Radioproteção em Medicina Nuclear

Desafios e Oportunidades

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Conflito de interesse

- Não tenho conflito de interesse nesta apresentação.

Desafios e Oportunidades

- Riscos e benefícios das práticas nucleares
- Não adoção de boas práticas
- Baixo acesso da população
- Escassez de incentivos à pesquisa
- Reduzida mão de obra qualificada

O IMPACTO CLÍNICO DA MEDICINA NUCLEAR

DRAUZIO

VÍDEOS

https://drauziovarella.uol.com.br/videos/especiais/a-importancia-da-medicina-nuclear/

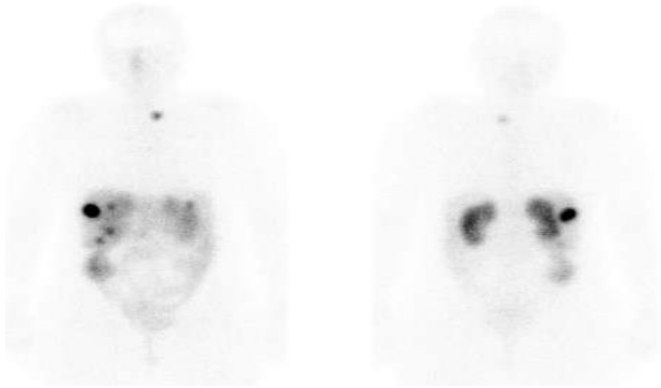
Anamnese

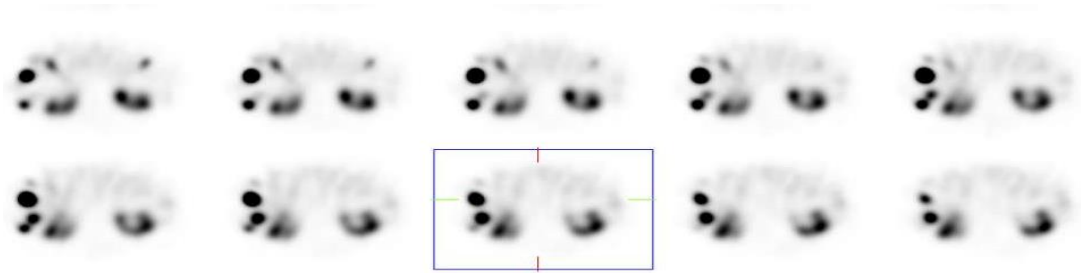
- Identificação: Paciente feminina, 61 anos.
- Diagnóstico de tumor neuroendócrino (TNE) de pâncreas, KI-67 de 4%, com metástases linfonodais e hepáticas.
- Em agosto de 2015, submeteu-se à pancreatectomia de corpo e cauda, esplenectomia, adrenalectomia à esquerda, ressecção de lesões hepáticas (segmentos I, II, III, IVa e VIII) e linfadenectomia.
- Seguia em terapia com Everolimus e Sandostatin LAR, porém exames evidenciam progressão de doença.
- Relatava um máximo de dois episódios diários de diarreia, e dispneia e raramente dor abdominal.
- Encaminhada para a terapia com ^{177}Lu-DOTATE (PRRNT).

PET/CT pré-PRRNT

- O PET/CT ^{68}Ga-DOTATE pré-PRRNT mostrava lesões com avidez pelo análogo de somatostatina (sendo o SUVmax do linfonodo paratraquel 19,1 e parênquima hepático com lesões entre 23,4 e 51,6),

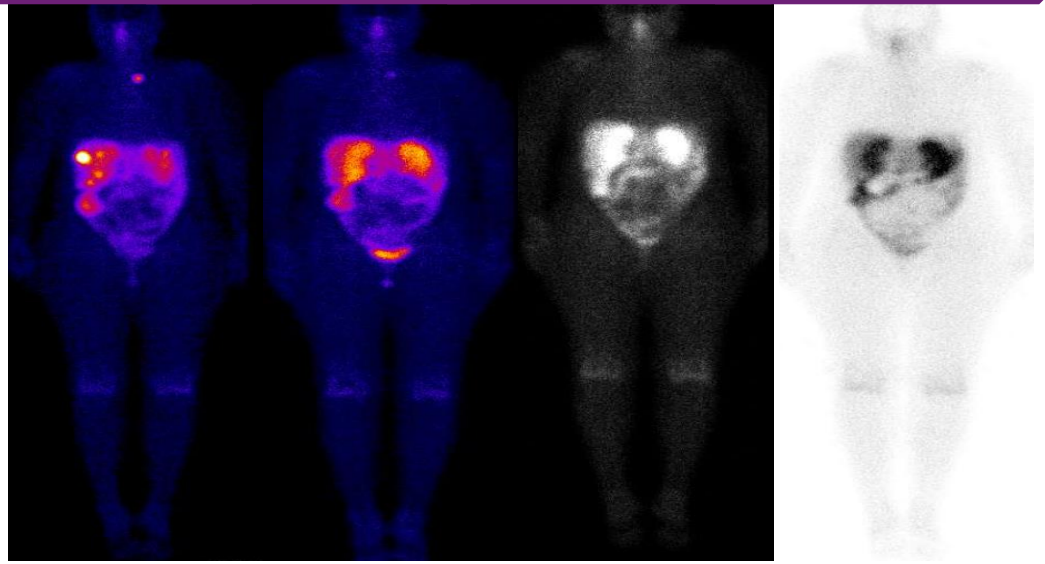
- O PET/CT ^{18}F-FDG não mostrava áreas de metabolismo anormal.



