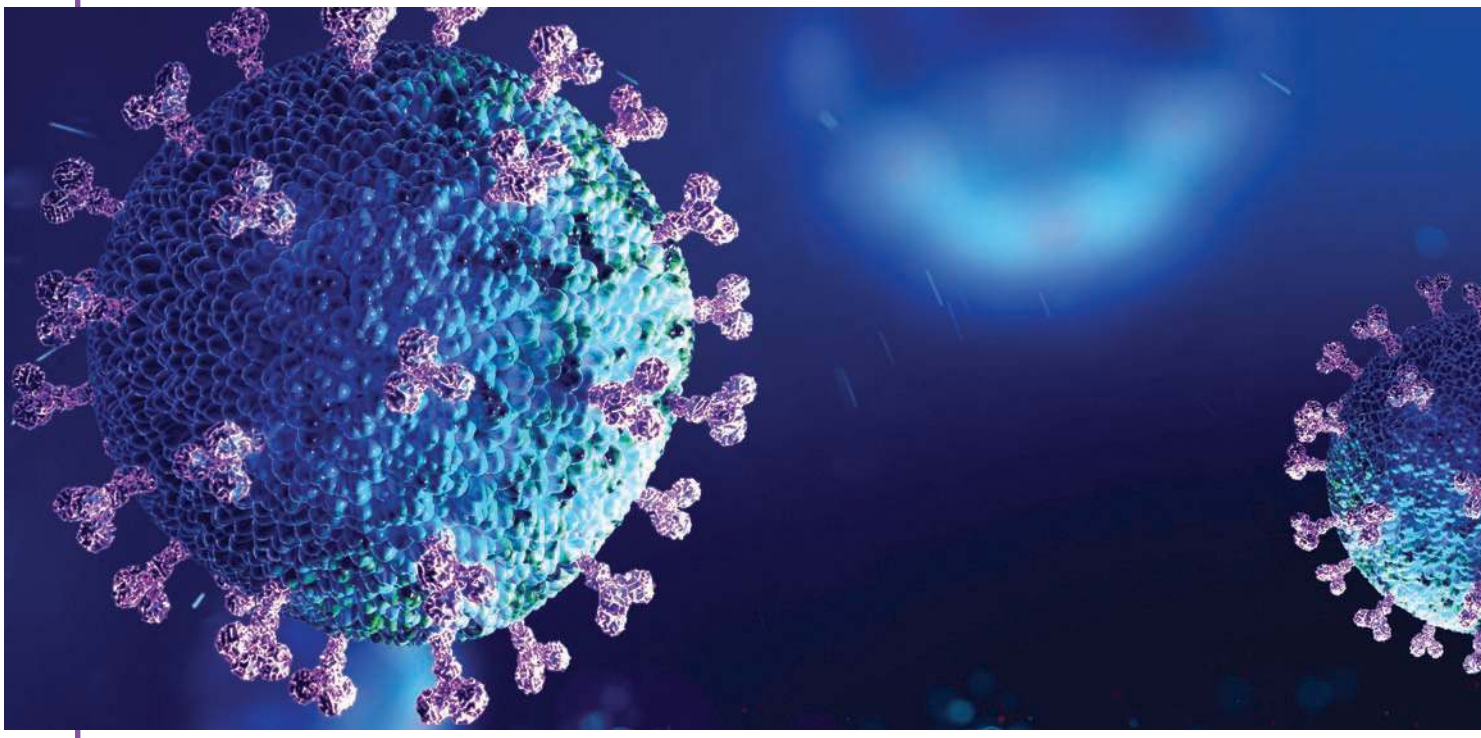
SAFE OPERATION OF THE NUCLEAR MEDICINE DEPARTMENT DURING THE COVID-19 SURGE IN NEW YORK CITY – A DIVISION HEAD PERSPECTIVE

Since its foundation in 1884 as the "Montefiore Home for Chronic Invalids", Montefiore Medical Center has grown into a large academic-based medical institution in New York City, spanning several teaching hospitals in the Bronx. It offers medical care in one of the most population-dense counties in the United States. Its Division of Nuclear Medicine has grown alongside the subspecialty to become a well-regarded and established provider of radionuclide-based diagnostic imaging studies and treatment for patients referred from diverse specialties. The Division offers a full array of PET-based, general, cardiovascular, and therapeutic procedures and has been very involved in promoting and documenting efficacy of classic nuclear medicine modalities, such as lung scintigraphy for the diagnosis of pulmonary embolism, and various functional imaging studies for the diagnosis of gastrointestinal motility disorders. The Division participates in training of radiology residents and cardiology fellows and has its own nuclear medicine residency program which contributes to its legacy of academic accomplishments.

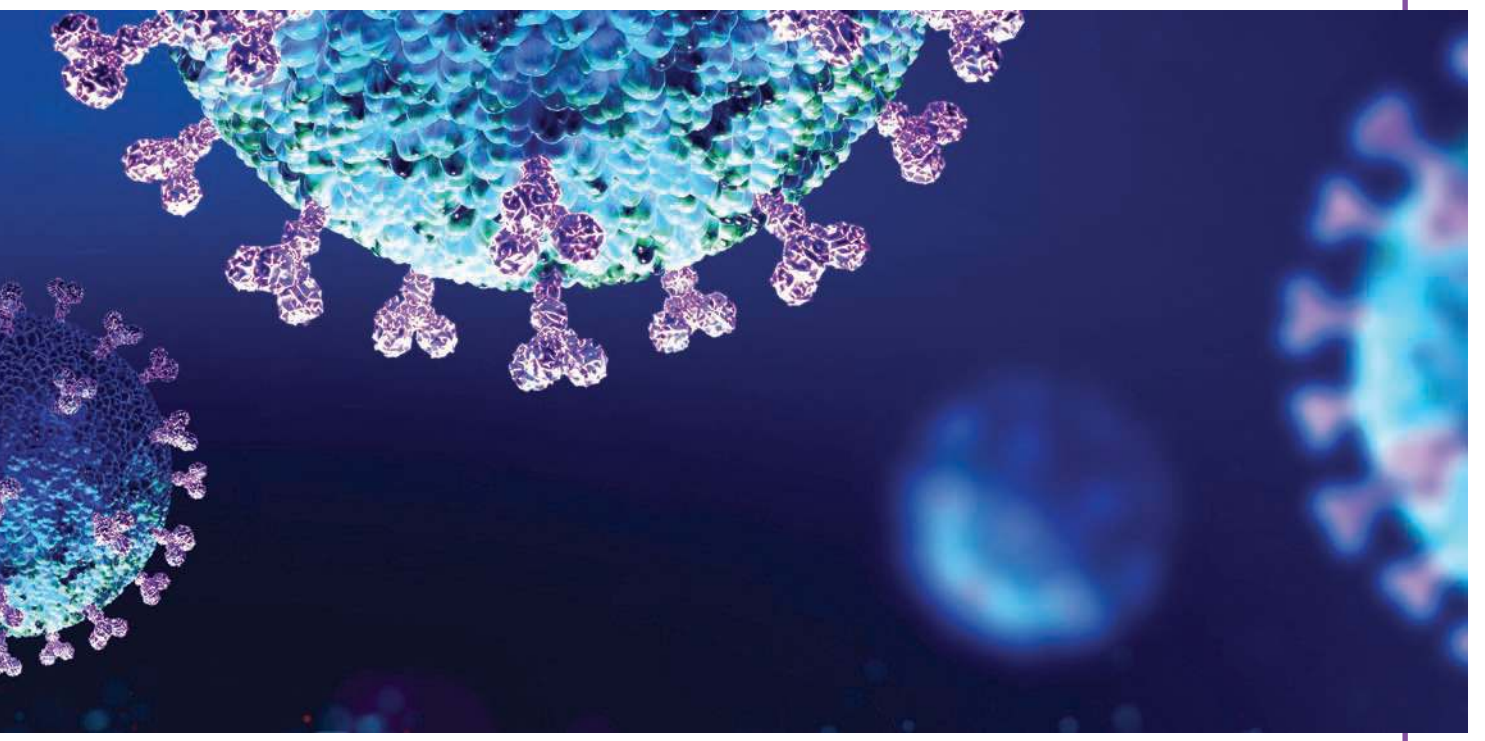
In early 2020, the projected threat from the developing COVID-19 pandemic drove medical institutions in New York City to take rapid measures to protect the densely-populated metropolis, and their own institutions, from the then-novel and quickly-spreading coronavirus (SARS-CoV-2). At its earliest onset in the United States, the epicenter of disease was centered on the boroughs of New York City, at a time when definitive knowledge was scanty, testing was not available, and personal protective equipment (PPE) was lacking. In this short communication we would like to convey the efforts made to provide emergency care at our institution while both promoting the health of its patients and staff. The Division Head has responsibility to the patients, staff and trainees and must make decisions aligned with direction from the institution.

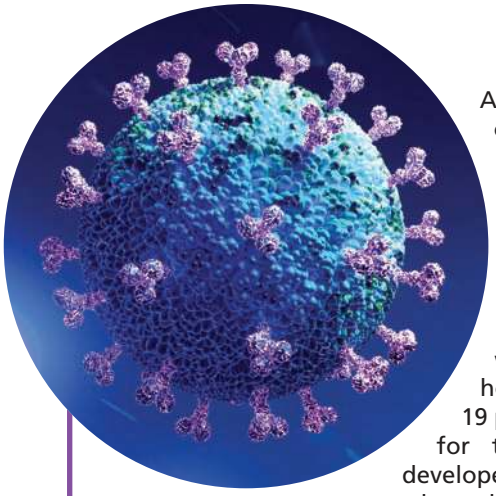


At the onset of initial cases, Montefiore Medical Center began to defer non-urgent diagnostic examinations which, of their own accord, had markedly decreased in volume due to a downstream effect of reduced general clinic visits and elective surgery. Screening temperature checks were implemented for patients upon entering a medical facility and patients were provided with a mask and required to fill out a short questionnaire screening for risk factors of exposure. Initial measures to control the risk of cross-infection included physical distancing in our waiting areas where seats were separated by six feet (1.8 m) from each other following recommendations from the Centers for Disease Control and Prevention (CDC) (1). Plexiglass barriers were installed between clerks and patients where possible.

The number of personnel in each independent medical examination and scanning room was limited to the minimum required for each intervention, patient interview, or procedure performed. These rooms were terminally disinfected after each patient and the use of PPE was encouraged among our staff by promoting awareness of personal safety and expanding accessibility to face shields and surgical and N95 masks. With careful rationing of PPE instituted by the medical system and internal conservation of resources, we had sufficient supplies to meet a greatly reduced demand. Ultimately, rules mandating the wearing of masks and faceshields were developed to govern appropriate staff behavior.

In the pandemic surge, before availability of antigen tests to establish infection or antibody tests to establish immunity, all patients were considered potentially infectious even without travel or exposure history, or typical symptoms, and precautions were taken to minimize potential for person-to-person spread. Beyond that, specific procedures with spread of aerosols or droplets potentially containing infectious material were considered high risk and efforts were made to avoid their performance (2). Leakage of radiopharmaceutical from devices used to create radiopharmaceuticals for ventilation scintigraphy had been previously studied in the context of employee dosimetry and it was known that a certain amount of activity is often released into the room air (3-6); for these reasons we therefore attempted to avoid ventilation scintigraphy over concern for escape of patient secretions into the air (7,8). Indeed, this is a valid concern as many symptoms of COVID-19 infection overlap those of PE including cough, shortness of breath, hypoxia and even hemoptysis. We therefore proposed an algorithm in which ventilation scintigraphy was not performed, and perfusion scintigraphy alone was used as a screening tool (9). When no significant defects were present, the patient was deemed free of embolism while if segmental perfusion defects were noted, further testing was indicated (such as CTPA or lower extremity doppler ultrasound in patients with lower extremity manifestations). Completion V/Q could be performed in those patients with contraindications to CTPA, with careful aerosol precautions and followed by terminal room decontamination.





As a teaching institution, our department is frequented by trainees and fellows, both from within and outside of our Division. Attending physicians and trainees traditionally work side-to-side however in the COVID-19 period, new paradigms for teaching had to be developed. To accomplish this, we adopted a "one workstation, one person" rule. Stations were now to be cleaned daily, and not shared during the course of a rotation. To the extent possible, clusters of workstations were dispersed, and the attending physicians' computers were configured to read and dictate studies, either within hospital offices, or from home, to the extent that that was allowed. An effort was made to elaborate minimum standards for monitors used to review nuclear medicine studies, something that was heretofore not clearly defined (10). Review (and teaching) sessions were implemented initially over Skype for Business, and subsequently over Teams (both Microsoft Corporation, Redmond, WA), fully supported on our enterprise-based equipment (11). Paradoxically, attending meetings virtually has eliminated travel time and increased the ability of staff to participate in group rounds and teaching. It has also lowered the bar and allowed us to invite national and international speakers to address our local group.

As the incidence of COVID-19 started decreasing in New York in mid-2020, our outpatient volumes have begun a recovery towards the "pre-COVID" volumes. Important cross-infection prevention measures remain in place including the use of masks, and screening for fever and other symptoms in addition to questionnaires to detect patients at risk from prior exposure to SARS-CoV-2. Ventilation and perfusion scintigraphy studies have undergone further adjustments: Patient charts are reviewed to determine COVID-19 status before protocolling these studies. "Complete" V/Q scans are performed in patients with a recent negative nasopharyngeal swab and full-dosage perfusion-only scintigraphy for those with recent positive nasopharyngeal swabs and/or moderate to high clinical concern. Lastly, low-dosage perfusion only scintigraphy is performed in patients with absent/pending swabs but low-risk of infection, with the option of subsequent completion V/Q scan immediately following perfusion, if needed.

The sudden adaptations we have innovated in response to the unexpected challenges of this pandemic have altered the way be run our divisions, specifically moving the medical field into relying more on connecting virtually. Some of these measures, borne of necessity, may be worth maintaining even follow resolution of the COVD-19 pandemic. ■

1. Centers for Disease Control and Prevention. Coronavirus (COVID-19). https://www.cdc.gov/coronavirus/2019-ncov/index.html. Accessed 10/18/2020.

2. National Center for Immunization and Respiratory Diseases (NCIRD) DoVD. Interim Infection Prevention and Control Recommendations for Patients with Suspected or Confirmed Coronavirus Disease 2019 (COVID-19) in Healthcare Settings. March 10, 2020; https://www.cdc.gov/coronavirus/2019-ncov/infection-control/control-recommendations.html. Accessed March 17, 2020.

3. Williams DA, Carlson C, McEnerney K, Hope E, Hoh CK. Technetium-99m DTPA aerosol contamination in lung ventilation studies. J Nucl Med Technol. 1998;26:43-44.

4. Achey B, Miller K, Erdman M, King S. Potential dose to nuclear medicine technologists from 99mTc-DTPA aerosol lung studies. Health Phys. 2004;86:S85-87.

5. Brudecki K, Borkowska E, Gorzkiewicz K, Kostkiewicz M, Mróz T. 99mTc activity concentrations in room air and resulting internal contamination of medical personnel during ventilation–perfusion lung scans. Radiation and Environmental Biophysics. 2019;58:469-475.