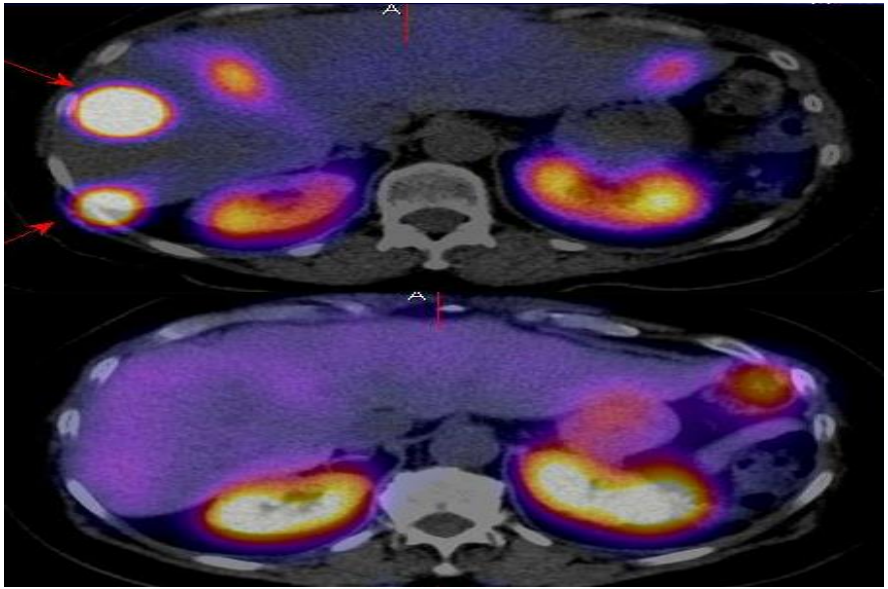


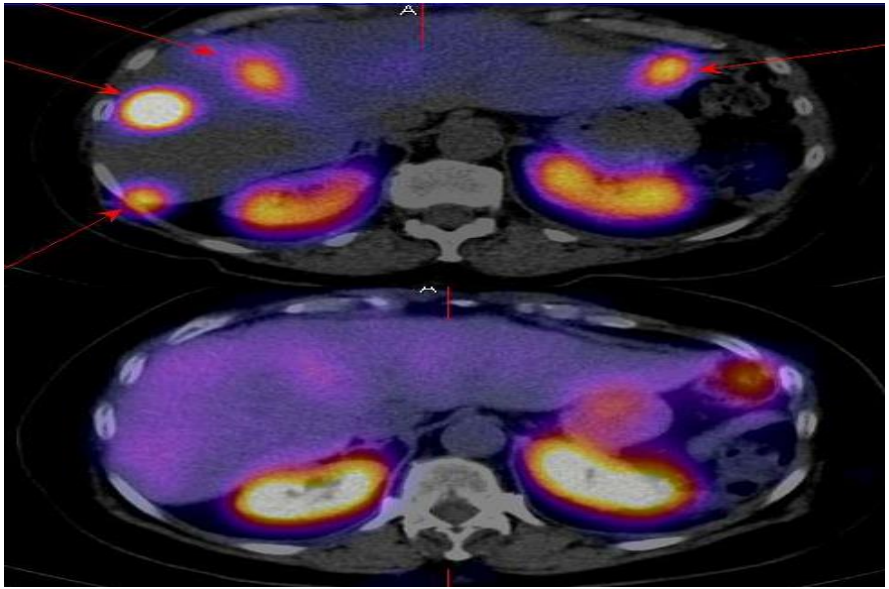
Imagens do 1º ciclo com ^{177}Lu-DOTATE

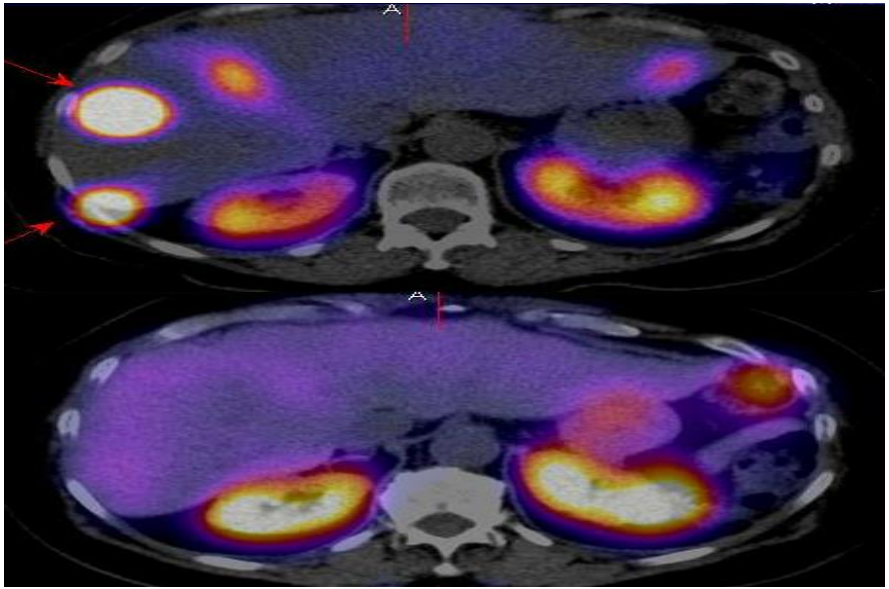
1º 2º 3º 4º

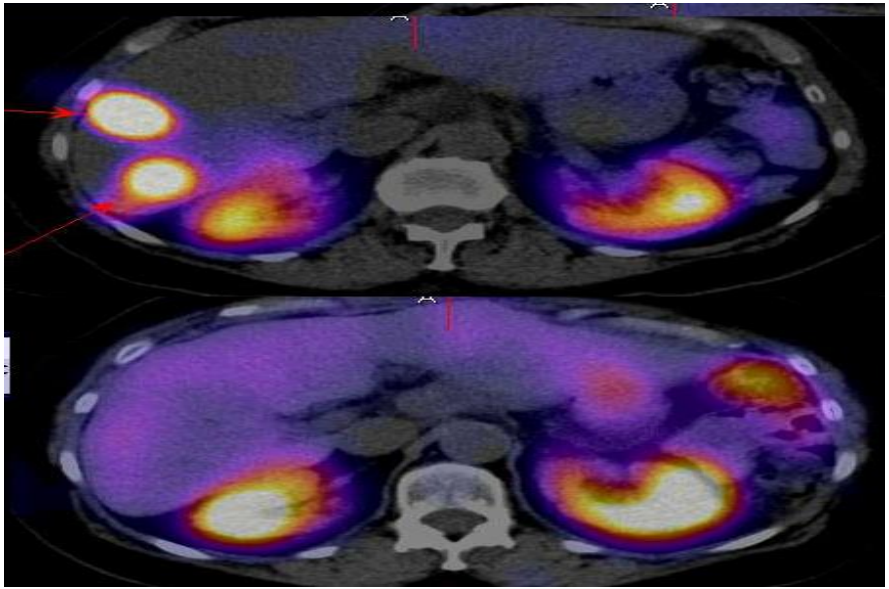


SPECT/CT$_{(05/2018)}$: resposta completa

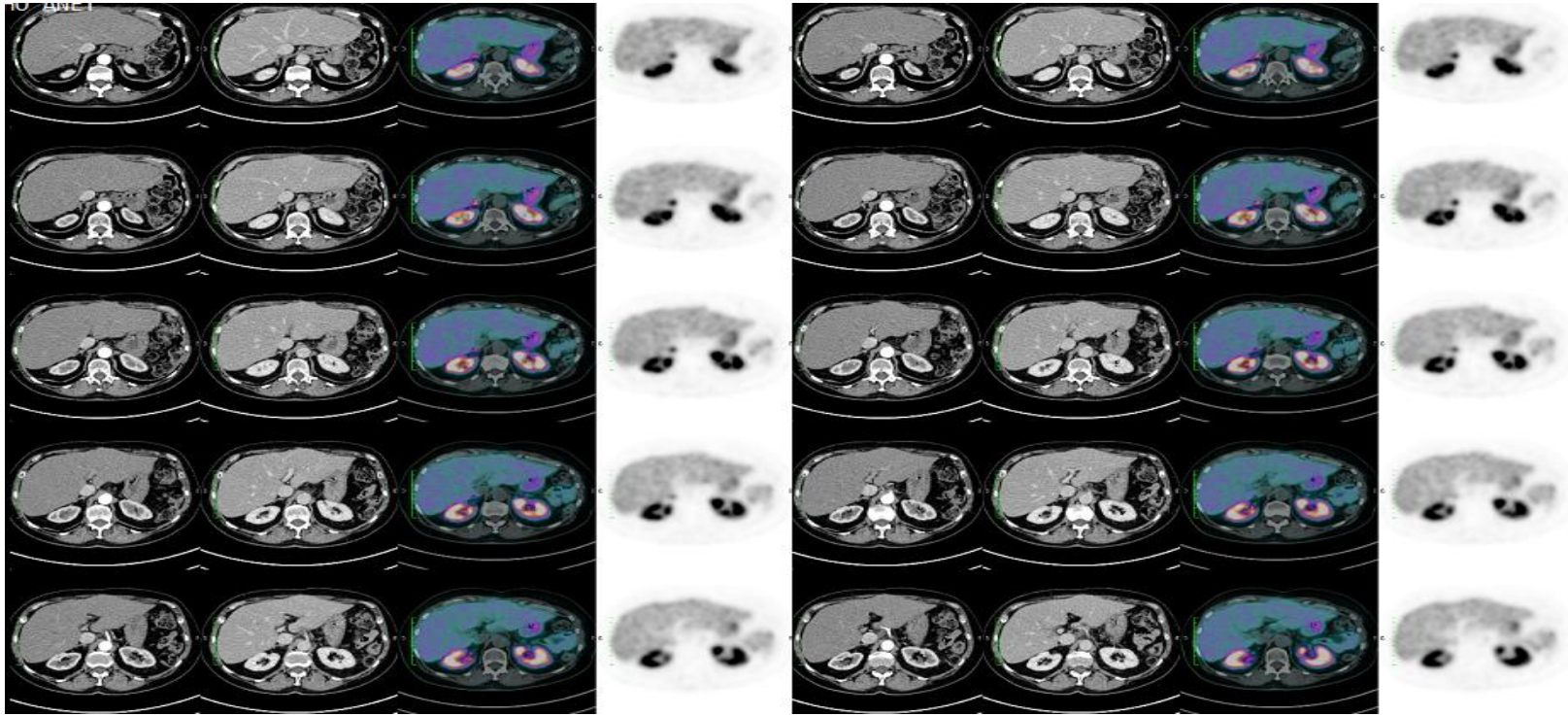








PET/CT ^{68}Ga-DOTA(08/2018)



Não se observa aumento anômalo da captação do radiofármaco no parênquima hepático ou em linfonodos, em projeção de lesões descritas em estudo de PET-CT com análogo da somatosatatina datado de 01/06/2016, realizado em outra instituição (imagens em mídia digital não disponíveis). Não se observa aumento da captação do radiotraçador no leito da pancreatectomia corpo caudal.

Em relação aos estudos de tomografia computadorizada datados de 04/09/2015 e 03/11/2016, realizados em outra instituição (ver fotos comparativas), observa-se diminuição gradual das dimensões de lesões hepáticas hipodensas, como uma no segmento II (medindo inicialmente 3,6 cm e agora 1,5 cm) e outra no segmento VI (medindo inicialmente 2,7 cm e agora 1,6 cm).

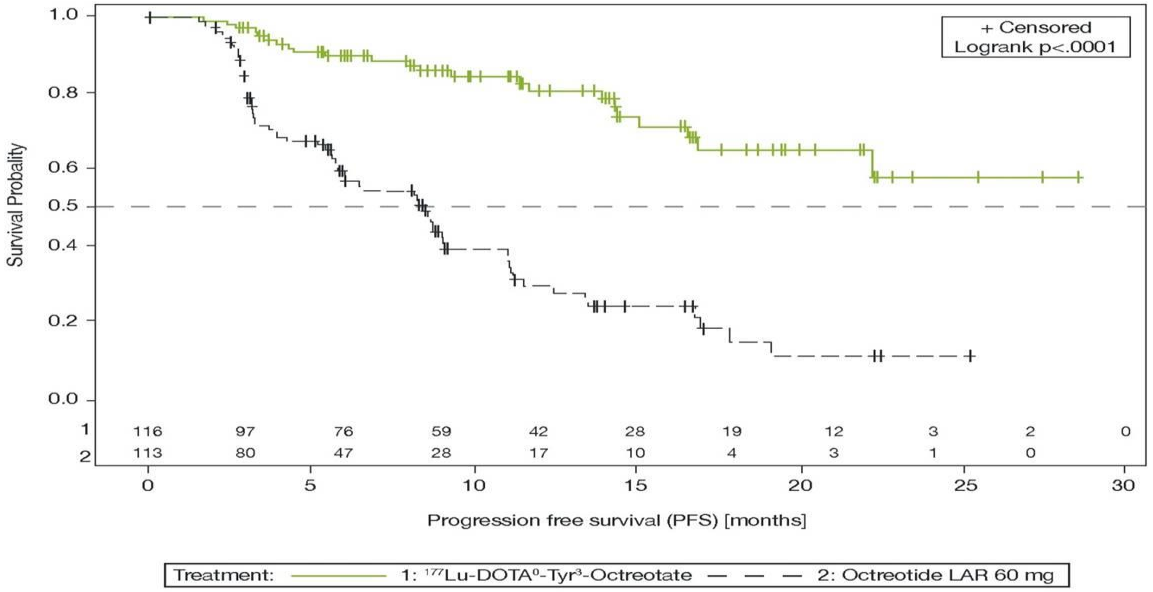
Progression-Free Survival

N = 229 (ITT)
Number of events: 91
^{177}Lu-Dotatate: 23
Oct 60 mg LAR: 68

Hazard ratio: **0.21**
[0.13 – 0.33]
p < 0.0001

79% reduction in the risk of disease progression/death

Estimated Median PFS in the Lu-DOTATATE arm ≈ 40 months



All progressions centrally confirmed and independently reviewed for eligibility (SAP)

Jonathan Strosberg at 2016 ASCO Annual Meeting – NEJM January 2018

Published in final edited form as:
N Engl J Med. 2017 January 12; 376(2): 125–135. doi:10.1056/NEJMoa1607427.

Phase 3 Trial of ^{177}Lu-Dotatate for Midgut Neuroendocrine Tumors

J. Strosberg, G. El-Haddad, E. Wolin, A. Hendifar, J. Yao, B. Chasen, E. Mittra, P.L. Kunz, M.H. Kulke, H. Jacene, D. Bushnell, T.M. O'Dorisio, R.P. Baum, H.R. Kulkarni, M. Caplin, R. Lebtahi, T. Hobday, E. Delpassand, E. Van Cutsem, A. Benson, R. Srirajaskanthan, M. Pavel, J. Mora, J. Berlin, E. Grande, N. Reed, E. Seregni, K. Öberg, M. Lopera Sierra, P. Santoro, T. Thevenet, J.L. Erion, P. Ruszniewski, D. Kwekkeboom, E. Krenning, and **for the NETTER-1 Trial Investigators***
The authors' full names, academic degrees, and affiliations are listed in the Appendix

and a half-life of 160 hours.[18] In a single-group trial of ^{177}Lu-Dotatate involving 310 patients who had gastroenteropancreatic neuroendocrine tumors, complete tumor remissions occurred in 2% of the patients and partial tumor remissions in 28%.[12] The median progression-free survival was 33 months.

SNMMI Value Initiative
SOCIETY OF NUCLEAR MEDICINE & MOLECULAR IMAGING

Advances in Oncology – Therapeutics, Personalized Medicine

- **ASCO clinical advance for 2019 – Progress in Rare Cancers**
  - ^{177}Lu-DOTATATE in advanced midgut cancers - one of 5 major advances last year

Five Rare Cancers in ASCO Report

1. **Anaplastic thyroid carcinoma (ATC)**. The FDA approved the first treatment for this rare form of thyroid cancer in nearly 50 years. The new treatment is a targeted therapy combination of dabrafenib plus trametinib for patients with *BRAF*-mutated ATC. The combination treatment produced tumor shrinkage in more than two-thirds of patients in clinical trials.

2. **Desmoid tumors**. Sorafenib became the first treatment to improve progression-free survival in patients with this rare form of sarcoma.

3. **Midgut neuroendocrine tumors**. The FDA approved lutetium Lu 177 dotatate, a treatment that delivers targeted radiation to tumor cells. The new therapy, which binds to somatostatin receptors to deliver radiation directly into tumor cells, is based on research showing that it lowers the risk of disease progression or death by 79 percent for patients with this kind of rare cancer who have advanced disease.

4. **Uterine serous carcinoma**. The drug trastuzumab was shown to slow the progression of HER2-positive uterine serous carcinoma, one of the most aggressive forms of endometrial cancer.

5. **Tenosynovial giant cell tumor**. Research identified the first promising therapy, pexidartinib, for this rare cancer of the joints. This promising treatment, a colony-stimulating factor 1R inhibitor, produced responses in nearly 40 percent (39.3%) of patients who received it.

2019

ASCO's Annual Report on Progress Against Cancer

European Journal of Nuclear Medicine and Molecular Imaging (2019) 46:129–138
https://doi.org/10.1007/s00259-018-4167-0

ORIGINAL ARTICLE

^{225}Ac-PSMA-617 in chemotherapy-naive patients with advanced prostate cancer: a pilot study

Mike Sathekge[1] · Frank Bruchertseifer[2] · Otto Knoesen[3] · Florette Reyneke[1] · Ismaheel Lawal[1] · Thabo Lengana[1] · Cindy Davis[1] · Johncy Mahapane[1] · Ceceila Corbett[1] · Mariza Vorster[1] · Alfred Morgenstern[1,2]