6. Mayes CD. Safe practice ventilation technique in lung scanning for pulmonary embolism. Nucl Med Commun. 2020.

7. Lam WW, Loke KS, Wong WY, Ng DC. Facing a disruptive threat: how can a nuclear medicine service be prepared for the coronavirus outbreak 2020? Eur J Nucl Med Mol Imaging. 2020.

8. Zuckier LS, Gordon SR. COVID-19 in the Nuclear Medicine Department, be prepared for ventilation scans as well! Nucl Med Commun. 2020;41:494-495.

9. Zuckier LS, Moadel RM, Haramati LB, Freeman LM. Diagnostic Evaluation of Pulmonary Embolism During the COVID-19 Pandemic. J Nucl Med. 2020;61:630-631.

10. Song N, Zuckier LS. A dearth of specifications regarding primary diagnostic monitors (PDMs) for nuclear medicine leaves us with little guidance during the COVID 19 pandemic. J Appl Clin Med Phys. 2020.

11. Moadel RM, Zamora E, Burns JG, et al. Remaining Academically Connected While Socially Distant: Leveraging Technology to Support Dispersed Radiology and Nuclear Medicine Training Programs in the Era of COVID-19. Acad Radiol. 2020;27:898-899.

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小胰腺癌患者^{18}氟—氟代脱氧葡萄糖正

目的 探究小胰腺癌患者^{18}氟-氟代脱氧葡萄糖（^{18}F-FDG）正电子发射断层成像/计算机断层扫描（PET/CT）影像学特点及其与临床特征的关系。**方法** 将63例行^{18}F-FDG PET/CT的胰腺癌患者根据肿瘤最大直径分对照组（肿瘤最大直径>2cm，42例）与观察组（最大直径<2cm，21例）比较两组影像学特点，分析不同分期患者的原发灶肿瘤代谢体积（MVT）最大标准摄取值（SUVmax），并分析两者与临床特征关系。**结果** 观察组患者早期SUVmax，延迟SUVmax值均明显高于对照组，CT值，远处转移发生率及瘤体处胰腺形态异常比例、瘤体界限不清比例均明显低于对照组，差异均有统计学意义（P<0.01）。随着胰腺癌分期的升高，MVT值逐渐升高（P<0.05）。不同分期胰腺癌患者的SUVmax值比较，差异无统计学意义（P>0.05）,MVT值与胰腺癌分期，SUVmax值均呈正相关，（r=0.396、0.450，P<0.01），SUVmax值与胰腺癌分期无相关性（r=0.195，P=0.08）。结论 胰腺癌原发灶MTV与临床分期、SUVmax值有一定的相关性。胰腺癌患者早期行^{18}F-FDG PET/CT检查测得肿瘤原发灶MTV 在一定程度上有助于胰腺癌的临床分期诊断。■

STUDY ON THE IMAGING CHARACTERISTICS OF 18-FLUORO-FLUORODEOXYGLUCOSE POSITRON EMISSION TOMOGRAPHY/COMPUTED TOMOGRAPHY IN PATIENTS WITH SMALL PANCREATIC CANCER AND ITS RELATIONSHIP WITH CLINICAL STAGING

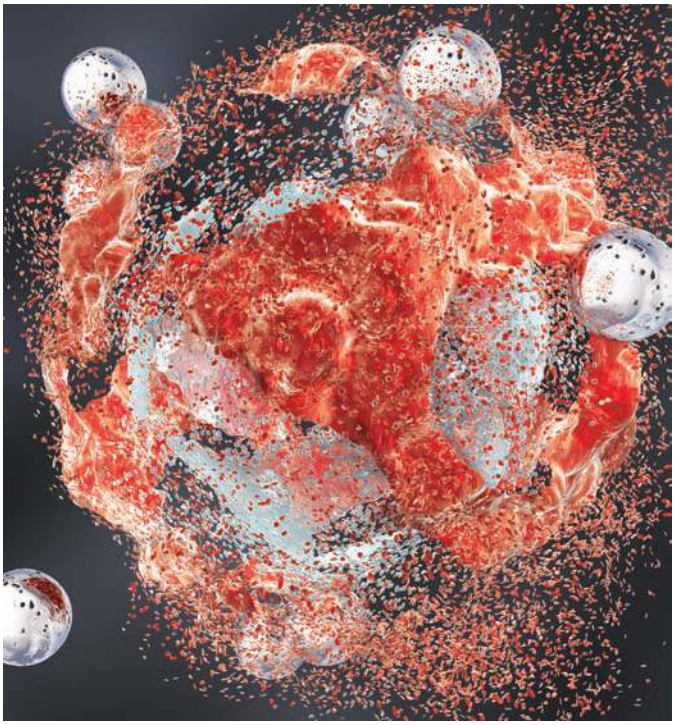
Objective- To explore the imaging characteristics of 18 fluoro-fluorodeoxyglucose (18F-FDG) positron emission tomography/computed tomography (PET/CT) and their relationship with clinical features in patients with small pancreatic cancer.

Methods- Sixty-three patients with pancreatic cancer underwent 18F-FDG PET/CT were divided into the control group (maximum tumor diameter> 2 cm, 42 cases) and observation group (maximum diameter <2 cm, 21 cases) according to the maximum tumor diameter to compare the imaging characteristics of the two groups.

Analyze the maximum standard uptake value (SUVmax) of the tumor metabolic volume (MVT) of the primary tumor in patients with different stages, and analyze the relationship between the two and the clinical characteristics.

Results- The early SUVmax and delayed SUVmax values of the observation group were significantly higher than those of the control group. The CT value, the incidence of distant metastasis, the proportion of abnormal pancreatic tumors, and the proportion of unclear tumors were significantly lower than those of the control group. Statistical significance (P<0.01). As the stage of pancreatic cancer increased, the MVT value gradually increased (P<0.05). There was no significant difference in the SUVmax value of patients with different stages of pancreatic cancer (P>0.05). The MVT value was positively correlated with the stage of pancreatic cancer, and the SUVmax value was positively correlated (r=0.396, 0.450, P<0.01). There was no correlation with cancer stage (r=0.195, P=0.08).

Conclusion- The MTV of primary pancreatic cancer has a certain correlation with clinical stage and SUVmax value. Early 18F-FDG PET/CT in patients with pancreatic cancer to detect the MTV of the tumor's primary tumor can help the clinical staging of pancreatic cancer to a certain extent. ■



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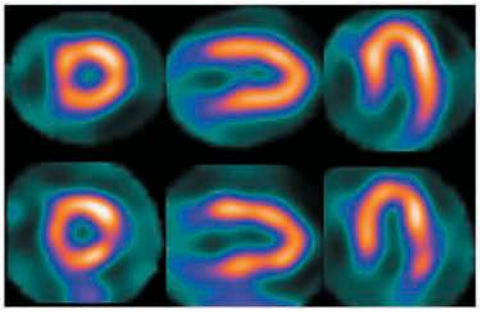

MYOVIEW™

(Kit for the Preparation of Technetium Tc99m Tetrofosmin Injection)

References: 1. Myoview [product monograph], February 12, 2018 (revised August 21, 2019), Control No. 211075.
2. Ravizzini GC, Hanson MW, Shaw LK, et al. Efficiency comparison between 99m Tc-tetrofosmin and 99m Tc-sestamibi myocardial perfusion studies. *Nucl Med Comm*. 2002;23:203-208.

MPI, myocardial perfusion imaging; **SPECT,** single-photon emission computed tomography.

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To report SUSPECTED ADVERSE REACTIONS, contact GE Healthcare at 1 800 654 0118 (option 2, then option 1), or email canadainfo@ge.com to request an adverse events form, or fax a request for a form to 905 847 5849. Adverse reactions can also be reported to Health Canada as follows:

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  - Fax to 1 866 678 6789 (toll-free)
  - Mail to Canada Vigilance Program, Health Canada, Postal Locator 0701E Ottawa, ON K1A 0K9
- Postage-paid labels and the Canada Vigilance Reporting Form are available at www.healthcanada.gc.ca/medeffect

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October 2020 JB00042CA

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Granby

LA TÉLÉMÉDECINE À L'HEURE DE LA PANDÉMIE À LA COVID-19

Depuis mars 2019 sévit l'importante pandémie à la « COVID-19 ». Depuis cette période il y a eu un confinement important et c'est imposé la distanciation sociale et le port du masque. Ces mesures ont impacté sur le travail de tous et chacun car on nous demandait de sortir que pour des raisons essentielles. Heureusement les mesures ce sont adoucit au fil des mois. Toutefois selon l'évolution récente de la pandémie les mesures sanitaires pourraient se resserrer.

Cette crise sanitaire a favorisé grandement le télétravail. Bien que déjà utilisé par beaucoup de professionnels et entreprises son usage a littéralement explosé et ce à la grandeur de la planète. Et la médecine n'y a pas fait exception. Beaucoup de médecins ont découvert une nouvelle façon de travailler avec ses avantages et inconvénients. Bien que rien ne remplace une consultation en présentiel, beaucoup de celles-ci se faisaient par téléphone ou virtuellement. Évidement les patients nécessitant un examen en personne avec un médecin était possible mais l'affluence aux hôpitaux et cliniques a diminuée de façon impressionnante comme on le souhaitait.

En plus des téléconsultations de nombreuses réunions, webinaires, formations ou colloque ce sont fait presqu'exclusivement en mode virtuel.

En imagerie médicale certaines procédures exigent la présence d'un médecin sur place. Par contre une très bonne partie du travail peut se faire à distance avec le matériel approprié. Tant en radiologie qu'en médecine nucléaire le télétravail ou télémédecine est bien implanté depuis plus d'une dizaine d'années et ce pour les gardes de soir, de nuit ou de fin de semaine.

Certains médecins ont des stations de télémédecine aussi efficaces à leur domicile qu'à l'hôpital ou à leur clinique. Avec l'avancement importante de la technologie, ces stations de télétravail sont disponibles à des prix non prohibitifs. La plupart du temps ces consoles ont les mêmes fonctionnalités

TELEMEDICINE IN THE AGE OF THE COVID-19 PANDEMIC

Since March 2020 the significant "COVID-19" pandemic has raged. From this period, there was significant confinement, social distancing and the wearing of masks were imposed. These measures have impacted on everyone's work because we were only asked to go out for essential reasons. Fortunately, the measures have softened over the months. However, depending on recent developments of the pandemic, health measures could tighten.

This health crisis has greatly favored teleworking. Although already used by many professionals and companies, its use has literally exploded all over the planet. Medicine was no exception; many doctors discovered a new way of working with advantages and disadvantages. Although nothing replaces a face-to-face consultation, many of these were done by phone or virtually. Obviously, patients requiring in-person examination with a doctor was possible, but the flow to hospitals and clinics declined dramatically as expected.

In addition to the teleconsultations, many meetings, webinars, trainings and seminars were held almost exclusively in virtual mode.

qu'en milieu clinique, c'est-à-dire logiciel de dicté, PACS, etc,.

Ces stations de travail peuvent prendre la forme d'une tour avec de multiples écrans ou encore être un portable ou tablette. Cette dernière option permet donc de faire du télétravail n'importe où.

Lorsque la pandémie est arrivée il a été rapide et simple de mettre les nucléistes et radiologiste en télétravail. Il a fallu tout de même augmenter significativement le nombre de station de télétravail. La principale difficulté fut d'obtenir les autorisations informatiques et c'était bien compréhensible vue les demandes tous azimuts de télétravail.

Lors de la pandémie, grâce à ces systèmes de télétravail bien établie, les médecins de l'imagerie ont pu rapidement s'adapter aux mesures de confinements. Cela fut utile aussi pour les médecins mis en quarantaine mais apte à travailler.

Les systèmes de télémédecine permettent en plus du télétravail à domicile, de brancher les systèmes d'imageries dédiés d'hôpitaux distants entre eux. Pour se faire les protocoles d'échange de données doivent être compatibles. L'utilité de ces échanges de données est multiple. Par exemple si un milieu temporairement sans médecin pour faire interprétation ses examens à distance par un autre médecin. On évite de cette façon de déplacer un patient et d'avoir des ruptures de services. Cela permet aussi à deux médecins se

In medical imaging, some procedures require the presence of a physician on site. However, a very good part of the

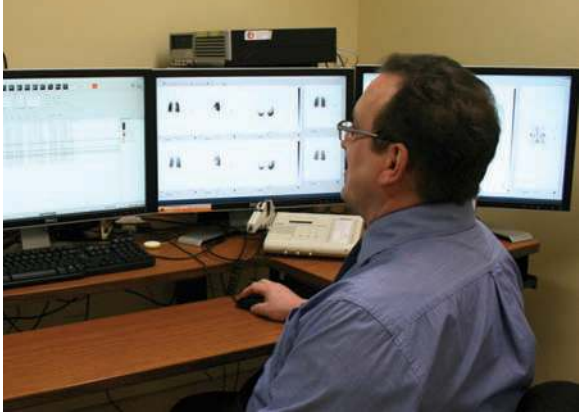
work can be done remotely with the appropriate equipment. In both radiology and nuclear medicine, teleworking or telemedicine has been well established for several years. Whether for evening, night or weekends shifts.

Some doctors have telemedicine workstations that are just as effective in their homes as they are in hospitals or clinics. With the significant advancement in technology, these telecommuting workstations are available at reasonable prices. Most of the time, these consoles have the same functionality as in a clinical setting, i.e. dictation software, PACS, etc.

These workstations can be a tower with multiple screens or even be a laptop or tablet. This last option therefore makes it possible to telework anywhere.

When the pandemic started, it was quick and easy to telecommute the nuclear medicine physicians and radiologists. However, the number of teleworking workstations had to be significantly increased. The main difficulty was getting the computer permissions and that was understandable given the all-out demands for teleworking.

During the pandemic, thanks to these well-established teleworking systems, imaging doctors



situant à des kilomètres de distance de discuter d'un cas compliqué.

Depuis le début de la pandémie les hôpitaux universitaires ont dû composer avec la proximité des résidents et spécialistes dans les salles de lectures. Pour respecter la distanciation sociale dans bien des cas la supervision des résidents a dû se faire à distance. Encore une fois grâce à une télémédecine bien établie en imagerie le déploiement de la technologie a pu se faire rapidement.

Au milieu des années 2000 le gouvernement de la province du Québec a voulu implanter une interface entre les différents système PACS de la province. Cette liaison entre les différents système PACS devait permettre d'échanger d'une façon fluide les examens d'imagerie entre les différents établissements de soins québécois. Malheureusement quinze ans plus tard l'exercice n'a pas été concluant, et principalement en médecine nucléaire. Parallèlement à cela, un groupe informatique dédié à l'informatique en médecine nucléaire le groupe HERMES SOLUTIONS MEDICALES, a développé tranquillement un réseau d'utilisateurs HERMES dans de nombreuse unité de médecine nucléaire québécoise. Ces différents services ayant le système HERMES peuvent donc échanger facilement des données, aussi complexes qu'elles soient. Un des avantages des systèmes HERMES est qu'ils peuvent recueillir des données natives ou non des différentes compagnies œuvrant en médecine nucléaire. Un tel réseau d'utilisateurs comme celui d'HERMES est précieux et surtout en période de pandémie. Avoir de nombreux utilisateurs reliés prévient la découverte, aident aux consultations entre collègues et aide a réaliser des projets de recherches multicentriques.