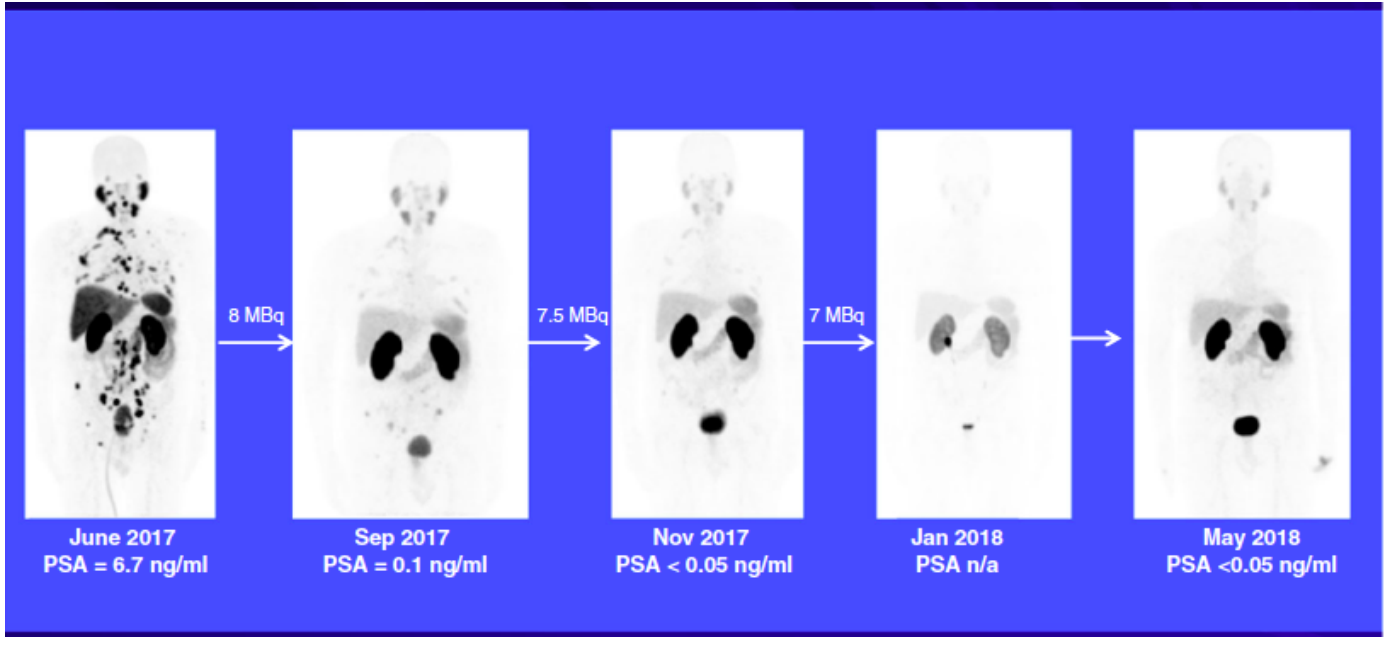
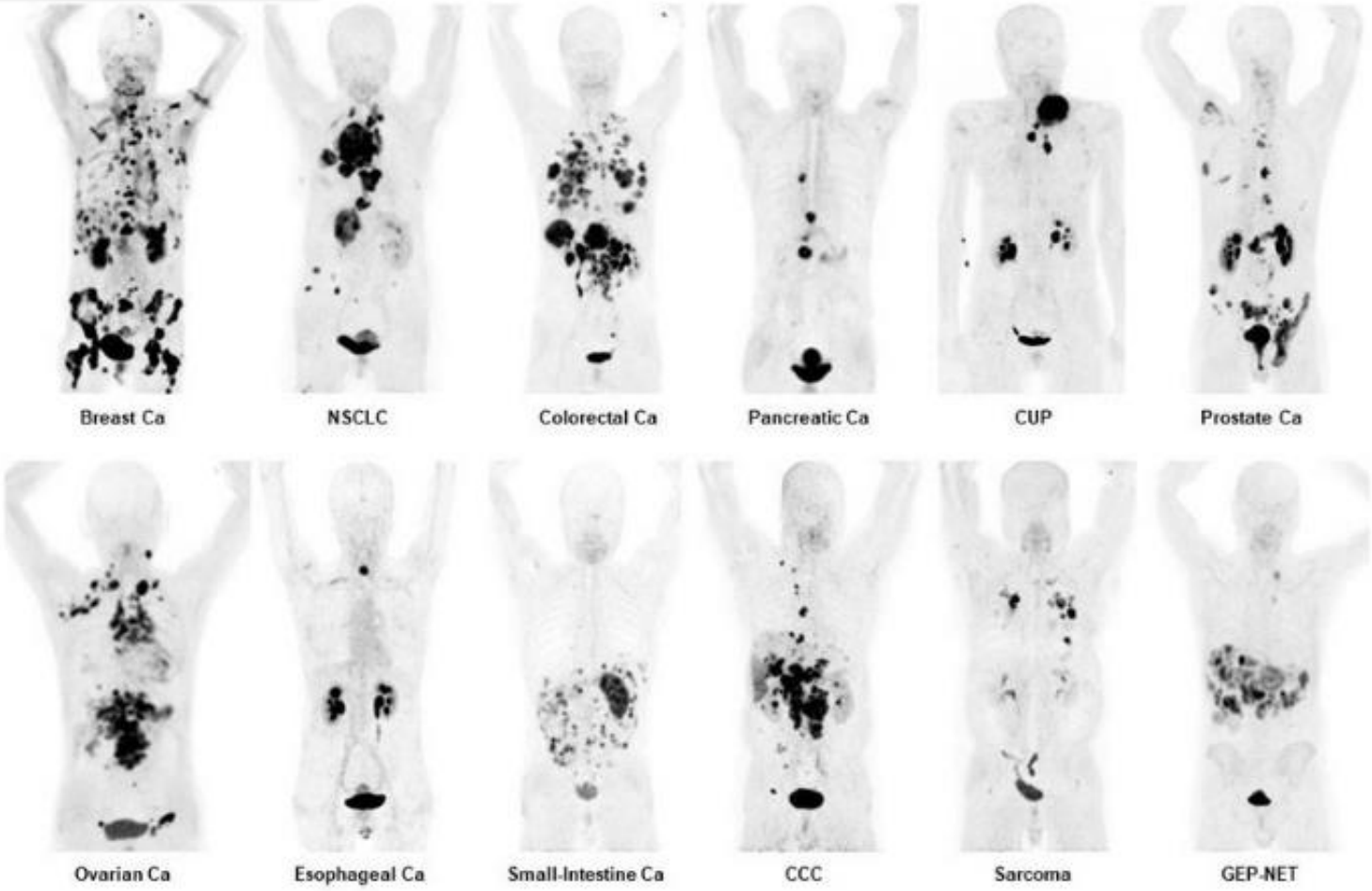
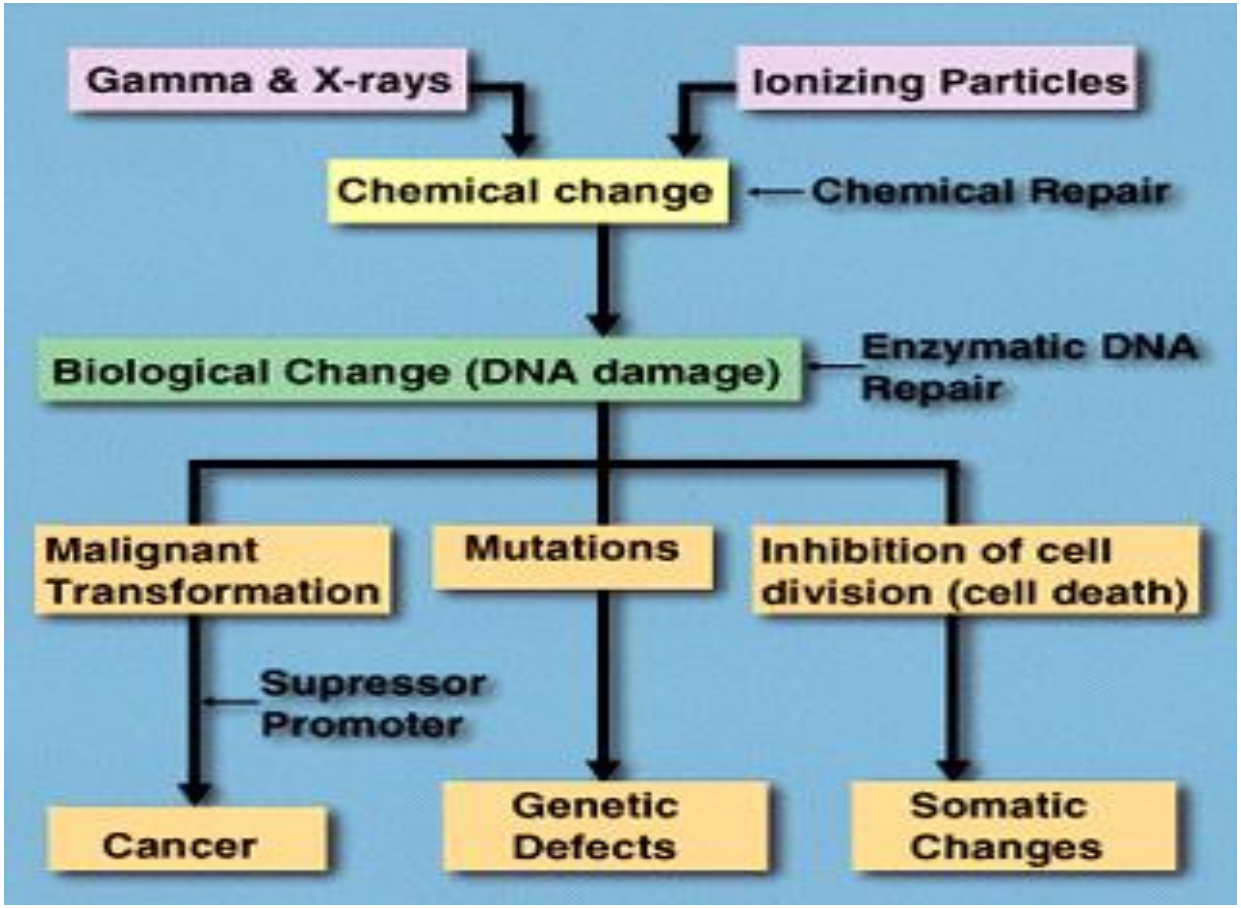


IMAGE OF THE YEAR 2019

FAPI-PET in different kinds of cancer



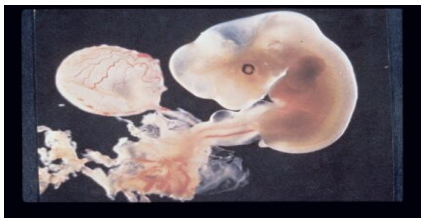


Riscos da Radiação

Risco da radiação fetal

- Há riscos relacionados com a radiação durante a gravidez que estão relacionados com a fase da gravidez e com a dose absorvida
- Riscos de radiação são mais significativos durante a organogénese e no período fetal precoce, um pouco menos no 2 º trimestre, e menos no 3 º trimestre

Mais risco



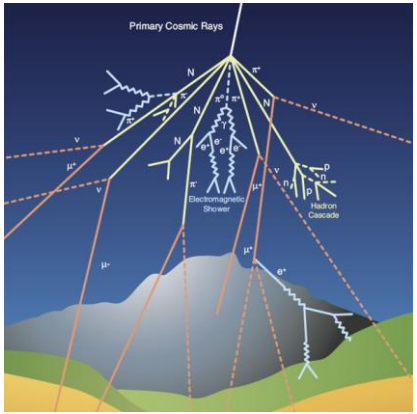
Menos

Mínimo

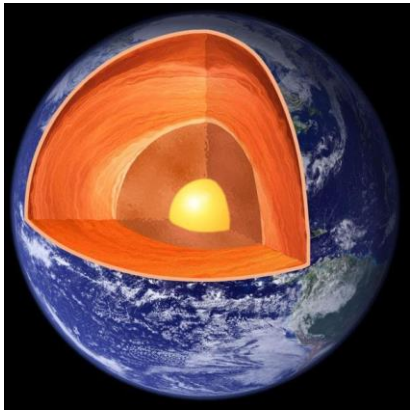
Malformações induzidas pela Radiação - Gravidez

- Malformações têm um limiar de 100-200 mGy ou superior e são normalmente associados a problemas do sistema nervoso central
- Doses fetais de 100 mGy não são alcançadas mesmo com 3 tomografias pélvicas ou 20 exames convencionais de raios-X de diagnóstico
- Estes níveis podem ser alcançados com procedimentos intervencionistas guiados por fluoroscopia da pelve ou com radioterapia

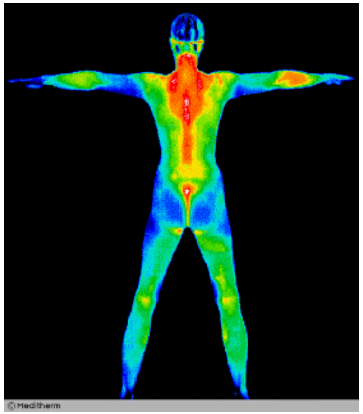
Estamos expostos diariamente à radiação!



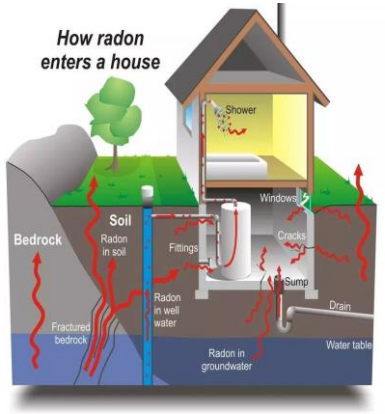
Raios Cósmicos do espaço



Radioatividade da Terra

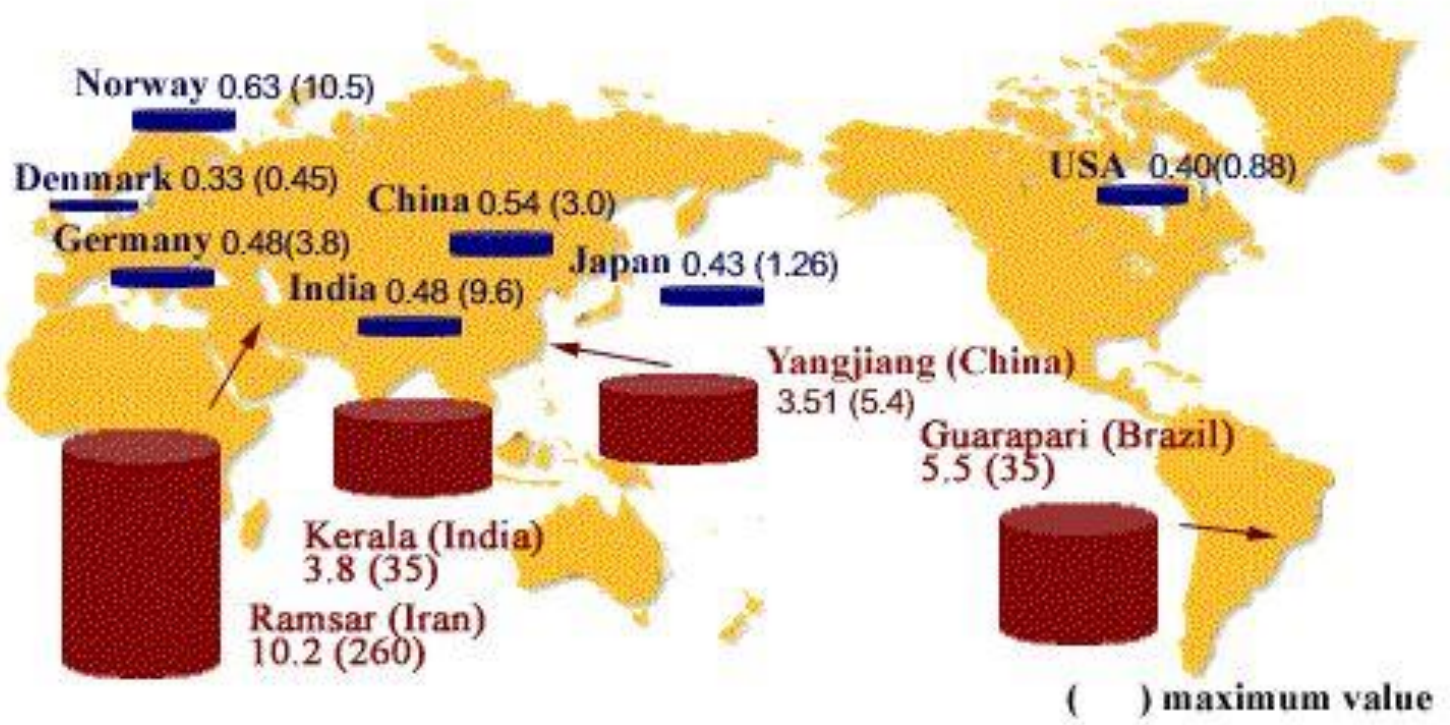


Radiação do corpo humano



Gás Radônio nas casas

Áreas com Radiação de "background" mais elevadas do mundo
mSV/ano



UNSCEAR 2000 report

Challenges and Opportunities in the use of Ionizing Radiation for Cardiovascular Diseases

Fernando de Amorim Fernandes,[1] Alair Augusto Sarmet Moreira Damas dos Santos,[1] Anderson de Oliveira,[2] Cláudio Tinoco Mesquita[1]

Hospital Universitário Antônio Pedro,[1] Niterói, RJ – Brazil
Comissão Nacional de Energia Nuclear,[2] Rio de Janeiro, RJ – Brazil

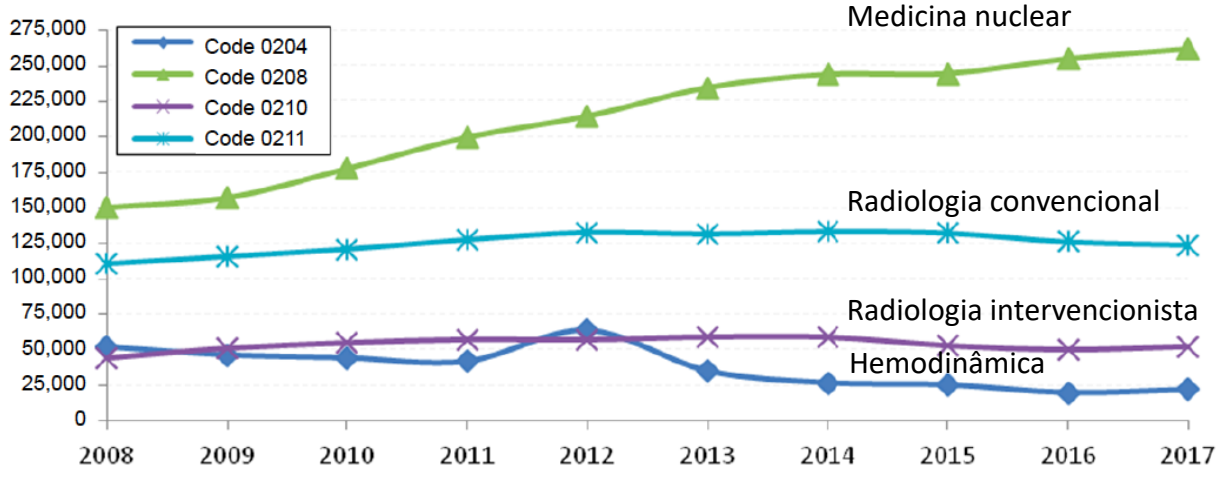


Figure 1 - Evolution of the number of procedures with ionizing radiation in the Brazilian Unified Health System (SUS). Codes of procedures: 0204 (Conventional Radiology), 0208 (Nuclear Medicine), 0210 (Interventional Radiology) e 0211 (Cardiac Catheterization).
Source: DATASUS – Portal da Saúde[3]