Cette période de pandémie a amené de nouveaux paradigmes dans le travail hospitalier ainsi que dans les autres sphères de travail. En médecine le télétravail est devenu une nouvelle norme qui ne disparaitra pas lorsque la pandémie sera finie. En médecine la téléconsultation s'avère très utile mais elle ne remplace pas toute une visite en présentiel. Certains réunions scientifiques ou formation se feront virtuellement. En imagerie le télétravail était bien implanté avant la pandémie mais ce fut une belle opportunité pour le consolidé. Médicalement nous seront mieux préparer s'il y a une nouvelle vague de la COVID-19. ■

were able to quickly adapt to containment measures. Very useful also for doctors quarantined, but able to work.

Telemedicine systems allow, in addition to teleworking from home, to connect the dedicated imaging systems of distant hospitals to each other. To do this, exchange protocols must be compatible. The usefulness of these exchanges is manifold. For example, if a site is temporarily without a doctor, exams can be interpreted by another doctor remotely. In this way, we avoid moving a patient and having service disruptions. Also, two doctors standing miles apart discussing a complicated case.

Since the beginning of the pandemic, university hospitals have had to deal with the proximity of residents and specialists in the reading rooms. To respect social distancing, in many cases the supervision of residents had to be done remotely (room nearby or in another establishment). Once again, thanks to a well-established telemedicine in imaging, the deployment of the technology was able to be done quickly to avoid a breakdown in supervision.

In the mid-2000s, the government of the province of Quebec wanted to establish an interface between the various PACS systems in the province. This link between the different PACS systems was supposed to make it possible to exchange imaging examinations in a fluid way between the different healthcare establishments in Quebec. Unfortunately, fifteen years later the exercise was not successful, and mainly in nuclear medicine. At the same time, an IT group dedicated to computing in nuclear medicine, the HERMES SOLUTIONS MEDICALES group, has gradually developed a network of HERMES users in numerous nuclear medicine units in Quebec. These different departments with this computer system can easily exchange data, regardless of the data complexity. One of the advantages of this computer platform is that it can collect data from different companies working in nuclear medicine. Such a network of users of this system is precious, especially during a pandemic. Having a large number of connected users prevents uncovering, helps consultation between colleagues and helps to carry out multicentre research projects.

This period of pandemic brought new paradigms in hospital work as well as in other spheres of work. In medicine, telecommuting has become a new norm that will not go away when the pandemic is over. In medicine, teleconsultation is very useful, but it does not replace an entire face-to-face visit. Some scientific meetings or training will take place virtually. In imaging, teleworking was well established before the pandemic, but it was a great opportunity to consolidate it. Medically, we will be better prepared if there is a new wave of COVID-19. ■

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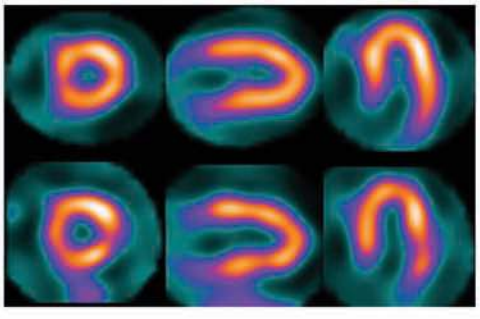
Quand la vitesse compte

Débuter l'imagerie cardiaque plus tôt

- Myoview vous permet de commencer à acquérir des informations diagnostiques tôt, 15 minutes après l'injection*[1]

*Selon la monographie de produit de Myoview, l'imagerie SPECT peut commencer 15 minutes après l'administration de l'agent.



Préparation efficace de la trousse[1]

- Myoview n'a pas besoin d'être bouilli et refroidi, ce qui peut faire gagner du temps avant son administration au patient

Durée de conservation post-reconstituée plus longue

- La durée de conservation de Myoview après reconstitution est de 12 heures[1]

La biodistribution de Myoview peut contribuer à raccourcir les études et les temps d'attente et peut aussi réduire le nombre d'examens répétés[2]

Au cours d'une étude prospective par Ravizzini :

- Il a été démontré que les études au repos et le temps d'étude total sont significativement plus courts avec Myoview[2]
- Les patients recevant Myoview ont subi moins d'examens répétés en raison d'une activité hors du cœur[2]

MYOVIEW™

[Trousse de préparation de la tétrofosmine marquée au technétium 99m (99mTc) pour injection]

Références : 1. Myoview [product monograph], February 12, 2018 (revised August 21, 2019), Control No. 211075.
2. Ravizzini GC, Hanson MW, Shaw LK, et al. Efficiency comparison between 99m Tc-tetrofosmin and 99m Tc-sestamibi myocardial perfusion studies. *Nucl Med Comm*. 2002;23:203-208.

IPM, Imagerie de perfusion myocardique; **TEMP,** tomographie par émission monophotonique.

INDICATIONS ET UTILISATION CLINIQUE DU PRODUIT : Myoview™ [Trousse de préparation de la tétrofosmine marquée au technétium 99m (99mTc) pour injection] est indiqué pour réaliser une scintigraphie myocardique après des administrations séparées sous stress (exercice et (ou) stress pharmacologique) et au repos chez les patients souffrant de coronaropathie connue ou soupçonnée. Il est utile dans la localisation des régions d'ischémie myocardique réversible en présence ou non de tissus myocardiques infarcis. L'épreuve de stress pharmacologique provoquée par du dipyridamole peut constituer une alternative à l'exercice chez les patients qui ne peuvent faire d'exercice adéquatement.

Renseignements importants sur l'innocuité de Myoview

CONTRE-INDICATIONS: Aucune connue. **MISES EN GARDE :** Lorsqu'on réalise des épreuves chez des patients présentant une coronaropathie connue ou soupçonnée, il est nécessaire d'assurer une surveillance cardiaque continue et de disposer des installations nécessaires pour administrer un traitement cardiaque d'urgence. L'usage de Myoview n'est pas recommandé chez les patients présentant une hypersensibilité connue à la tétrofosmine. Des réactions graves d'hypersensibilité et des réactions anaphylactoïdes ont été signalées pour Myoview. Le contenu d'un flacon de Myoview est destiné à être utilisé uniquement dans la préparation de tétrofosmine marquée au technétium 99m en injection et NON à être administré directement au patient. L'induction pharmacologique de stress cardiovasculaire peut être associée à de graves réactions indésirables telles que l'infarctus du myocarde, l'arythmie, l'hypotension, la bronchoconstriction et des accidents cérébrovasculaires. La prudence est de mise lorsque le stress pharmacologique provoqué par du dipyridamole est l'alternative retenue à l'exercice; cette substance doit être utilisée au moment indiqué et conformément à la monographie du produit et aux instructions relatives au dipyridamole (Persantine®). **MISES EN GARDE – Générales :** Des réactions allergiques et une anaphylaxie peuvent survenir avec Myoview. L'injection de tétrofosmine marquée au technétium 99m, comme c'est le cas de tout médicament radioactif, doit être manipulée avec précaution et des mesures de sécurité appropriées doivent être utilisées pour réduire au minimum l'exposition aux rayonnements pour le personnel clinique. Le contenu de cette trousse n'est pas radioactif. Cependant, après l'ajout du pertechnétate de sodium Tc-99m, un blindage adéquat de la préparation finale doit être maintenu pour réduire au minimum l'exposition aux rayonnements pour les travailleurs et les patients. Des précautions doivent également être prises pour réduire au minimum l'exposition des patients aux rayonnements, conformément à une prise en charge appropriée des patients. Afin de réduire au minimum la dose de rayonnements dans la vessie, les patients doivent être encouragés à vider leur vessie lorsque l'examen est terminé et aussi souvent que possible par la suite. Une hydratation adéquate doit être encouragée pour permettre des mictions fréquentes. Les réactions de marquage du Tc-99m dépendent du maintien de l'étain (ion stanneux) à l'état réduit. Par conséquent, les oxydants contenant du pertechnétate de sodium Tc-99m ne doivent pas être utilisés. Les produits radiopharmaceutiques devraient être utilisés uniquement par les praticiens dûment qualifiés dans l'utilisation de substances radioactives prescrites chez ou sur les humains. Les composants du flacon de réactif sont stériles et apyrogènes. Il est essentiel que l'utilisateur suive attentivement les instructions et applique une technique aseptique stricte. **Interactions médcamenteuses :** Les interactions médicamenteuses n'ont pas été notées et n'ont pas été étudiées dans les études cliniques au cours desquelles Myoview a été administré à des patients recevant un traitement concomitant. Des médicaments tels que les bêtabloquants, les inhibiteurs des canaux calciques et les nitrates peuvent influencer le fonctionnement du myocarde et la circulation sanguine. Les effets de ces médicaments sur les résultats d'imagerie ne sont pas connus. **Carcinogenèse, mutagenèse, altération de la fertilité :** Aucune étude n'a été menée pour évaluer le potentiel cancérogène ou les effets sur la fertilité. Le sulfosalicylate de tétrofosmine n'était pas mutagène *in vitro* dans le test d'Ames, le lymphome de souris ou les tests de lymphocytes humains, ni clastogène *in vivo* dans le test des micronoyaux chez la souris. **Utilisation chez les femmes enceintes :** Étant donné qu'aucune étude adéquate sur la reproduction n'a été réalisée chez l'animal pour déterminer si ce médicament affecte la fertilité des mâles ou des femelles, s'il a un potentiel tératogène ou s'il a des effets indésirables sur le fœtus, cette préparation radiopharmaceutique ne doit pas être administrée aux femmes enceintes, sauf si l'on considère que le les avantages l'emportent sur les dangers potentiels. **Femmes qui allaitent :** Le pertechnétate de technétium Tc-99m peut être excrété dans le lait maternel. Lorsqu'une évaluation du rapport avantage/risque suggère l'utilisation de ce produit chez les mères qui allaitent, le lait maternel doit être remplacé par du lait maternisé. **Utilisation pédiatrique :** Il n'existe pas d'études adéquates pour soutenir l'utilisation de ce produit radiopharmaceutique chez les enfants. **RÉACTIONS INDÉSIRABLES :** Les événements suivants ont été observés chez moins de 1 % des patients à l'étude : Angine de poitrine, hypertension, torsades de pointes, rougeurs, vomissements, douleur/gêne abdominale, allergie cutanée, hypotension, dyspnée, goût de métal, sensation de brûlure dans la bouche, sentir une odeur et vision anormale. Il y avait une faible fréquence (moins de 4 %) d'une augmentation transitoire et cliniquement non significative du nombre de leucocytes après l'administration de l'agent. **Pharmacovigilance :** Les réactions indésirables comprenaient une hypersensibilité, un choc anaphylactique ou anaphylactoïde, une réaction anaphylactique ou anaphylactoïde, une altération du goût, des étourdissements, une tachycardie, des douleurs thoraciques, une hypotension, une dyspnée, un bronchospasme, un serrement de la gorge, une toux, des nausées, des vomissements, des douleurs abdominales, de l'urticaire, des démangeaisons, des éruptions cutanées et un œdème de Quincke.

Avant l'administration de Myoview, veuillez lire la monographie complète du produit, disponible en appelant au 1 800 654-0118 (option 2, puis option 3).

Pour signaler des RÉACTIONS INDÉSIRABLES SOUPÇONNÉES, contactez GE Healthcare au 1 800 654-0118 (option 2, puis option 1), ou écrivez à l'adresse courriel canadainfo@ge.com pour demander un formulaire de signalement des réactions indésirables, ou encore envoyez une demande de formulaire par télécopieur au 905 847-5849. Les réactions indésirables peuvent également être signalées à Santé Canada comme suit :

- En ligne sur le site Web www.santecanada.gc.ca/medeffet
- Par téléphone au 1 866 234-2345 (sans frais)
- En remplissant un formulaire de déclaration du programme Canada Vigilance et en l'envoyant
  - par télécopieur au 1 866 678-6789 (sans frais);
  - par la poste au programme Canada Vigilance, Santé Canada, localisateur postal 0701E Ottawa, ON K1A 0K9
- Les étiquettes avec frais de port et le formulaire de déclaration de Canada Vigilance sont disponibles au www.santecanada.gc.ca/medeffet

MYOVIEW™

[Trousse de préparation de la tétrofosmine marquée au technétium 99m (99mTc) pour injection]

Novembre 2020 JB00042CA

ASSOCIATION DES MÉDECINS SPÉCIALISTES EN MÉDECINE NUCLÉAIRE DU QUÉBEC

Dr. Norman Laurin
Président

Je suis très heureux de vous présenter le nouveau comité exécutif de l'Association des Médecins Spécialistes en Médecine Nucléaire du Québec (AMSMNQ). La présence d'une première femme au sein du comité était attendue depuis longtemps. C'est chose faite avec l'arrivée de Dre Karine Provost. Les défis posés par la pandémie de COVID-19 sont gigantesques, et ensemble nous serons en meilleure posture pour les affronter. Je ne me souviens pas d'une telle période d'effervescence en médecine nucléaire au Québec. Nous avons lieu d'être optimistes, malgré les défis importants auxquels nous faisons face. D'abord le déploiement de la TEP a été un succès dont nous pouvons être fiers. Avec 22 appareils en fonction (hormis ceux du privé et ceux dédiés à la recherche), le Québec est le chef de file au Canada pour le financement public de la TEP. L'arrivée de nouveaux traceurs (TEP et non TEP) homologués par Santé Canada a élargi l'investigation pour plusieurs pathologies. Nous sommes à l'aube d'une révolution en théranostique pour les tumeurs neuro-endocrines et pour le cancer de la prostate. Les nouveaux appareils TEP vont permettre une résolution anatomique, une productivité et une amélioration notable de la dosimétrie. Presque toutes les caméras à scintillation vendues au Québec sont des caméras hybrides SPECT-TDM, ce qui confirme l'adoption de l'imagerie hybride par nos membres et les médecins référents. Bref, beaucoup d'éléments positifs. Parmi nos plus grands défis, on doit mentionner la pénurie de technologues en médecine nucléaire, la complexité de l'approbation des radiopharmaceutiques par Santé Canada (nouveaux et anciens), et la pérennité du financement public du système de santé universel dont jouissent tous les Canadiens. La situation des finances publiques qui se sont détériorées avec la pandémie nous préoccupe beaucoup car elle aura nécessairement un impact sur le financement du système de santé. L'AMSMNQ va continuer de collaborer avec l'Association Canadienne de Médecine Nucléaire (ACMN/CANM) dans plusieurs dossiers, dont celui de la certification des spécialistes en médecine nucléaire par le Collège Royal, l'élaboration des guides de bonne utilisation des examens de médecine nucléaire, et le développement de la théranostique.

Je n'ai aucun doute que chacun d'entre nous saura se consacrer à l'avancement de la médecine nucléaire et à la défense de nos patients. Ensemble, nous sommes capables du meilleur.

I am very happy to present to you the new executive committee of the Association des Médecins Spécialistes en Médecine Nucléaire du Québec (AMSMNQ). The presence of a first woman on the committee was long overdue. We are proud to announce the arrival of Dr. Karine Provost. The challenges posed by the COVID-19 pandemic are enormous, and together we will be in a better position to face them. I do not remember such a period of effervescence in nuclear medicine in Quebec. We have reason to be optimistic, despite the significant challenges we face. First, the deployment of PET was a success of which we can be proud. With 22 devices in operation (except those for the private sector and those dedicated to research), Quebec is the leader in Canada for public financing of PET. The arrival of new tracers (PET and non-PET) approved by Health Canada has broadened the investigation for several pathologies. We are on the cusp of a theranostics revolution for neuroendocrine tumors and prostate cancer. The new PET devices will allow anatomical resolution, productivity and a significant improvement in dosimetry. Almost all scintillation cameras sold in Quebec are hybrid SPECT-TDM cameras, which confirms the adoption of hybrid imaging by our members and referring physicians. In short, a lot of positive things. Among our greatest challenges are the shortage of nuclear medicine technologists, the complexity of Health Canada approval of radiopharmaceuticals (new and old), and the sustainability of public funding for the universal health care system enjoyed by all Canadians. The situation of public finances, which deteriorated with the pandemic, is of great concern to us because it will necessarily have an impact on the financing of the health system. The AMSMNQ will continue to collaborate with the Canadian Association of Nuclear Medicine (ACMN / CANM) on several issues, including the certification of nuclear medicine specialists by the Royal College, the development of guides for the proper use of nuclear medicine exams and the development of theranostics.

I have no doubt that each of us will be dedicated to the advancement of nuclear medicine and to the defense of our patients. Together, we are capable of the best.

AMSMNQ

ASSOCIATION DES MÉDECINS SPÉCIALISTES EN MÉDECINE NUCLÉAIRE DU QUÉBEC

AMSMNQ

L'IMAGERIE PERSONNALISÉE PAR LA MÉDECINE NUCLÉAIRE

« La mission du comité de développement professionnel continu (DPC) de l'Association des médecins spécialistes en médecine nucléaire du Québec (AMSNMQ) est de soutenir les médecins nucléistes à acquérir et à préserver leur expertise médicale, ainsi qu'à améliorer leurs compétences de collaboration et de communication dans le but de prioriser la qualité des soins aux patients. »

COMITÉ EXÉCUTIF

Dr. Norman Laurin
Président

Dr. Frédéric Arsenault
Secrétaire

Dr. Karine Provost
Conseillière

Dr. Anthony Ciarollo
Trésorier

Dr. Éric Turcotte
Conseillier

Dr. Francois Lamoureux
Président sortant (invité)

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Médico Nuclear
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Hospital Universitario
Columbia
South América

MEDICINA NUCLEAR EN AMILOIDOSIS CARDÍACA

La Amiloidosis es una enfermedad sistémica en la cual se depositan fibrillas insolubles en varios órganos a nivel extracelular, fibrillas que están compuestas de proteínas que tienen un plegamiento anormal. Frecuentemente, la Amiloidosis compromete el corazón, produciendo Amiloidosis Cardíaca (AC), la cual es una de las formas de falla cardíaca progresiva más comunes. En el tejido cardíaco generalmente se comprometen estructuras como las aurículas y ventrículos, las válvulas, vasos pequeños y el sistema de conducción cardíaco, lo cual produce disfunción sistólica y diastólica, arritmias, bloqueos de conducción y falla cardíaca. Esta entidad causante de falla cardíaca es subestimada en muchos pacientes.

El diagnóstico de amiloidosis cardíaca (AC) frecuentemente se demora, por sus manifestaciones clínicas variadas, y dado que los valores de los biomarcadores cardíacos no son específicos, por la poca sospecha clínica de esta enfermedad y por la disponibilidad hasta hace poco de técnicas específicas para su diagnóstico. El tratamiento selectivo también se retarda en estos pacientes por el diagnóstico tardío de la enfermedad.

La AC tiene dos tipos: la amiloidosis de cadenas livianas (AL) y la Amiloidosis Transtiretina (ATTR). La Amiloidosis Transtiretina se puede dividir a su vez en el tipo "salvaje" o Amiloidosis senil y una forma hereditaria con depósitos de Transtiretina mutante. En la Amiloidosis tipo AL, las fibrillas de amiloide se derivan de las cadenas livianas de inmunoglobulina, producidas por una alteración en las células plasmáticas, mientras que en el tipo ATTR se forman a partir de la proteína transtiretina producida en el hígado.

En la Amiloidosis de tipo AL, el compromiso cardíaco es la principal causa de mortalidad (en un 50% de los pacientes) ocasionada por pérdida acelerada de la función contráctil que progresa desde una falla cardíaca con función ventricular preservada hasta una falla cardíaca con fracción de eyección reducida. La AC tiene una sobrevida promedio si no se trata, de menos de 6 meses para el tipo AL y de 3 a 5 años si es amiloidosis de ATTR.

La identificación del tipo de amiloide cardíaco es un verdadero reto y presenta implicaciones en el tratamiento y en el pronóstico de los pacientes. Hasta hace poco, la AC se podía diagnosticar solamente mediante una biopsia endomiocárdica

o con una combinación de biopsia extracardíaca con una ecocardiografía con hallazgos de espesor de la pared del ventrículo izquierdo mayor de 12 mm, sin alguna causa que explicase este hallazgo. Actualmente la biopsia endomiocárdica se reserva para casos equívocos o en pacientes con hallazgos discordantes entre el cuadro clínico y las imágenes.

Importancia del diagnóstico temprano y preciso en AC

Los síntomas de la enfermedad cardíaca por amiloidosis generalmente son inespecíficos y dada la heterogeneidad de su presentación cardíaca, con los diversos subtipos y con las nuevas opciones terapéuticas que están apareciendo en el mercado, se requiere de una técnica de diagnóstico eficaz, rápida y precisa para el tratamiento oportuno de los pacientes.

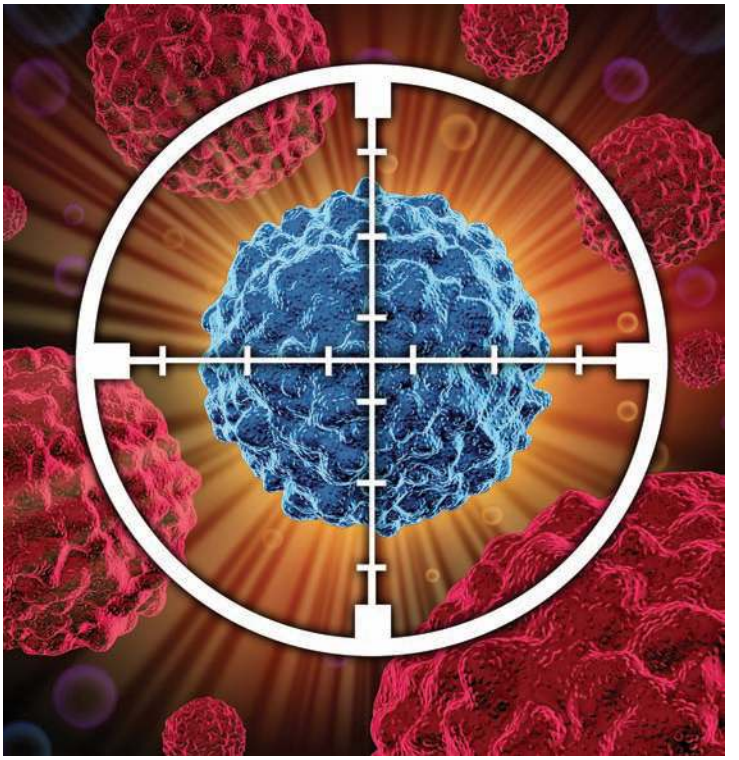
El compromiso cardíaco por amiloidosis de tipo AL predispone a eventos cardíacos adversos importantes. Las imágenes cardíacas en AC tienen la ventaja de identificar pacientes con AL, que tienen alto riesgo de mortalidad y pueden orientar en la elección del tratamiento con agentes para quimioterapia usados de forma temprana. Por el contrario, si se identifica AC de tipo ATTR se puede iniciar de forma oportuna el tratamiento con medicamentos antiamiloides. Por esto, la identificación temprana del compromiso cardíaco en amiloidosis y su caracterización en los tipos AL o ATTR es de vital importancia para instaurar de forma adecuada y oportuna el tratamiento.

Imágenes de Amiloidosis Cardíaca con Medicina Nuclear

La biopsia endomiocárdica es específica y hasta hace poco era la prueba patrón de referencia para el diagnóstico de AC. Sin embargo, su naturaleza invasiva limita su realización como prueba de tamizaje temprano. La tendencia actual es a la realización de pruebas no invasivas y más específicas para caracterizar el compromiso cardíaco en la amiloidosis. La Resonancia Magnética Cardíaca (RMC) con contraste con Gadolinio y mapeo en secuencia T1 tiene una alta resolución, provee imágenes cuantitativas y una adecuada caracterización tisular; sin embargo, aún no está ampliamente disponible, requiere mucha experiencia en su interpretación y puede estar contraindicada en algunos pacientes. Adicionalmente, su utilidad en la diferenciación de los tipos de amiloidosis cardíaca es controversial.

Las imágenes de AC con Medicina Nuclear tienen ventajas importantes: están ampliamente disponibles; no son invasivas, permiten hacer cuantificación, permiten hacer imágenes de todo el corazón para valorar la carga de amiloide y se pueden realizar de forma seriada para valorar la respuesta al tratamiento.

Las imágenes con radioisótopos tienen un papel importante en la valoración de la AC. Actualmente



pueden realizarse varios tipos de imágenes, desde imágenes de la inervación simpática del miocardio; imágenes de perfusión miocárdica hasta imágenes del metabolismo e imágenes de los depósitos de amiloide. La gamagrafía con agentes para la valoración del sistema óseo, utilizando el isótopo radioactivo Tecnecio-99m (^{99}mTc) como el 3,3- ácido difosfo-1,2-propanodicarboxílico (^{99}mTc-DPD), Pirofosfato (^{99}mTc-PYP) y el Hidroximetilen Difosfonato (^{99}mTc-HMDP) han demostrado una buena sensibilidad y especificidad para el diagnóstico de ATTR, permitiendo diferenciar el tipo de AC y proveen un diagnóstico temprano no invasivo en la valoración inicial y en el monitoreo seriado para la valoración de la respuesta al tratamiento. Estos agentes tienen una buena eficacia para el diagnóstico de AC de tipo ATTR, permitiendo hacer el diagnóstico diferencial entre ATTR y AL. La sensibilidad varía entre un 83 a un 100% (con un valor promedio estimado en 92.2%) y la especificidad varía de un 67 a un 100% (con un promedio estimado en 95.4%).

Aunque el mecanismo exacto de la acumulación de los radiofármacos para el sistema óseo en la AC tipo ATTR no está claro, se postula que puede deberse a los iones de calcio; a algunos metales presentes y/o a los grupos sulfidrilo del amiloide ATTR.

Los radiofármacos para gamagrafía ósea tiene mejor valor que otras técnicas imagenológicas como la ecocardiografía y la RMC ya que la gamagrafía permite diferenciar la AC de tipo ATTR de otras formas de enfermedad cardíaca con engrosamiento de la pared ventricular. Sin embargo, la técnica gamagráfica carece de información estructural y hemodinámica, por lo

tanto, la gamagrafía puede usarse en conjunto con la Ecocardiografía y la RMC para un mejor diagnóstico.

El uso de la gamagrafía cardíaca con trazadores óseos en el tamizaje de AC en poblaciones específicas, obtiene resultados importantes: permite diagnosticar AC de tipo ATTR en el 14% de pacientes hospitalizados con falla cardíaca con fracción de eyección preservada; en un 16% de los pacientes que van a ser sometidos a reemplazo valvular aórtico transcatéter y en el 10% de los pacientes con síndrome del túnel del canal del carpo.

Trazadores óseos

^{99}mTc-DPD: es uno de los radiotrazadores más estudiados para las imágenes de AC. Sin embargo, su disponibilidad es limitada y su uso casi que limitado a Europa. Este radiotrazador tiene una alta sensibilidad, cercana al 100%, mayor que la de la ecocardiografía o de la RMC y una especificidad del 100% en el diagnóstico diferencial de ATTR versus AL. Permite estimar la carga de amiloide cardíaco y predice el riesgo de hospitalización por falla cardíaca. También permite detectar captación en los tejidos blandos mediante la realización de gamagrafía de cuerpo entero con mayor sensibilidad que con otros radiotrazadores.

^{99}mTc-HMDP: ha mostrado eficacia diagnóstica cercana a los otros radiotrazadores para el estudio de la AC.

^{99}mTc-PYP: es el único radiotrazador óseo aprobado para uso clínico en amiloidosis en Estados Unidos.

Trazadores de inervación cardíaca

Los pacientes con Amiloidosis tienden a desarrollar disautonomía cardíaca que puede estar causada por infiltración de amiloide en el tejido de conducción cardíaco, tanto en ATTR como en AL. El trazador Metayodobencil Guanidina marcado con yodo – 123 (^{123}I-MIBG), sustancia análoga de la norepinefrina, se usa en la evaluación de la inervación miocárdica. Aunque el ^{123}I-MIBG no se une de forma directa al amiloide, provee información indirecta sobre la infiltración del sistema nervioso simpático cardíaco. Las imágenes de la captación cardíaca de ^{123}I-MIBG pueden detectar cambios en la inervación mucho antes que otras modalidades diagnósticas y tiene un amplio valor en el pronóstico del paciente y en la mortalidad a corto plazo.

Radiotrazadores de PET

Comparativamente con la técnica de SPECT, el PET/CT tiene mejor resolución espacial, y permite realizar una cuantificación mucho más absoluta de la carga de depósito de amiloide, aunque su uso en AC aún es limitado. Los trazadores de PET se pueden clasificar en dos categorías: agentes específicos del amiloide o agentes para el sistema óseo.

Los Radiotrazadores para uso en PET/CT de unión al amiloide son sustancias similares a la Tioflavina-T y son el ^{11}C-PiB; el ^{18}F-Florbetapir, el ^{18}F-Florbetaben y el ^{18}F-Flumetamol, que están aprobados por la FDA en imágenes de la enfermedad de Alzheimer y que han sido usados para imágenes de AC, pero no cuentan con aprobación de la FDA para el diagnóstico de AC y tampoco permiten hacer el diagnóstico diferencial con precisión de AC entre los tipos ATTR y AL. Permiten valorar la captación extracardíaca del amiloide.

Radiofármacos de PET para hueso

Las imágenes de PET con 18F-Fluoruro de Sodio (^{18}F-NAF) son prometedoras para el diagnóstico de AC, dada su mejor resolución espacial y permitiendo diagnosticar el compromiso cardíaco en etapas tempranas de la enfermedad y permitiendo una cuantificación más precisa, con la ventaja sobre otros trazadores de PET de poder diferenciar adecuadamente entre ATTR y AL.

Cuantificación

Para la interpretación de una gamagrafía ósea ante la sospecha de AC, se realizan análisis visuales y semicuantitativos. Para el análisis visual, se recomienda la comparación visual de la captación miocárdica con respecto al tejido óseo, llamado índice de Perugini, en el cual un resultado de 0 refleja la ausencia de captación miocárdica, el grado 1 es la captación miocárdica menor que la captación en costillas; el grado 2 es la captación miocárdica similar a la captación costal y el grado 3 es la captación miocárdica mayor que la captación costal. Se considera positivo para ATTR un índice mayor o igual a 2.

Para los índices semicuantitativos se han usado varias técnicas, como la retención cardíaca; la captación cardíaca correlacionada con la captación en todo el cuerpo; la relación de captación corazón versus cráneo o la relación de captación corazón versus captación en el tórax contralateral, siendo este último considerado mejor que el análisis visual.