A medicina nuclear apresenta crescimento no SUS.
Cerca de 85% da radiação é proveniente dos exames cardiovasculares

Int J Cardiovasc Sci. 2019; [online].ahead print, PP.0-0

Challenges and Opportunities in the use of Ionizing Radiation for Cardiovascular Diseases

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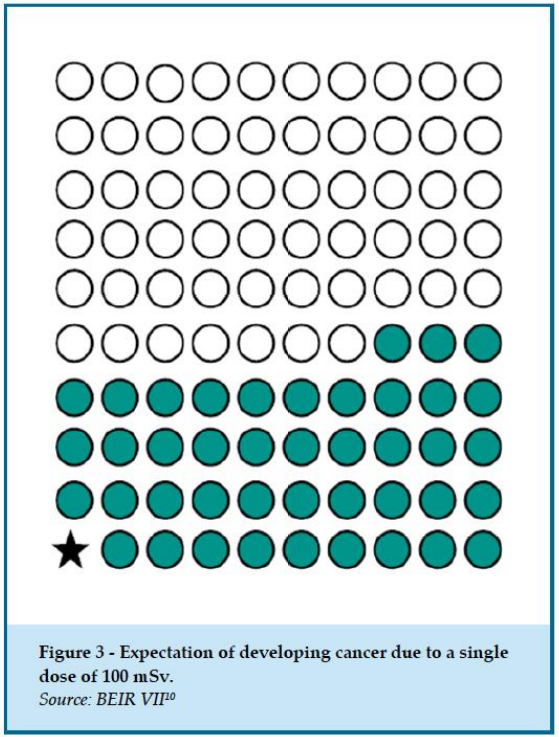


Figure 3 - Expectation of developing cancer due to a single dose of 100 mSv.
Source: BEIR VII[10]

A exposição de 100 pessoas a 100 mSv causa um caso de câncer adicional. Dentre estas 100 pessoas 42 já desenvolveriam câncer naturalmente.

A exposição de 1.000 pessoas a 10 mSv está associada a uma probabilidade de 1 desenvolver câncer ao longo da vida.

A exposição à radiação por procedimentos cardiovasculares aumentou 73% nos últimos 10 anos

Int J Cardiovasc Sci. 2019; [online].ahead print, PP.0-0

Tabela de risco de Vida	
Exposição ao Risco	Chances de Fatalidades por Milhão de Pessoas ao Ano
Fumantes de 20 Cigarros por dia (Todos os efeitos)	5.000
Fumantes de 20 Cigarros por dia (Câncer)	2.000
Bebida (Todos os efeitos)	380
Mineração USA	198
Viajando com Veiculo Motorizado	145
Acidentes Domésticos	110
Fatalidades dados OIT (Mundo/ 2008)	107
Construção Civil USA	95
Atropelamento por veículos	35
Mineração na Austrália	35
Acidentes Ferroviário	30
Construção UK	23
Viajando de Avião	10

Source: D.J Higson, Risk to Individuals in NSW and in Australia as a Whole, Australian Nuclear Science and Technology Organisation, July 1989.

A chance de ter um câncer fatal para 2000 pessoas que fazem um exame de medicina nuclear é de 1 caso. Entretanto, como a prevalência natural de câncer é de 22%: outros 440 pacientes terão câncer naturalmente.

OS DESAFIOS PARA MEDICINA NUCLEAR

Brasil x Argentina
Medicina Nuclear

1) Centro PET: 131
2) Centro SPECT: 394
3) Centros 131Iodo (tireoide): 100
4) Físicos de Medicina Nuclear: 302

População: 210 milhões

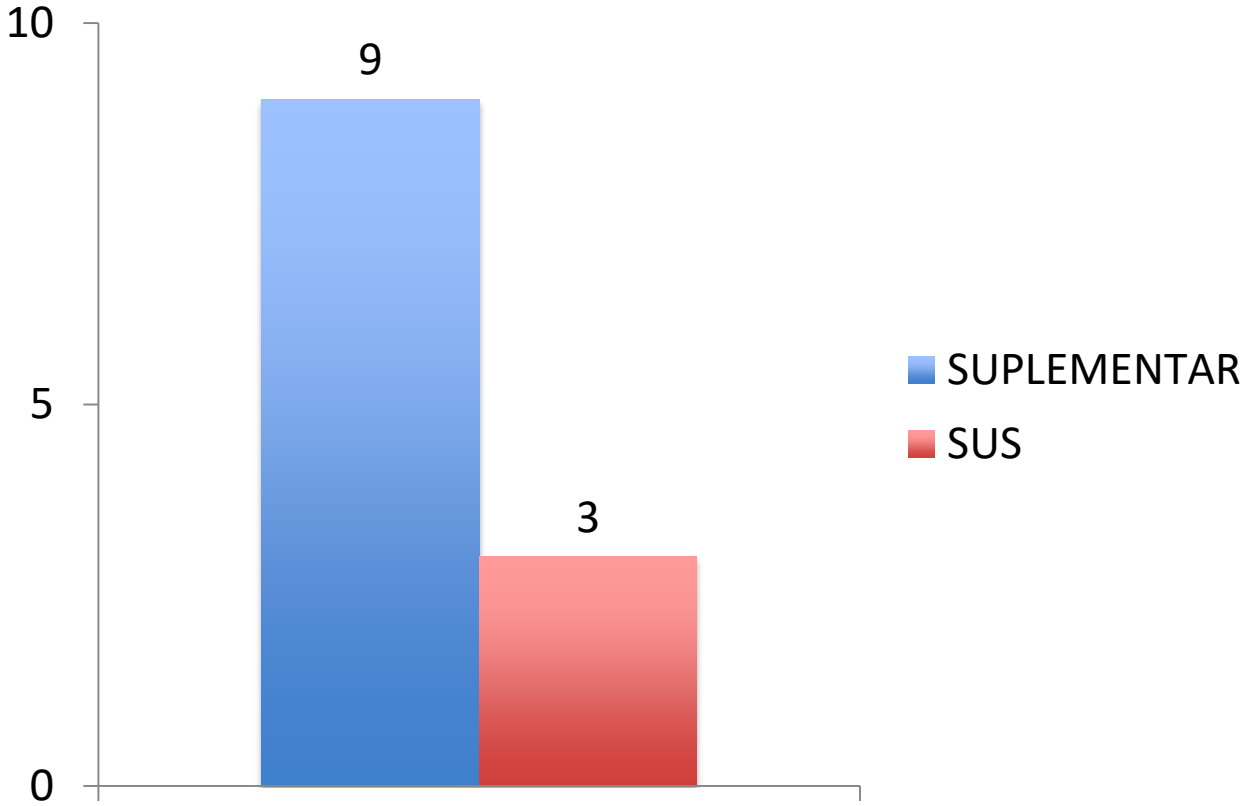
Relação PET/milhão hab: 0,6
Relação SPECT/milhão hab: 1,8

1) Centro PET: 40
2) Centro SPECT: 242
3) Centros 131Iodo (tireoide): 150
4) Físicos de Medicina Nuclear: 18