Esta técnica semicuantitativa de las imágenes planares con radiofármacos para gamagrafía ósea (^{99}mTc-PYP; ^{99}mTc-DPD o ^{99}mTc-HMDP) se realiza mediante el índice de captación del miocardio versus el pulmón contralateral, tanto en las imágenes tempranas (de 1 hora) como en las tardías (3 horas). Valores de cuantificación mayores de 1.5 en las imágenes de 1 hora de inyección del radiotrazador y mayores de 1.3 en las imágenes tardías, permiten diferenciar con gran precisión la ATTR de la AL con una sensibilidad del 97% y una especificidad del 100%

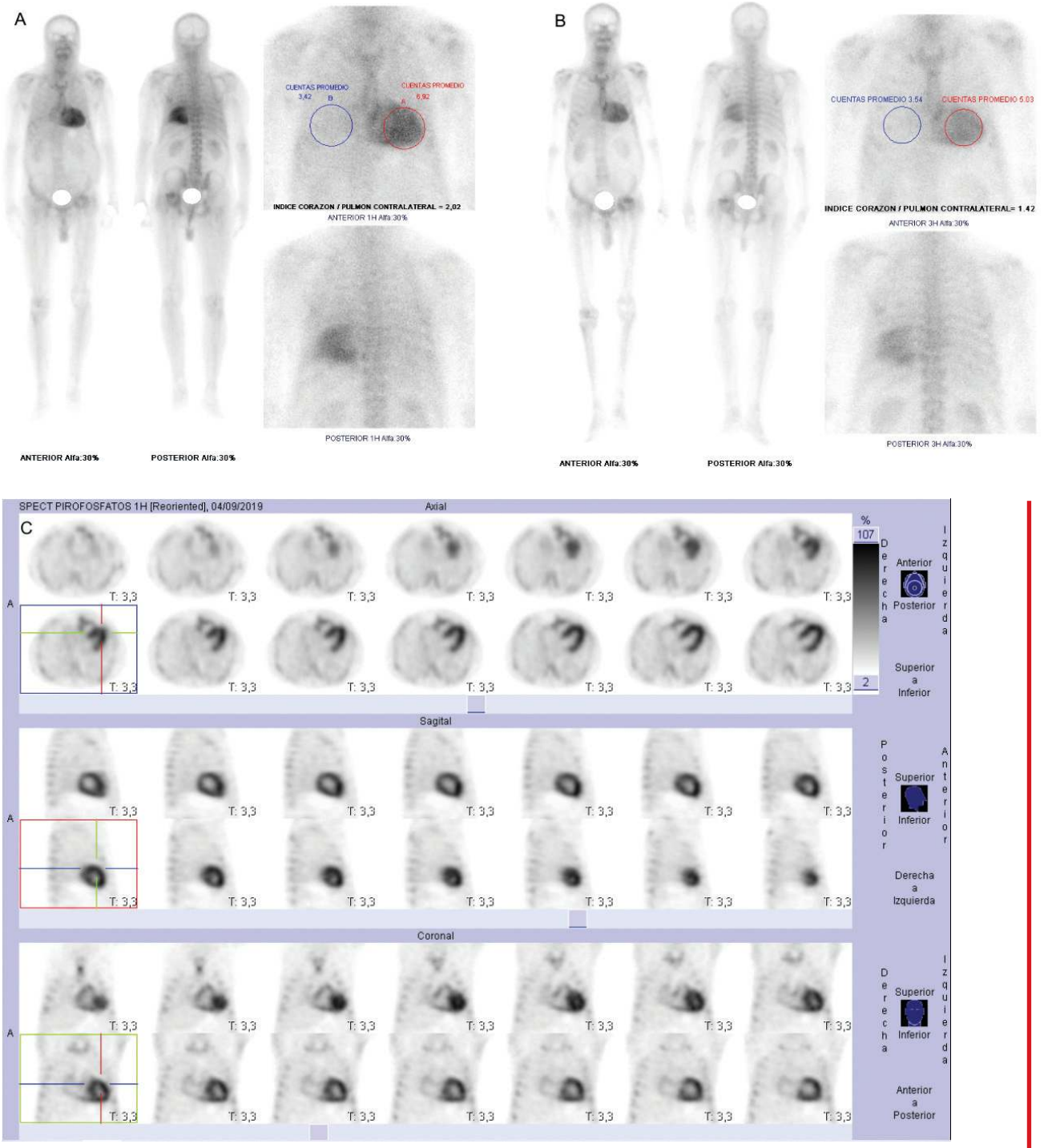


Figura 1.
Paciente de 55 años, con falla cardíaca con fracción de eyección preservada. Con sospecha de Amiloidosis cardíaca.

Gamagrafía ósea con 99mTc – Pirofosfato, 20 mCi de Tecnecio-99m. Imágenes de cuerpo entero, tórax anterior y posterior 1 hora después de la administración del radiofármaco (A) y 3 horas después (B). SPECT de tórax (C).

Índice de PERUGINI de 3 en las imágenes de 1 y 3 horas (captación cardíaca mayor que la captación costal). Índices de cuantificación corazón/pulmón contralateral positivos (mayor de 1.5 en la imagen de 1 hora y mayor de 1.3 en la imagen de 3 horas).

Conclusión: estudio compatible con Amiloidosis Cardíaca, de tipo ATTR.

Indicaciones para las imágenes de Medicina Nuclear con radiofármacos para el sistema óseo:

- Pacientes con falla cardíaca y aumento inexplicado del espesor de la pared del ventrículo izquierdo.

- Afroamericanos mayores de 60 años con falla cardíaca sin explicación o con espesor de la pared del ventrículo izquierdo mayor de 12 mm.

- Pacientes mayores de 60 años con falla cardíaca sin causa aparente y con fracción de eyección preservada.

- Ancianos, especialmente de sexo masculino con neuropatía sin causa aparente, con túnel del canal del carpo bilateral o fibrilación auricular sin los factores de riesgo asociados a ésta y signos o síntomas de falla cardíaca.

- Evaluación del compromiso cardíaco en pacientes con amiloidosis hereditaria sospechada o conocida.

- Diagnóstico de ATTR en pacientes con resultados compatibles con AC en una ecocardiografía o resonancia magnética cardíaca.

- Pacientes con sospecha de ATTR y contraindicaciones para la realización de una resonancia magnética cardíaca (insuficiencia renal o la presencia de un dispositivo metálico implantable).

- Valoración del riesgo de eventos cardíacos en pacientes con AC conocida.

- Valoración de la progresión de la enfermedad y valoración de la respuesta al tratamiento.

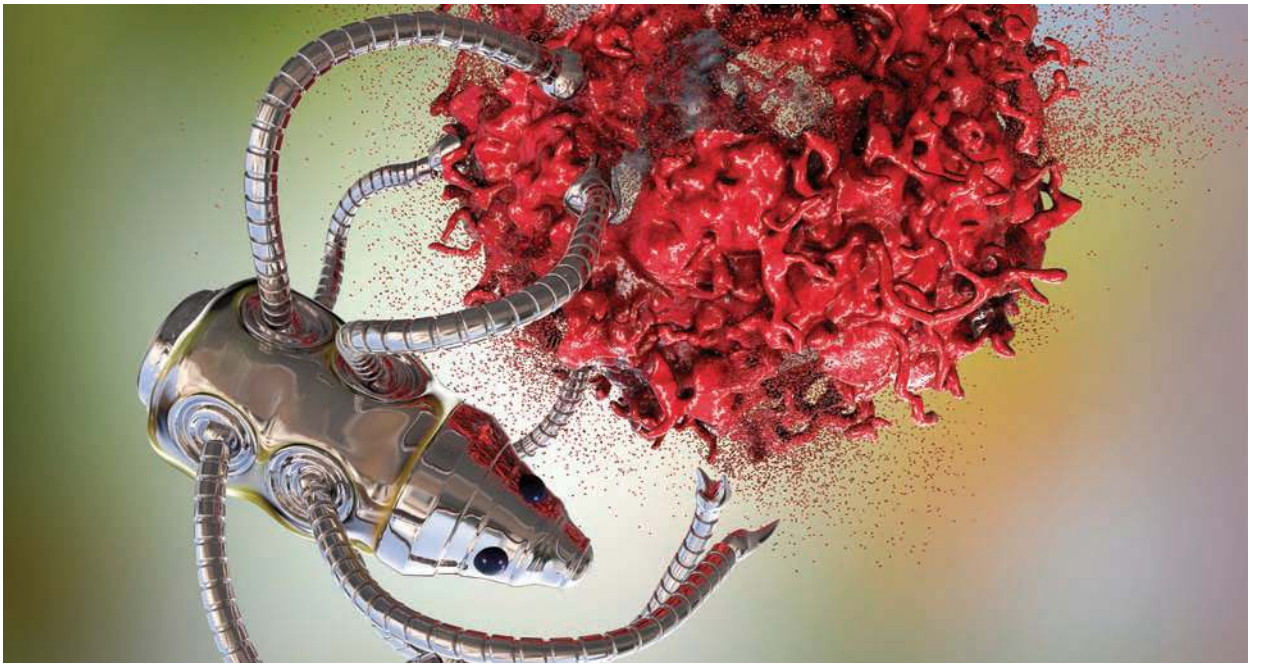
Tratamiento de la Amiloidosis cardíaca

Los tratamientos disponibles están dirigidos a reducir la producción o a estabilizar a la proteína precursora de los depósitos de amiloide y por lo tanto detener o disminuir la acumulación de amiloide. En la AL el tratamiento se dirige contra las células plasmáticas productoras de cadenas livianas. Recientemente medicamentos que silencian el gene de oligonucleótidos que inhiben la síntesis hepática del precursor de la proteína transtiretina han demostrado eficacia en la amiloidosis ATTR, con detención de la progresión de polineuropatía periférica y de la progresión de las manifestaciones cardíacas, incluso con reversión del compromiso cardíaco.

Conclusiones

El diagnóstico oportuno de la AC, en especial la del subtipo ATTR es más importante ahora que en el pasado. Los radiotrazadores para el sistema óseo útiles para imágenes cardíacas de amiloidosis han demostrado la habilidad de la medicina nuclear para el diagnóstico específico, temprano y no invasivo de la AC de tipo ATTR, evitando el uso de biopsia endomiocárdica.

La gamagrafía ósea para AC permite el tamizaje de poblaciones específicas con alto riesgo de AC de tipo ATTR. Los pacientes con falla cardíaca pueden ser diagnosticados por primera vez y de forma oportuna con AC de tipo ATTR y ser estratificados mediante el uso de esta técnica semicuantitativa, lo cual permite el uso temprano de nuevas terapias dirigidas y específicas que modificarán el curso de la enfermedad, mejorando el pronóstico, disminuyendo la cantidad de hospitalizaciones y mejorando y la sobrevida de los pacientes. ■



CANM ACMN

The Canadian Association of Nuclear Medicine
Association canadienne de médecine nucléaire

In the investigation of movement disorders in which Dopamine transporter loss is a potential component, most commonly Parkinsonism, and there is diagnostic uncertainty, imaging with 123I-ioflupane can provide important information. As a Health Canada approved imaging agent is now available, the Canadian Association of Nuclear Medicine has produced this set of guidelines to aid clinicians in utilizing and performing the test in the evaluation and treatment of Canadian patients. It has been produced by a group of expert Nuclear Medicine Physicians and Movement Disorder Neurologists assessing best practices in Canada, Europe and the United States.

L'évaluation de la densité des récepteurs dopaminergiques est un paramètre déterminant dans l'évaluation des troubles du mouvement, particulièrement pour le diagnostic de la maladie de Parkinson et des syndromes parkinsoniens. De nombreuses études cliniques ont démontré la contribution de l'imagerie scintigraphique des noyaux caudés et du pallidum au moyen de la molécule d'ioflupane marquée à l'iode 123. L'administration intraveineuse de ce radiopharmaceutique qui est maintenant approuvé par Santé Canada permet de quantifier la densité de ces récepteurs et procure au cliniciens un outil diagnostique précieux pour l'évaluation des troubles du mouvement.

L'Association Canadienne de Médecine Nucléaire a demandé à un groupe d'experts en médecine nucléaire et en neurologie d'établir des lignes directrices pour l'utilisation de l'ioflupane en pratique clinique au Canada sur base des pratiques médicales en vigueur au Canada, en Europe et aux Etats-Unis.

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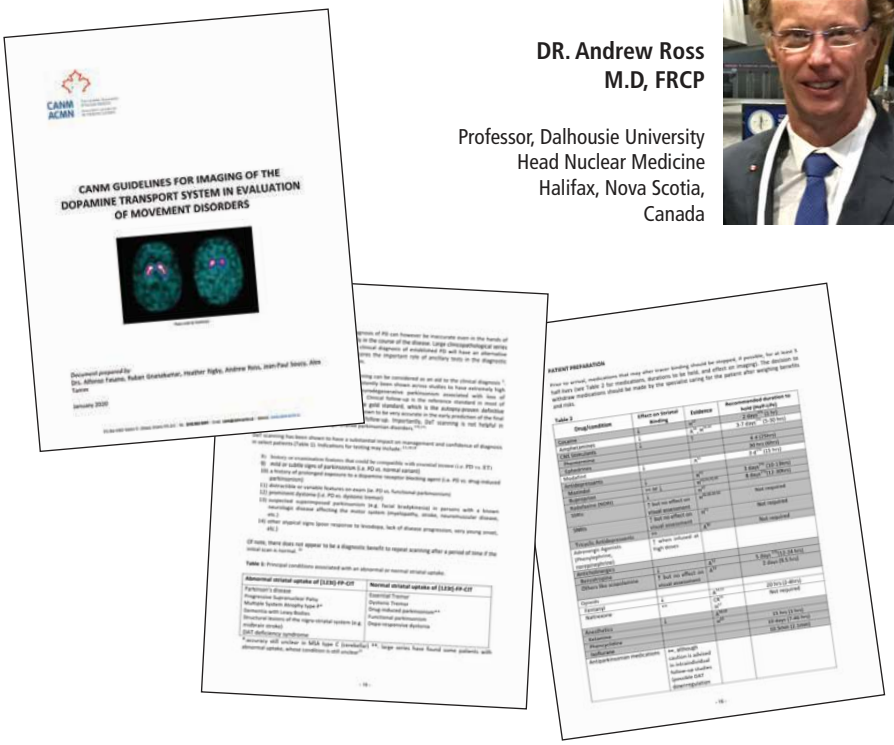

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CANM GUIDELINES FOR IMAGING OF THE DOPAMINE TRANSPORT SYSTEM IN EVALUATION OF MOVEMENT DISORDERS

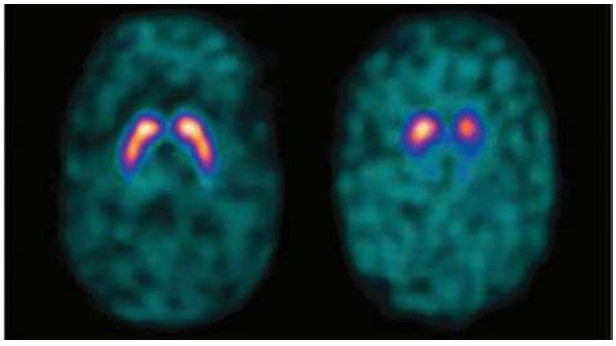

Photo credit GE Healthcare

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January 2020

ABSTRACT

In the investigation of movement disorders in which Dopamine transporter loss is a potential component, most commonly Parkinsonism, and when there is diagnostic uncertainty, imaging with 123I-ioflupane can provide important information. It is recommended in the following situations:

1) history or examination features that could be compatible with essential tremor (i.e. PD vs. ET)
2) mild or subtle signs of parkinsonism (i.e. PD vs. normal variant)
3) a history of prolonged exposure to a dopamine receptor blocking agent (i.e. PD vs. drug-induced parkinsonism)
4) distractible or variable features on exam (ie. PD vs. functional parkinsonism)
5) prominent dystonia (i.e. PD vs. dystonic tremor)
6) suspected superimposed parkinsonism (e.g. facial bradykinesia) in persons with a known neurologic disease affecting the motor system (myelopathy, stroke, neuromuscular disease, etc.)
7) other atypical signs (poor response to levodopa, lack of disease progression, very young onset, etc.)

The only contraindications include:

Absolute:

1. Pregnancy.
2. Inability to cooperate with brain imaging.
3. Known hypersensitivity to the active substance or to any of its excipients. An iodine allergy is not an absolute contraindication.

Relative:

1. Breastfeeding.

Patient preparation, obtaining history and ensuring the patient is not on interfering agents is vital. Additionally, exam acquisition parameters and patient positioning are an integral component to obtaining a diagnostic exam and should be followed.

The report should provide an overall impression of scan as Normal or Abnormal.

Interpretation can involve both qualitative assessment and semiquantitative analyses by physicians trained to assess the images.

The referring clinician can then utilize the results of the 123I-ioflupane scan to best manage the patient's condition.

RÉSUMÉ

CANADIAN ASSOCIATION OF NUCLEAR MEDICINE GUIDELINES FOR IMAGING OF THE DOPAMINE TRANSPORT SYSTEM IN EVALUATION OF MOVEMENT DISORDERS

INTRODUCTION

The Canadian Association of Nuclear Medicine (CANM) strives for excellence in the practice of diagnostic and therapeutic nuclear medicine by promoting the continued professional competence of nuclear medicine specialists, establishing guidelines of clinical practice, and encouraging biomedical research. We work with all professionals in

nuclear medicine to ensure that Canadians have access to the highest quality nuclear medicine services.

These practice guidelines have been developed with input from clinician experts in movement disorders as well as neuroimaging through a consensus process and have been extensively reviewed and approved by the CANM Board of Directors. They are proposed as a reference tool to clinicians dealing with patients with movement disorders to help provide appropriate care. They are not considered to be inflexible rules or requirements of practice. The final decision regarding the ordering and use of any procedure or course of action is made by the clinician based on the situation and the clinician's judgement. These guidelines are intended for clinicians as well as nuclear medicine physicians to aid in understanding the test, provide guidance with appropriate ordering as well as for interpretation and reporting.

Clinical diagnosis of Parkinsonism is straightforward and arrived at based on clinical observations without the use of additional tests in the vast majority of cases. However, for incomplete syndromes, or an overlap between multiple concurrent conditions especially in early stage presentation, utilizing imaging of the dopamine transport system provides an improvement in diagnostic accuracy.[1,2,3]

N-v-fluoropropyl-2b-carbomethoxy-3b-(4-123I-iodo-phenyl) nortropane (123I-ioflupane) is a molecular imaging agent used to demonstrate the location and concentration of cell membrane dopamine transporters (DaTs) located on axon terminals of nigral dopaminergic projection neurons. It has shown efficacy for detecting degeneration of the dopaminergic nigro-striatal pathway, allowing better separation of patients with essential tremor from those with Parkinsonian syndromes, as well as differentiating between some causes of Parkinsonism (e.g. functional/psychogenic or iatrogenic forms).

This document provides information and guidance for the indications, technical aspects, interpretation, and reporting of DaT single photon emissions computed tomography (SPECT) scans with 123I-ioflupane. These have been developed using the previous work of the European Association of Nuclear Medicine and the Society of Nuclear Medicine and Molecular Imaging.[4,5,6]

INDICATIONS

Making a diagnosis of idiopathic Parkinson's disease (PD) generally relies on the identification of cardinal motor signs and the absence of features indicative of another disease with the support of levodopa responsiveness. In the vast majority of cases, the diagnosis of PD can be made based entirely on the clinical assessment. Up until 2015, the most widely accepted clinical criteria for PD diagnosis was the UK Brain bank criteria.[6] In 2015, the International Parkinson and Movement Disorder Society published new guidelines that have been implemented in the 2nd edition of the Canadian Guideline for PD.[7,8]

The clinical observations useful in the diagnosis of PD can however be inaccurate even in the hands of experienced neurologists, particularly early in the course of the disease. Large clinicopathological series estimate that 10-25% of patients with a clinical diagnosis of established PD will have an alternative diagnosis at autopsy.[6,9,10,11] This underscores the important role of ancillary tests in the diagnostic work-up of select patients with Parkinsonism.

In cases of diagnostic uncertainty, DaT scanning can be considered as an aid to the clinical diagnosis[3]. Abnormal uptake of [123I]-FP-CIT has consistently been shown across studies to have extremely high sensitivity and specificity in cases of neurodegenerative parkinsonism associated with loss of nigrostriatal dopamine neurons.[12,13,14,15,16,17]

Clinical follow-up is the reference standard in most of these studies but is only a surrogate of the gold standard, which is the autopsy-proven definitive diagnosis. However, DaT imaging has been shown to be very accurate in the early prediction of the final clinical diagnosis obtained after long term follow-up. Importantly, DaT scanning is not helpful in differentiating between neurodegenerative parkinsonian disorders.[17b,17c]

DaT scanning has been shown to have a substantial impact on management and confidence of diagnosis in select patients (Table 1). Indications for testing may include:[3,5,18,19]

1) history or examination features that could be compatible with essential tremor (i.e. PD vs. ET)
2) mild or subtle signs of parkinsonism (i.e. PD vs. normal variant)
3) a history of prolonged exposure to a dopamine receptor blocking agent (i.e. PD vs. drug-induced parkinsonism)
4) distractible or variable features on exam (ie. PD vs. functional parkinsonism)
5) prominent dystonia (i.e. PD vs. dystonic tremor)
6) suspected superimposed parkinsonism (e.g. facial bradykinesia) in persons with a known neurologic disease affecting the motor system (myelopathy, stroke, neuromuscular disease, etc.)
7) other atypical signs (poor response to levodopa, lack of disease progression, very young onset, etc.)

Of note, there does not appear to be a diagnostic benefit to repeat scanning after a period of time if the initial scan is normal.[20]

Table 1: Principal conditions associated with an abnormal or normal striatal uptake.

Abnormal striatal uptake of [123I]-FP-CIT	Normal striatal uptake of [123I]-FP-CIT
Parkinson's disease	Essential Tremor
Progressive Supranuclear Palsy	Dystonic Tremor
Multiple System Atrophy type P*	Drug-induced parkinsonism**
Dementia with Lewy Bodies	Functional parkinsonism
Structural lesions of the nigro-striatal system (e.g. midbrain stroke)	Dopa-responsive dystonia
DAT deficiency syndrome	

*:accuracy still unclear in MSA type C (cerebellar) **: large series have found some patients with abnormal uptake, whose condition is still unclear

Variable findings

DaT imaging is a reliable surrogate of nigro-striatal degeneration and some conditions (PD in particular) are always associated with it, thus explaining the diagnostic role of SPECT scans with ^{123}I-ioflupane. In some condition however, the impairment of the nigro-striatal fiber is variable and so is the striatal uptake.

'Vascular parkinsonism' has undergone a drastic nosologic revision in recent years and it is now acknowledged that it is often an over-

diagnosed condition in patients with degenerative diseases also featuring vascular changes of the white matter (the so-called "pseudovascular parkinsonism").[22] In some cases of pseudovascular parkinsonism a more diffuse and symmetrical reduction of uptake is observed[23] often with irregularities in the profile of the putamen. In "definite" vascular parkinsonism there is an ischemic or hemorrhagic stroke involving the substantia nigra and/or nigrostriatal pathway and DaT imaging is positive. Most of these cases are unilateral parkinsonism. By contrast, DaT is normal in "vascular pseudoparkinsonism" (e.g., akinetic mutism resulting from bilateral mesial frontal strokes or apathetic depression from bilateral striatal lacunar strokes).[24]

Cortico-basal syndrome (CBS) is the most challenging movement disorder from a diagnostic standpoint as its underlying pathology is cortico-basal degeneration only in a minority of cases (other being caused by progressive supranuclear palsy (PSP), Alzheimer or even prion pathology). Not surprisingly DaT imaging is variable depending on the underlying pathology, with some cases showing normal uptake.[25]

A similar scenario is seen in **orthostatic tremor** (OT), in which an abnormal DaT is supposed to be found in the so-called 'plus' forms (as opposed to primary or secondary forms), occurring when OT is associated with PD or other cases of degenerative parkinsonism.[26]

Likewise, **primary progressive freezing of gait** may herald many different degenerative processes and an abnormal DaT is seen in cases caused by PSP pathology while a normal uptake is more often seen in cases evolving towards CBS or motor neuron diseases.[27]

Holmes tremor is another heterogenous condition supposedly caused by a strategic (usually vascular) lesion involving both the nigrostriatal system and the cerebello-thalamic fibers. However, due to the variability of lesions, a normal DaT study is still possible (e.g. in case of lesions not involving the midbrain).[28]

Many other conditions are associated with variable involvement of the nigra which therefore present with different DaT imaging appearances (e.g. Huntington disease) and in some cases an improvement of the uptake has been reported following treatment, such as in Normal Pressure Hydrocephalus (NPH). Not many papers have explored the role of DaT imaging in NPH but the following scenarios can be hypothesized: 1) an abnormal uptake in patients with co-existing PD or other degenerative conditions involving the pars compacta of the substantia nigra, 2) an abnormal uptake in patients mistakenly diagnosed with NPH while having PD or other degenerative conditions involving the pars compacta of the substantia nigra, 3) a normal uptake (e.g. in the so-called "pseudovascular pseudoparkinsonism"[29], and 4) an abnormal uptake caused by the mechanical compression of the fiber reaching the putamen.

The role of DaT imaging in research

DaT imaging has different roles in research protocols, some of which is still not fully explored but at least 5 principal applications can be listed here:

1. DaT imaging as a biomarker to assess PD progression, for example, in the Parkinson Progression Marker Initiative funded by the Michael J Fox Foundation[30]
2. Study of the regional differences in uptake to understand different PD presentations
3. Use of DaT imaging as endophenotype in populations at risk of developing PD, such as carriers of genetic mutation[31] or patients with REM sleep behavioral disorder
4. DaT scanning can be used as a marker of the protective effect of surgical[32] or pharmacological treatment.[33]

As for the last point, it should be emphasized that the DaT expression is influenced by factors other than number of dopaminergic neurons (e.g. up or downregulation influenced by drugs), thus its role in proving a disease modifying effect is object of debate.

CONTRAINDICATIONS

Absolute:

1. Pregnancy.
2. Inability to cooperate with brain imaging.
3. Known hypersensitivity to the active substance or to any of its excipients. An iodine allergy is, however, not an absolute contraindication to receiving this radiotracer.

Relative:

Breastfeeding. If possible, consider delaying the examination until breastfeeding has ceased. It is unknown if ioflupane is secreted in human milk, therefore, if administration is considered necessary, breast-feeding should be interrupted for a minimum of 1 day and up to 6 days.[34,35,36]

REQUEST/REQUISITION SUGGESTED FORMAT

The suggested format for the requisition is to have boxes to allow the referring clinician to provide the following information:

a. Description of patient symptoms and clinical question
   - For neurological symptoms, specify the type, duration, and right or left sidedness

b. Relevant past medical history
   - This would include history of brain surgery, trauma or tumor, stroke, psychiatric illness and epilepsy

c. List of current medications
   - For any medications that may affect tracer binding (see below), indicate when the medication was last taken

d. History of use of recreational drugs that affect tracer binding (see below)
   - If so, indicate when it was last taken

e. Previous brain imaging studies, including date and location of study
   - This should include CT, MRI, SPECT, PET

f. Can the patient lie still for 30-45 minutes for the test?

PATIENT PREPARATION

Prior to arrival, medications that may alter tracer binding should be stopped, if possible, for at least 5 half-lives (see Table 2 for medications, durations to be held, and effect on imaging). The decision to withdraw medications should be made by the specialist caring for the patient after weighing benefits and risks.

Table 2

Drug/condition	Effect on Striatal Binding	Evidence	Recommended duration to hold (Half-Life)
Cocaine	↓	H[37]	2 days[37b] (1 hr)
Amphetamines	↓	A[38], H[39,40]	3-7 days[37b] (5-30 hrs)
CNS Stimulants	↓	T	
Phentermine			6 d (25hrs)
Ephedrines			30 hrs (6hrs)
Modafinil	↓	A[41]	3 d[37b] (15 hrs)
Antidepressants			
Mazindol	↓	H[42]	3 days[37b] (10-13hrs)
Buproprion	↔ or ↓	H[43,44,45,46]	8 days[37b] (12-30hrs)
Radafaxine (NDRI)	↓	H[47]	
SSRIs	↑ but no effect on visual assessment	H[46,48,49,50]	Not required
SNRIs	↑ but no effect on visual assessment	H[51]	Not required
Tricyclic Antidepressents	↔	A[50]	Not required
Adrenergic Agonists (Phenylephrine, norepinephrine)	↑ when infused at high doses		
Anticholinergics			
Benzatropine	↓	A[52]	5 days [37b](12-24 hrs)
Others like scopolamine	↑ but no effect on visual assessment	A[53]	2 days (9.5 hrs)
Opioids			
Fentanyl	↓	A[54,55]	20 hrs (2-4hrs)
Naltrexone	↔	CR[56] H[57]	Not required
Anesthetics	↓	A[58,59]	
Ketamine		H[60]	15 hrs (3 hrs)
Phencyclidine			10 days (7-46 hrs)
Isoflurane			10.5min (2.1min)
Antiparkinsonian medications	↔, although caution is advised in intraindividual follow-up studies (possible DAT downregulation with L-DOPA)		
L-DOPA60		H[61,62]	Not required
Dopamine agonists		H[63,64]	Not required
NMDA receptor blockers		T	Not required
MAO-B inhibitors		H[65,66]	Not required
COMT inhibitors		T	Not required
Cholinesterase Inhibitors	↔	H[67]	Not required
Neuroleptics/ Antipsychotics	↔	A[68], H[69]	Not required
Estrogen replacement post menopause	↑ but no effect on visual assessment	H[70]	Not required
Menstrual cycle	↔		
Lithium	↓	CR[71]	5 days (24 hrs)

↑ increase binding, ↓ decrease binding, ↔ no effect, NDRI = norepinephrine-dopamine reuptake inhibitor, SSRI = selective serotonin reuptake inhibitors, SNRIs = Serotonin-norepinephrine reuptake inhibitors, MAO-B = monoamine oxidase-B, COMT = catechol-O-methyltransferase, DAT = dopamine transporter. T = theoretical, H = human data, A = animal data., CR = case report

At least 1 hour prior to radiotracer injection, a single 400mg dose of potassium perchlorate or 100mg equivalent of iodide in Lugol's solution should be administered to reduce exposure of the thyroid to free ^{123}I. This is not mandatory as the radiation dose expected to the thyroid gland would be very low and it may be avoided if patients are known to have sensitivities. A dim or quiet environment is not necessary for the uptake period.