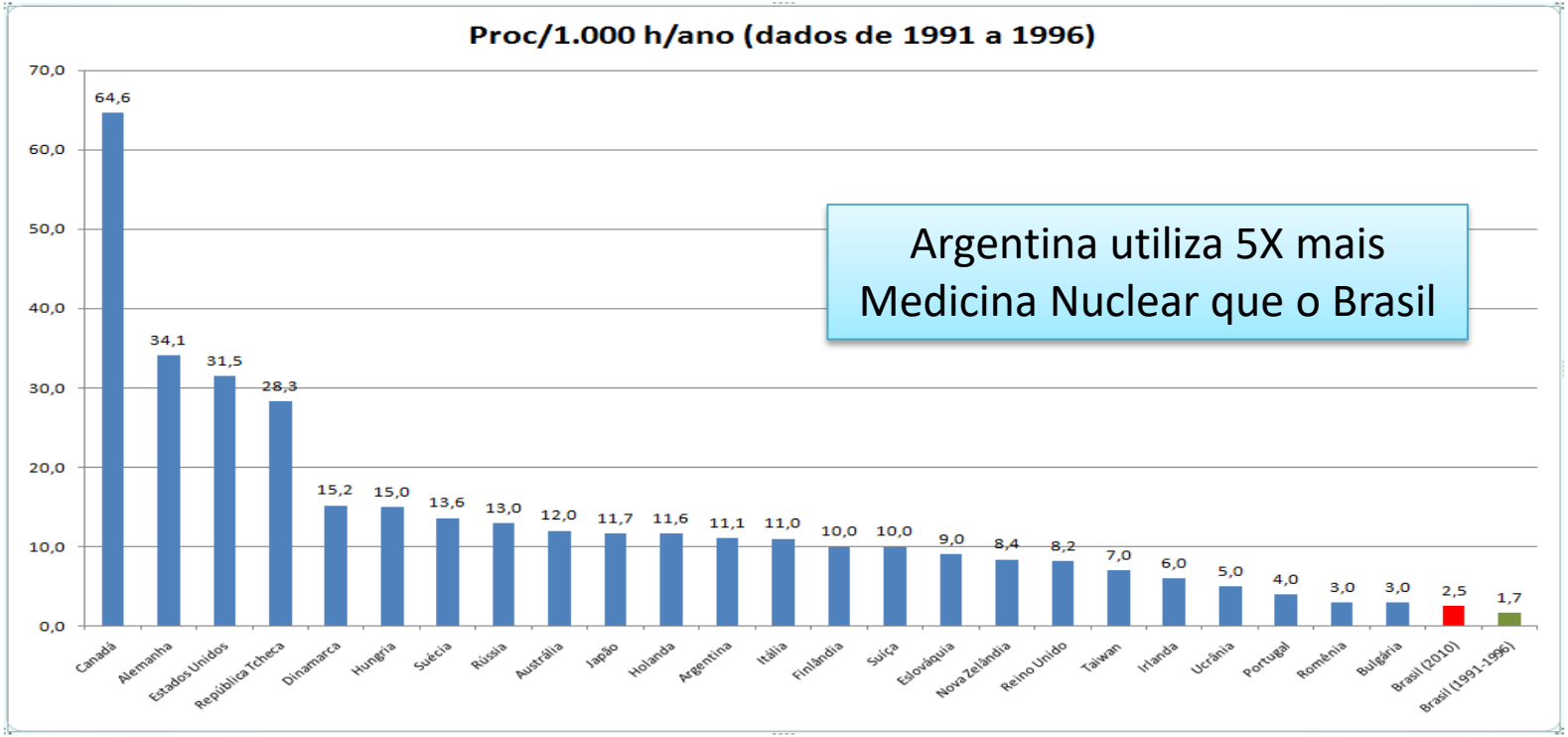
População: 45 milhões

Relação PET/milhão hab: 0,9
Relação SPECT/milhão hab: 5,3

Indicações Aprovadas PET CT 2019



Procedimentos de Medicina Nuclear em Diversos Países



Beatriz Leme, economista, SBMN 2012

PET research in Brazil: how are we so far?

Wiefels et al

BRAZIL x BRASIL x PET x POSITRON EMISSION TOMOGRAPHY

AT LEAST ONE BRAZILIAN AUTHOR
RESEARCH CONDUCTED IN BRAZIL

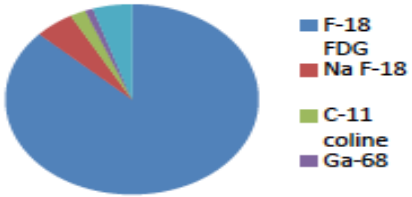
418 → 100 ARTICLES MET ALL THE CRITERIAS

RESULTS

- 17,960 J Clin Oncol
- 5,800 Eur J Surg Oncol

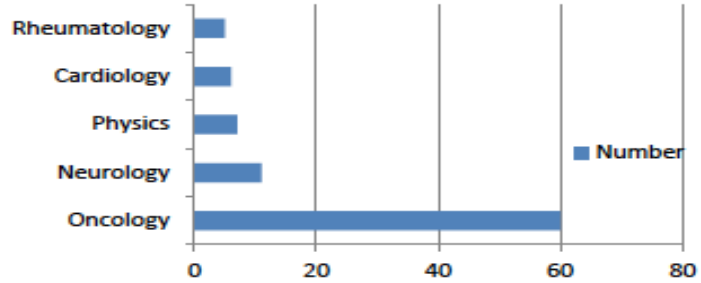
Low impact factors (ISI Web of Knowledge)

Radioisotope used



407 NUCLEAR MEDICINE SERVICES
102 SERVICES WITH PET

Areas of expertise



Importance of international cooperation!!!

Demografia Médica

- 660 especialistas de medicina nuclear no País
- 55% estão no Sudeste
- 0,25% de todos os médicos especialistas registrados no Brasil

"Demografia Médica no Brasil – Vol. 2", do Conselho Federal de Medicina (CFM) e do Conselho Regional de Medicina do Estado de São Paulo (Cremesp).

European Heart Journal (2015) **36**, 1689–1696
doi:10.1093/eurheartj/ehv117

Current worldwide nuclear cardiology practices and radiation exposure: results from the 65 country IAEA Nuclear Cardiology Protocols Cross-Sectional Study (INCAPS)

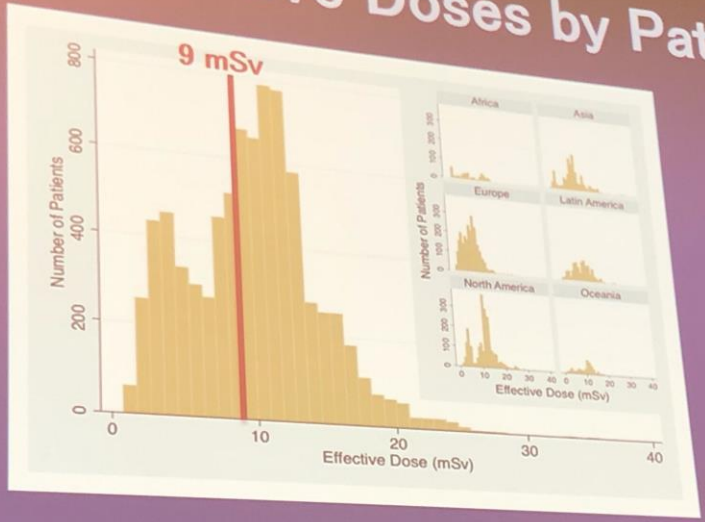
Andrew J. Einstein[1,2]*, Thomas N. B. Pascual[3], Mathew Mercuri[1], Ganesan Karthikeyan[4], João V. Vitola[5], John J. Mahmarian[6], Nathan Better[7], Salah E. Bouyoucef[8], Henry Hee-Seung Bom[9], Vikram Lele[10], V. Peter C. Magboo[11,12], Erick Alexánderson[13], Adel H. Allam[14], Mouaz H. Al-Mallah[15], Albert Flotats[16], Scott Jerome[17,18], Philipp A. Kaufmann[19], Osnat Luxenburg[20,21], Leslee J. Shaw[22], S. Richard Underwood[23,24], Madan M. Rehani[25], Ravi Kashyap[3], Diana Paez[3], and Maurizio Dondi[3], for the INCAPS Investigators Group