IMAGING

Set Up and Positioning

2.5 or 5-mL solution containing 185 or 370MBq of ^{123}I-ioflupane is administered intravenously as a slow bolus over roughly 20 s followed by a saline flush.[3] Binding of the radiotracer is stable between 3 and 6 hours after injection, at which point SPECT imaging can be acquired. It is encouraged that each centre optimize reproducibility and reduce variability by maintaining the same interval.[56,72,73]

Voiding is recommended prior to scanning to avoid interruptions and frequently after imaging to reduce radiation exposure. All eyeglasses, earrings, hair clips, combs or hearing aids should be removed if possible.[74] The patient should be supine with the head straight (chin in neutral position and vertical canthomeatal line) and instructed to remain still during the image acquisition. Reducing head tilt is desirable but should not jeopardize patient comfort as images can be reoriented following acquisition. The corpus striatum(caudate nucleus and putamen) and occiput are required in the field of view. A case by case strategic decision should be considered in patients with L-DOPA induced dyskinesias as whether to hold the drug. Patients with severe tremor should likely be scanned under the effect of the therapy but this noted in the report. Although rarely of use, restraint devices can be utilized to minimize movement. If movement is an issue, short-acting benzodiazepine sedation does not affect image quality and can be used if agreed upon by the patient or patient's legal representative, referring physician and the patient has arranged appropriate transport following the exam.[35]

Equipment & Image Acquisition

Detector:
Multiple detector or dedicated SPECT camera are strongly preferred over single headed cameras due to shortened scan time to achieve adequate counts at the routine doses administered for data acquisition.[35] The field of view should include the entire brain and the smallest possible, safe rotation radius should be used (typically 11-15cm).[35]

Collimator:
Low Energy High Resolution (LEHR) parallel-hole collimation is adequate, but, if available, fan-beam collimators may be preferred for improved resolution at the cost of count rate capability.

Photopeak:
The photopeak should be 159keV +/- 10%. Additional energy windows can be used for scatter correction.

Matrix:
A 128 x 128 matrix is recommended. Acquisition pixel size should be one-third to one-half of the expected resolution. Hardware

zoom may be necessary to achieve an appropriate pixel size of 3.5-4.5mm. Slices should be 1 pixel thick.

Angular Sampling, Scan Time and Total Detected Events:
3-degree angular sampling for 360 degrees of coverage (180 degrees for each head in a dual head camera) is recommended, although continuous rotation may also be used. The number of seconds per position depends on the sensitivity of the system, but usually 30-40s are required.

A minimum of 1.5 million total counts should be collected for optimal images if scatter correction is applied (otherwise >3 million). Total acquisition time will vary according to camera specifications, but is often between 30-45 minutes. Consider segmenting data acquisition into multiple sequential acquisitions which may permit exclusion of data with artefacts (i.e. exclude segments with movement artifact).

Image Processing:
Projection data in cine mode and sinograms should be displayed to assess scan quality of data, patient motion, and artifacts. Rescanning will be required for large movements, but motion correction can be applied to correct for minor movements.

Iterative reconstruction is preferred but filtered back projection is adequate. The entire brain volume should be reconstructed at the highest pixel resolution (i.e. one-pixel slice thickness).

A low-pass filter (i.e. Butterworth) is recommended and should preserve the linearity of the count rate response. Other filters may introduce artifact and are not recommended for general use. All 3 dimensions should be filtered either by 2D prefiltering of the projection data or by applying a 3D postfilter to the reconstructed data.

Attenuation correction is recommended. Attenuation maps can be measured from a sequentially or simultaneously acquired CT or transmission scan or calculated according to the Chang technique (broad beam linear correction coefficient for ^{123}I: $= 0.11 cm^{-1}$). Variance may occur with fan-beam collimators and accuracy should be verified with an appropriate phantom.

Images are reconstructed into slices in 3 standard planes (axial, coronal, sagittal). Transverse slices should be parallel to a standard, reproducible anatomic orientation, such as the anterior commissure-posterior commissure line. Correct reorientation aids visual assessment and is crucial for quantitative assessments.

Quantification assesses the ratio of activity in a structure/region of interest to activity in a reference region (generally striatum or striatal subregions compared to the occipital area (or possibly cerebellum)). Regions/volumes of interest may be drawn manually, using automated systems or voxel-based mathematical systems. For both manual and automated semiquantification, the left and right striatum as well as the caudate and putamen should be quantified separately.

INTERPRETATION

In general, visual assessment of the images is sufficient to make an accurate diagnosis when the uptake is clearly abnormal. However, the addition of semiquantification has been shown to allow readers with limited experience in the interpretation of DaT imaging to perform as well as more experienced readers. The addition of semiquantification and comparison to age matched normal values has also been shown to increase reader confidence in the interpretation of DaT imaging.

The images should be viewed using appropriate computer software, which allows for adjustment of the alignment, colour table, background subtraction or contrast. It is recommended that readers become familiar with one color scale to allow for consistency in interpretation between studies.

Visual interpretation should begin by assessing the quality of the images. Alignment of the head should be checked, as a misalignment could result in artificial asymmetry and a misinterpretation of the images. The raw images of the SPECT scan should be viewed in the cine mode or sinogram mode to assess for movement or other technical artifacts. If applicable, the possible affect of any medications known to interfere with 123I-ioflupane striatal binding should be considered. Using a fixed set of reference images at all levels (Normal to severe decrease) can aid in providing a qualitative assessment of uptake.

The striata should be assessed for their shape, extent, symmetry and intensity. On axial images in a normal study the striata will be symmetric with well defined borders and have a comma or crescent shape. Abnormal studies are characterized by decreased intensity of the striatum on one or both sides, as well as decrease in size to a circle or oval shape.

The head of the caudate and the putamen should have high contrast to the background in patients of all ages and for all colour scales. With normal aging, some decrease in striatal binding occurs in both the caudate and putamen and should be recognized to avoid overinterpretation. Activity in the head of the caudate should be compared to activity in the putamen, as when abnormal, the putamen is usually more severely affected than the caudate nucleus, especially in iPD. In a normal healthy patient, the striata should be fairly symmetric although mild asymmetry may be seen. In the disease state, abnormalities usually first become visible in the putamen contralateral to the neurological signs.

Some common patterns can be seen on visual interpretation. In Parkinson's disease, there is usually a decrease in activity in the dorsal putamen contralateral to the neurological signs and this progresses anteriorly ipsilaterally over time. In contrast, in atypical Parkinson's syndromes the abnormalities tend to be more symmetric and involve more of the caudate.

In cases of vascular parkinsonism, striatal uptake is usually normal or only slightly decreased except in cases of striatal infarcts. An infarct usually appears as a punched out defect when compared to the neurodegenerative syndrome abnormalities described above.

Correlation with available CT or MRI studies of the brain should occur and may provide additional information that could aid in accurate interpretation of studies, in particular by showing anatomic lesions that may alter the appearance of the striatal structures.

QUANTITATIVE ANALYSES

Quantification with use of validated age-matched reference values may be helpful to accurately interpret DaT imaging. Further benefits of quantification include earlier detection of disease, the ability to objectively assess loss of presynaptic dopaminergic neurons over subsequent studies and providing useful data for research and multicenter studies.

There is no universally accepted cut-off value for normal or abnormal, as quantitative data can be affected by the camera system, calibra-

tion, image acquisition protocol, post-acquisition processing including corrections and quantification protocol. Quantitative data needs to be compared to a suitable database of reference values, ideally age-matched. To use quantification, each site needs to determine a reference range by scanning a population of healthy controls or alternatively calibrate its procedure with a site that has a reference database. Cross-calibration can be done by establishing the relationship between measured uptake ratio and true activity using an anthropomorphic phantom filled with different concentrations of activity and comparing to the same done at another site.

Quantification is subject to interobserver variability especially for inexperienced readers, which may be secondary to differences in reorientation of the head and errors in placement of the reference regions of interest. However, this can be overcome with the use of automated systems to analyze volumes of interest.

For manual quantification, standardized alignment of the head should be used and the sum of at least 3 consecutive slices with standardized region of interests of at least twice the full width and half maximum represents the minimum requirement of tissue volume sampling. A consistent number of slices should be used. For automated quantification, a 3D volume of interest is preferred but the placement of the region of interest should be checked visually.

Quantitative data can be reported as striatal binding expressed as percentage of normal binding for age-matched reference uptake.

REPORT

The report should include the usual demographic information used in imaging reports at the imaging site for example the patient's name, date of birth and hospital identification number. The name of the referring physician and date of the scan should also be included.

a) History
The provided clinical history should be included in the report, including the type, duration and side of neurological symptoms and any relevant past medical history.

State whether the patient is on any drugs known to interfere with 123I-ioflupane binding, and if so which drugs.

If sedation was used, state the dosage, route and timing in relation to the scan.

b) Technique
State the injected dose the radiopharmaceutical, the elapsed time between the injection of the radiopharmaceutical and image acquisition.

c) Findings
Describe any factors that limit image quality, such as patient motion.

Describe the visual interpretation of striatal binding as normal or abnormal. If abnormal, report the location and severity of reduced striatal binding. For severity of reduced binding descriptions such as mild, moderate and severe are suggested. If relevant, compare the findings with any previous 123I-ioflupane studies for the patient. Correlate with previous ^{18}F-FDG PET, CT or MRI studies of the brain, as applicable.

If semiquantitative analysis was performed, report the values and reference range. An age matched reference range is preferred.

d) Impression
State overall impression of scan as Normal or Abnormal.

An abnormal study indicates that a presynaptic striatal dopaminergic terminals deficit is present and can be seen in conditions such as PD, PSP, multiple system atrophy, and dementia with Lewy bodies. The reporting physician should avoid referring to a clear diagnosis for example, PD, as these remain a clinical diagnosis for which. DATscan provides supportive information. If required to clarify the diagnosis, further studies such as ^{18}F-FDG PET may be recommended.

REFERENCES

1- Meara J, Bhowmick BK, Hobson P. Accuracy of diagnosis in patients with pre-sumed Parkinson's disease. Age Ageing. 1999;28:99–102.

2- Hughes AJ, Ben-Shlomo Y, Daniel SE, Lees AJ. What features improve the accuracy of clinical diagnosis in Parkinson's disease: a clinicopathologic study. Neurology. 2001;57(suppl 3):S34–S38.

3- Marshall V, Grosset D. Role of dopamine transporter imaging in routine clinical practice. Mov Disord. 2003;18:1415–1423.

4- Darcourt J, Booij J, Tatsch K, et al. EANM procedure guidelines for brain neurotransmission SPECT using 123I-labelled dopamine transporter ligands, ver-sion 2. Eur J Nucl Med Mol Imaging. 2010;37:443–450.

5- David S.W. Djang1, Marcel J.R. Janssen2, et al. SNM Practice Guideline for Dopamine Transporter Imaging with 123I-Ioflupane SPECT 1.0 THE JOURNAL OF NUCLEAR MEDICINE • Vol. 53 • No. 1 • January 2012.

6- Hughes AJ, Daniel SE, Kilford L, Lees AJ. Accuracy of clinical diagnosis of idiopathic Parkinson's disease: a clinico-pathological study of 100 cases. J Neurol Neurosurg Psychiatry 1992;55:181-184.

7- Postuma RB, Berg D, Stern M, et al. MDS clinical diagnostic criteria for Parkinson's disease. Mov Disord 2015;30:1591-1601.

8- Grimes D, Fitzpatrick M, Gordon J, et al. Canadian guideline for Parkinson disease. CMAJ 2019;191:E989-E1004.

9- Adler CH, Beach TG, Hentz JG, et al. Low clinical diagnostic accuracy of early vs advanced Parkinson disease: Clinicopathologic study. Neurology 2014;83:406-412.

10- Hughes AJ, Daniel SE, Lees AJ. Improved accuracy of clinical diagnosis of Lewy body Parkinson's disease. Neurology 2001;57:1497-1499.

11- Jellinger KA. The neuropathologic diagnosis of secondary parkinsonian syndromes. Adv Neurol 1996;69:293-303.

12- Benamer TS, Patterson J, Grosset DG, et al. Accurate differentiation of parkinsonism and essential tremor using visual assessment of [123I]-FP-CIT SPECT imaging: the [123I]-FP-CIT study group. Mov Disord 2000;15:503-510.

13- Catafau AM, Tolosa E. Impact of dopamine transporter SPECT using 123I-Ioflupane on diagnosis and management of patients with clinically uncertain Parkinsonian syndromes. Mov Disord 2004;19:1175-1182.

14- Marshall VL, Reininger CB, Marquardt M, et al. Parkinson's disease is overdiagnosed clinically at baseline in diagnostically uncertain cases: a 3-year European multicenter study with repeat [123I]FP-CIT SPECT. Mov Disord 2009;24:500-508.

15- Sadasivan S, Friedman JH. Experience with DaTscan at a tertiary referral center. Parkinsonism Relat Disord 2015;21:42-45.

16- Vlaar AM, de Nijs T, Kessels AG, et al. Diagnostic value of 123I-ioflupane and 123I-iodobenzamide SPECT scans in 248 patients with parkinsonian syndromes. Eur Neurol 2008;59:258-266.

17a- Pirker W, Asenbaum S, Bencsits G, et al. [123I]beta-CIT SPECT in multiple system atrophy, progressive supranuclear palsy, and corticobasal degeneration. Mov Disord 2000;15:1158-1167.

17b- Vlaar AM, de Nijs T, Kessels AG, et al. Diagnostic value of 123I-ioflupane and 123I-iodobenzamide SPECT scans in 248 patients with parkinsonian syndromes. Eur Neurol 2008;59:258-266.

17c- Pirker W, Asenbaum S, Bencsits G, et al. [123I]beta-CIT SPECT in multiple system atrophy, progressive supranuclear palsy, and corticobasal degeneration. Mov Disord 2000;15:1158-1167.

18- Bega D, Gonzalez-Latapi P, Zadikoff C, Spies W, Simuni T. Is There a Role for DAT-SPECT Imaging in a Specialty Movement Disorders Practice? Neurodegener Dis 2015;15:81-86.

19- Kupsch AR, Bajaj N, Weiland F, et al. Impact of DaTscan SPECT imaging on clinical management, diagnosis, confidence of diagnosis, quality of life, health resource use and safety in patients with clinically uncertain parkinsonian syndromes: a prospective 1-year follow-up of an open-label controlled study. J Neurol Neurosurg Psychiatry 2012;83:620-628.

20- Apostolova I, Taleb DS, Lipp A, et al. Utility of Follow-up Dopamine Transporter SPECT With 123I-FP-CIT in the Diagnostic Workup of Patients With Clinically Uncertain Parkinsonian Syndrome. Clin Nucl Med 2017;42:589-594.

21- Tinazzi M, Morgante F, Matinella A, Bovi T, Cannas A, Solla P, Marrosu F, Nicoletti A, Zappia M, Luca A, Di Stefano A, Morgante L, Pacchetti C, Minafra B, Sciarretta M, Dallocchio C, Rossi S, Ulivelli M, Ceravolo R, Frosini D, Cipriani A, Barbui C. Imaging of the dopamine transporter predicts pattern of disease progression and response to levodopa in patients with schizophrenia and parkinsonism: a 2-year follow-up multicenter study. Schizophr Res. 2014 Feb;152(2-3):344-9. doi: 10.1016/j.schres.2013.11.028. Epub 2013 Dec 25. PubMed PMID: 24369987.

22- Vizcarra JA, Lang AE, Sethi KD, Espay AJ. Vascular Parkinsonism: deconstructing a syndrome. Mov Disord. 2015 Jun;30(7):886-94. doi: 10.1002/mds.26263. Epub 2015 May 21.

23- Cummings et al. Brain 2011.

24- Vizcarra JA, Lang AE, Sethi KD, Espay AJ. Vascular Parkinsonism: deconstructing a syndrome. Mov Disord. 2015 Jun;30(7):886-94. doi:10.1002/mds.26263. Epub 2015 May 21.

25- Cilia R, Rossi C, Frosini D, Volterrani D, Siri C, Pagni C, Benti R, Pezzoli G, Bonuccelli U, Antonini A, Ceravolo R. Dopamine Transporter SPECT Imaging in Corticobasal Syndrome. PLoS One. 2011 May 2;6(5):e18301. doi: 10.1371/journal.pone.0018301. PubMed PMID: 21559307;

26- Estre TA, Lang AE, Ferreira JJ, Almeida V, de Carvalho M, Miyasaki J, Chen R, Fox S. Associated movement disorders in orthostatic tremor. J Neurol Neurosurg Psychiatry. 2012 Jul;83(7):725-9. doi: 10.1136/jnnp-2012-302436. Epub 2012 May 10. Erratum in: J Neurol Neurosurg Psychiatry. 2012 Nov;83(11):1132. Lang, A E [corrected to Lang, Anthony E]. PubMed PMID: 22577231.

27- Fasano A, Baldari S, Di Giuda D, Paratore R, Piano C, Bentivoglio AR, Girlanda P, Morgante F. Nigro-striatal involvement in primary progressive freezing gait: insights into a heterogeneous pathogenesis. Parkinsonism Relat Disord. 2012 Jun;18(5):578-84. doi: 10.1016/j.parkreldis.2012.03.002. Epub 2012 Mar 28. PubMed PMID: 22459564.

28- Gajos A, Budrewicz S, Koszewicz M, Bie kiewicz M, D browski J, Ku mierek J, Sławek J, Bogucki A. Is nigrostriatal dopaminergic deficit necessary for Holmes tremor to develop? The DaTSCAN and IBZM SPECT study. J Neural Transm (Vienna). 2017 Nov;124(11):1389-1393. doi: 10.1007/s00702-017-1780-1. Epub 2017 Aug 23. PubMed PMID: 28836067; PubMed Central PMCID: PMC5653710.

29- Vizcarra JA, Lang AE, Sethi KD, Espay AJ. Vascular Parkinsonism: deconstructing a syndrome. Mov Disord. 2015 Jun;30(7):886-94. doi: 10.1002/mds.26263. Epub 2015 May 21.

30- Parkinson Progression Marker Initiative. The Parkinson Progression Marker Initiative (PPMI). Prog Neurobiol. 2011 Dec;95(4):629-35. doi: 10.1016/j.pneurobio.2011.09.005. Epub 2011 Sep 14. Review. PubMed PMID: 21930184.

31- Ricciardi L, Petrucci S, Di Giuda D, Serra L, Spanò B, Sensi M, Ginevrino M, Cocciolillo F, Bozzali M, Valente EM, Fasano A. The Contursi Family 20 Years Later: Intrafamilial Phenotypic Variability of the SNCA p.A53T Mutation. Mov Disord. 2016 Feb;31(2):257-8. doi: 10.1002/mds.26549. Epub 2016 Jan 22. PubMed PMID: 26799529.

32- Hesse S, Strecker K, Winkler D, Luthardt J, Scherfler C, Reupert A, Oehlwein C, Barthel H, Schneider JP, Wegner F, Meyer P, Meixensberger J, Sabri O, Schwarz J. Effects of subthalamic nucleus stimulation on striatal dopaminergic transmission in patients with Parkinson's disease within one-year follow-up. J Neurol. 2008 Jul;255(7):1059-66. doi: 10.1007/s00415-008-0849-z. Epub 2008 May 2. PubMed PMID: 18446306.

33- Morrish PK. How valid is dopamine transporter imaging as a surrogate marker in research trials in Parkinson's disease? Mov Disord. 2003 Oct;18 Suppl 7:S63-70. Review. PubMed PMID: 14531048.

34- DaTscan (English) Product Monograph Canada Control No 201481 (December 7 2017).pdf.

35- Djang, D. S. W. et al. SNM Practice Guideline for Dopamine Transporter Imaging with 123I-Ioflupane SPECT 1.0. J. Nucl. Med. 53, 154–163 (2012).

36- Darcourt, J. et al. EANM procedure guidelines for brain neurotransmission SPECT using 123I-labelled dopamine transporter ligands, version 2. Eur. J. Nucl. Med. Mol. Imaging 37, 443–450 (2010).

37- Volkow, N. D. et al. Relationship between subjective effects of cocaine and dopamine transporter occupancy. Nature 386, 827–830 (1997).

38- Laruelle, M. et al. SPECT imaging of dopamine and serotonin transporters with [123I]beta-CIT: pharmacological characterization of brain uptake in nonhuman primates. Synap. N. Y. N 13, 295–309 (1993).

39- Volkow, N. D. et al. Association of Dopamine Transporter Reduction With Psychomotor Impairment in Methamphetamine Abusers. Am. J. Psychiatry 158, 377–382 (2001).

40- Chou, Y.-H. et al. Dopamine transporters and cognitive function in methamphetamine abuser after a short abstinence: A SPECT study. Eur. Neuropsychopharmacol. 17, 46–52 (2007).

41- Madras, B. K. et al. Modafinil Occupies Dopamine and Norepinephrine Transporters in Vivo and Modulates the Transporters and Trace Amine Activity in Vitro. J. Pharmacol. Exp. Ther. 319, 561–569 (2006).

42- Malison, R. T. et al. [123I] -CIT SPECT imaging of dopamine transporter availability after mazindol administration in human cocaine addicts. 5.

43- Árgyelán, M. et al. Dopamine transporter availability in medication free and in bupropion treated depression: A 99mTc-TRODAT-1 SPECT study. J. Affect. Disord. 89, 115–123 (2005).

44- Meyer, J. H. et al. Bupropion occupancy of the dopamine transporter is low during clinical treatment. Psychopharmacology (Berl.) 163, 102–105 (2002).

45- Learned-Coughlin, S. M. et al. In vivo activity of bupropion at the human dopamine transporter as measured by positron emission tomography. Biol. Psychiatry 54, 800–805 (2003).

46- Kugaya, A. et al. Changes in Human In vivo Serotonin and Dopamine Transporter Availabilities during Chronic Antidepressant Administration. Neuropsychopharmacology 28, 413–420 (2003).

47- Volkow, N. D. et al. The slow and long-lasting blockade of dopamine transporters in human brain induced by the new antidepressant drug radafaxine predict poor reinforcing effects. Biol. Psychiatry 57, 640–646 (2005).

48- de Win, M. M. L. et al. Validation of [123I] -CIT SPECT to Assess Serotonin Transporters In Vivo in Humans: a Double-Blind, Placebo-Controlled, Crossover Study with the Selective Serotonin Reuptake Inhibitor Citalopram. Neuropsychopharmacology 30, 996–1005 (2005).

49- Booij, J. et al. Quantification of Striatal Dopamine Transporters with 123I-FP-CIT SPECT Is Influenced by the Selective Serotonin Reuptake Inhibitor Paroxetine: A Double-Blind, Placebo-Controlled, Crossover Study in Healthy Control Subjects. J. Nucl. Med. 48, 359–366 (2007).

50- Booij, J. & Kemp, P. Dopamine transporter imaging with [123I]FP-CIT SPECT: potential effects of drugs. Eur. J. Nucl. Med. Mol. Imaging 35, 424–438 (2008).

51-Shang, Y. et al. Displacement of Serotonin and Dopamine Transporters by Venlafaxine Extended Release Capsule at Steady State: A [123I]2 -Carbomethoxy-3 -(4-Iodophenyl)-Tropane Single Photon Emission Computed Tomography Imaging Study. J. Clin. Psychopharmacol. 27, 71–75 (2007).

52- Madras, B. K. et al. Dopamine Transporter (DAT) Inhibitors Alleviate Specific Parkinsonian Deficits in Monkeys: Association with DAT Occupancy in Vivo. J. Pharmacol. Exp. Ther. 319, 570–585 (2006).

53- Kilbourn, M. R., Kemmerer, E. S., Desmond, T. J., Sherman, P. S. & Frey, K. A. Differential effects of scopolamine on in vivo binding of dopamine transporter and vesicular monoamine transporter radioligands in rat brain. Exp. Neurol. 188, 387–390 (2004).

54- Xiao, Z. et al. Changes of dopamine transporter function in striatum during acute morphine addiction and its abstinence in rhesus monkey. Chin. Med. J. (Engl.) 119, 1802–1807 (2006).

55- Collins, S. L., Gerdes, R. M., D'Addario, C. & Izenwasser, S. Kappa opioid agonists alter dopamine markers and cocaine-stimulated locomotor activity. Behav. Pharmacol. 12, 237–245 (2001).

56- Bergström, K. A. et al. Fentanyl decreases beta-CIT binding to the dopamine transporter. Synap. N. Y. N 29, 413–415 (1998).

57- Zaaijer, E. R. et al. Effect of extended-release naltrexone on striatal dopamine transporter availability, depression and anhedonia in heroin-dependent patients. Psychopharmacology (Berl.) 232, 2597–2607 (2015).

58- Tsukada, H. et al. Ketamine alters the availability of striatal dopamine transporter as measured by [(11)C]beta-CFT and [(11)C]beta-CIT-FE in the monkey brain. Synap. N. Y. N 42, 273–280 (2001).

59- Harada, N., Ohba, H., Fukumoto, D., Kakiuchi, T. & Tsukada, H. Potential of [(18)F]beta-CFT-FE (2beta-carbomethoxy-3beta-(4-fluorophenyl)-8-(2-[(18)F]fluoroethyl)nortropane) as a dopamine transporter ligand: A PET study in the conscious monkey brain. Synap. N. Y. N 54, 37–45 (2004).

60- Schiffer, W. K., Logan, J. & Dewey, S. L. Positron Emission Tomography Studies of Potential Mechanisms Underlying Phencyclidine-Induced Alterations in Striatal Dopamine. Neuropsychopharmacology 28, 2192–2198 (2003).

61- Schillaci, O. et al. The effect of levodopa therapy on dopamine transporter SPECT imaging with 123I-FP-CIT in patients with Parkinson's disease. Eur. J. Nucl. Med. Mol. Imaging 32, 1452–1456 (2005).

62- Winogrodzka, A., Booij, J. & Wolters, E. C. Disease-related and drug-induced changes in dopamine transporter expression might undermine the reliability of imaging studies of disease progression in Parkinson's disease. Parkinsonism Relat. Disord. 11, 475–484 (2005).

63- Winogrodzka, A. et al. [123I]ß-CIT SPECT is a useful method for monitoring dopaminergic degeneration in early stage Parkinson's disease. J. Neurol. Neurosurg. Psychiatry 74, 294–298 (2003).

64- Ahlskog, J. E. et al. The effect of dopamine agonist therapy on dopamine transporter imaging in Parkinson's disease. Mov. Disord. 14, 940–946 (1999).

65- Innis, R. B. et al. Effect of treatment with L-dopa/carbidopa or L-selegiline on striatal dopamine transporter SPECT imaging with [123I] -CIT. Mov. Disord. 14, 436–442 (1999).

66- Fowler, J. S. et al. Evidence that L-deprenyl treatment for one week does not inhibit MAO A or the dopamine transporter in the human brain. Life Sci. 68, 2759–2768 (2001).

67- Taylor, J. et al. Cholinesterase inhibitor use does not significantly influence the ability of 123I FP CIT imaging to distinguish Alzheimer's disease from dementia with Lewy bodies. J. Neurol. Neurosurg. Psychiatry 78, 1069–1071 (2007).

68- Lavalaye, J. et al. [123 I]FP-CIT binding in rat brain after acute and sub-chronic administration of dopaminergic medication. Eur. J. Nucl. Med. Mol. Imaging 27, 346–349 (2000).

69- Mateos, J. J. et al. Lower striatal dopamine transporter binding in neuroleptic-naive schizophrenic patients is not related to antipsychotic treatment but it suggests an illness trait. Psychopharmacology (Berl.) 191, 805–811 (2007).

70- Best, S. E. et al. Striatal dopamine transporter availability with [123I] -CIT SPECT is unrelated to gender or menstrual cycle. Psychopharmacology (Berl.) 183, 181–189 (2005).

71- Cilia, R., Marotta, G., Belletti, A., Siri, C. & Pezzoli, G. Reversible dopamine transporter reduction in drug-induced parkinsonism. Mov. Disord. 29, 575–577 (2014).

72- Booij, J. et al. [123I]FP-CIT SPECT shows a pronounced decline of striatal dopamine transporter labelling in early and advanced Parkinson's disease. J. Neurol. Neurosurg. Psychiatry 62, 133–140 (1997).

73- Booij, J. One-Day Protocol for Imaging of the Nigrostriatal Dopaminergic Pathway in Parkinson's Disease by [123I]FPCITSPECT. 10.

74- Grabher, B. J. Brain Imaging Quality Assurance: How to Acquire the Best Brain Images Possible. J. Nucl. Med. Technol. 47, 13–20 (2019).

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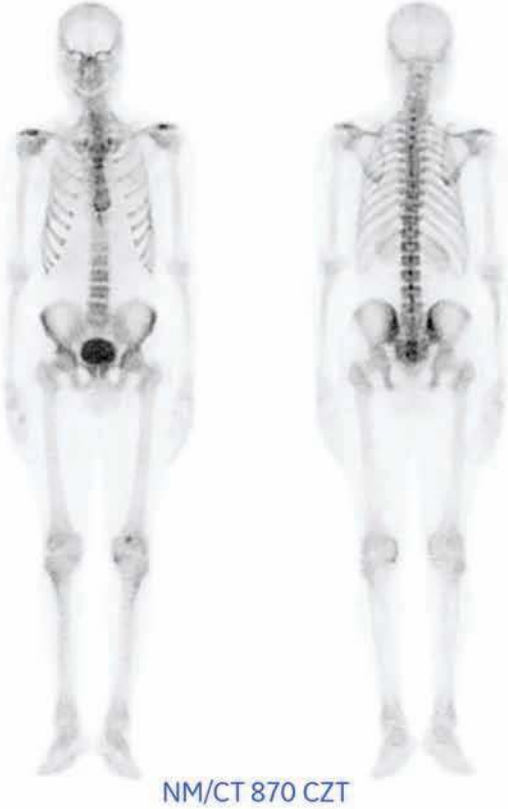

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References:
1 Together with Clarity 2D and Evolution® and compared to Discovery NM/CT 670 Pro/ES/DR without Clarity 2D and Evolution®. As demonstrated in phantom testing using a bone scan protocol, and the NEMA IEC Body Phantom. The actual time/dose reduction depends on the clinical task, patient size, anatomical location and clinical practice.
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