Table 1 Definitions of the eight best practices

1. **Avoid thallium stress:** No thallium stress tests were performed in patients ≤70 years old. SPECT MPI performed with thallium-201 is associated with a considerably higher radiation dose to patients than when it is performed with technetium-99m.[29] This excludes thallium rest-redistribution viability studies and stress-redistribution-reinjection stress-and-viability studies.
2. **Avoid dual isotope:** No dual isotope (rest thallium and stress technetium) stress tests were performed in patients ≤70 years old. Dual isotope MPI is associated with the highest radiation dose of any protocol.[29]
3. **Avoid too much technetium:** No study was performed with administered activity >1332 MBq (36 mCi) for an injection of technetium, and mean total effective dose was <15 mSv for all studies using just technetium injections. 1332 MBq is the highest recommended activity in guidelines,[15] and 15 mSv is a high radiation dose for a study using technetium-99m.
4. **Avoid too much thallium:** For each nuclear stress test involving thallium, no more than 129.5 MBq (3.5 mCi) was administered at stress. The expert committee maintained that no more than this activity is needed for patients who are good candidates to receive thallium MPI.
5. **Perform stress-only imaging:** The laboratory performed at least one stress-only study, in which rest imaging was omitted, or the laboratory only does PET-based stress tests. If stress images are completely normal, subsequent rest imaging can be avoided to reduce radiation dose by up 80%. PET MPI studies have low radiation dose, the dosimetric advantage of stress-only is less, and there is less evidence regarding stress-only PET MPI.
6. **Use camera-based dose-reduction strategies**: The laboratory performed at least one study using at least one of the following: (i) attenuation correction (CT or line source), (ii) imaging patients in multiple positions, e.g. both supine and prone, (iii) high-technology software (e.g. incorporating iterative reconstruction, resolution recovery, and noise reduction), and (iv) high-technology hardware (e.g. PET, a high-efficiency solid-state SPECT camera, or a cardiac-focused collimator). Each of these approaches reduces the radiation dose needed or facilitates performance of stress-only imaging.
7. **Weight-based dosing for technetium:** The laboratory had a statistically significant positive correlation between patient weight and administered activity (MBq), for injections of technetium. Tailoring the administered activity to the patient size offers an opportunity to reduce radiation dose.
8. **Avoid inappropriate dosing that can lead to 'shine through' artefact**: The laboratory performed no SPECT MPI studies with technetium rest and stress injections on the same day, in which activity of the second injection was <3× that of the first injection. Shine through occurs in two injection, single-day technetium studies when residual radioactivity from the first injection interferes with interpretation of images for the second injection. To avoid shine through, it is recommended in guidelines that the activity (mCi or MBq) imaged for the second injection be at least three to four times that of the first injection; in some cases, this can be achieved with a second injection that has less than four times the activity by waiting for some of the technetium-99 m to decay. Reflecting guidelines, we considered a second injection of less than three times the activity of the first injection to constitute dosing that can lead to shine through.[14,15,21,30]

A committee of international experts convened at the IAEA, including physicians and medical physicists, developed these criteria to be applied to nuclear cardiology laboratories. SPECT, single-photon emission computed tomography; MPI, myocardial perfusion imaging; MBq, megabecquerel; mCi, millicurie; PET, positron emission tomography; CT, computed tomography.

Radiation Effective Doses by Patient



	Africa	Asia	Europe	Latin America	North America	Oceania	World	P
Mean	9.7	11.4	7.9	11.8	10.5	9.3	10.0	<0.001
IQR	5.1–15.6	9.2–13.5	5.1–10.1	8.4–14.6	8.0–12.9	6.5–11.7	6.7–12.7	n/a
Range	1.8–20.0	1.0–35.6	0.8–25.9	2.2–27.1	0.9–28.1	0.9–17.9	0.8–35.6	n/a
# with ED≤9mSv	173(50%)	358(24%)	1420(60%)	304(27%)	649(30%)	161(37%)	3065(39%)	<0.001

Original Article

Current Practices in Myocardial Perfusion Scintigraphy in Brazil and Adherence to the IAEA Recommendations: Results of a Cross-Sectional Study

Carlos Vitor Braga Rodrigues,[1] Anderson Oliveira,[2] Christiane Cigagna Wiefels,[1] Maurício de Souza Leão,[1] Cláudio Tinoco Mesquita[1]

Setor de Medicina Nuclear - Hospital Universitário Antônio Pedro (HUAP) - Universidade Federal Fluminense (UFF),[1] Niterói, RJ; Comissão Nacional de Energia Nuclear,[2] Rio de Janeiro, RJ – Brazil

Table 2 – Comparison of the mean numbers of myocardial perfusion scintigraphy (MPS) performed at the 63 nuclear medicine services

	N	Mean	Median	Standard deviation	p value
Number of MPS per month					
≥ 6 Good practices	13	298	280	230	0.043*
< 6 Good practices	50	186	120	304	

** Mann-Whitney U test*

Table 3 – Frequency (%) of the adoption of each good practice at the nuclear medicine services assessed in Brazil, 2016

Good practices	Brazil	
A	63	(100)
B	63	(100)
C	27	(42.86)
D	63	(100)
E	4	(6.35)
F	12	(19.05)
G	33	(52.38)
H	41	(65.08)

A: Avoid thallium-stress protocol; B: Avoid dual-isotope protocol; C: Avoid high Tc-99m activities; D: Avoid high Tl-201 activities; E: Perform only "Stress-Only"; F: Use strategies focused on dose reduction; G: Patient's weight-based activities; H: Avoid inappropriate activities that can generate the shine-through artifact.

Conclusion: A considerable number of NMS in Brazil have not adopted at least six practices recommended by the IAEA. Despite the difficulties found in nuclear practice in some Brazilian regions, almost all obstacles observed can be overcome with no cost increase, emphasizing the importance of developing strategies for adopting "good practices" when performing MPS. (Arq Bras Cardiol. 2018; 110(2):175-180)

AS SOLUÇÕES PARA MEDICINA NUCLEAR

Applicability of the Appropriate use Criteria for Myocardial Perfusion Scintigraphy

Anderson de Oliveira[1,2], Maria Fernanda Rezende[1,3], Renato Corrêa[3], Rodrigo Mousinho[3], Jader Cunha Azevedo[1,3], Sandra Marina Miranda[1], Aline Ribeiro Oliveira[1], Ricardo Fraga Gutterres[2], Evandro Tinoco Mesquita[1,3], Cláudio Tinoco Mesquita[1,3]

Universidade Federal Fluminense – UFF[1], Niterói, RJ; Comissão Nacional de Energia Nuclear – CNEN[2]; Hospital Pró-Cardíaco[3], Rio de Janeiro, RJ - Brazil

Table 2 – 2005 and 2009 ACC appropriateness criteria

	2005	2009
Criterion	**N (%)**	**N (%)**
Appropriate	255 (69.5)	249 (67.8)
Inappropriate	13 (3.5)	19 (5.2)
Uncertain	49 (13.6)	19 (5.2)
Nonclassifiable	50 (13.4)	80 (21.8)

Cintilografia Miocárdica:

68% dos procedimentos apropriados, Entretanto 27% das indicações são incertas/inclassificáveis.

Melhorar as diretrizes e ampliar o uso!

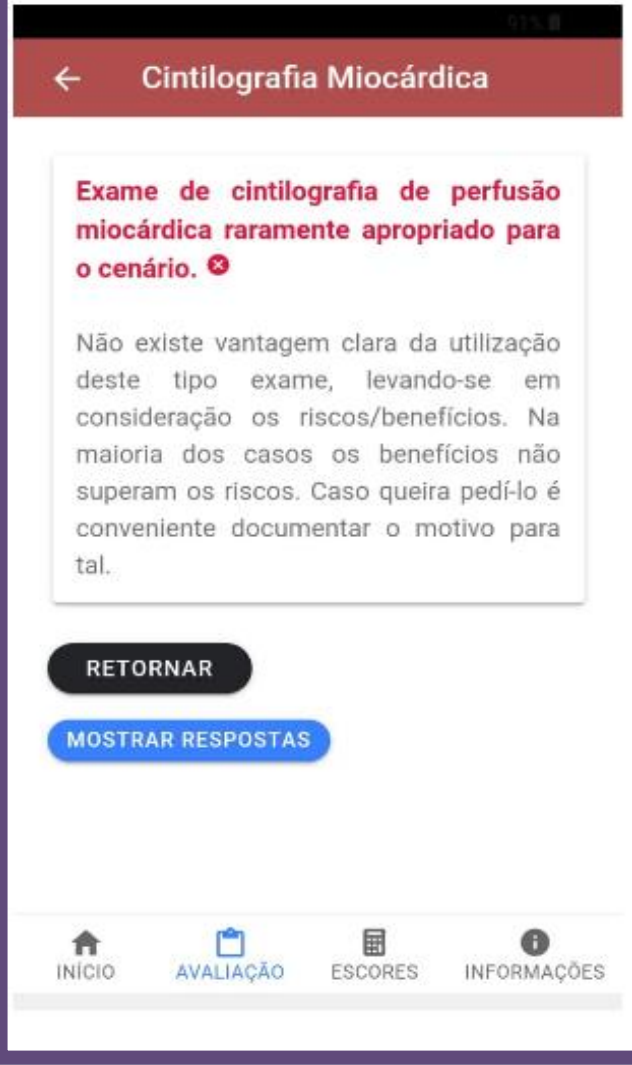
Arq Bras Cardiol. 2014; 103(5):375-381

Universidade Federal Fluminense
Pós Graduação em Ciências Cardiovasculares
Instituto de Computação - UFF

Uso de critérios de apropriação para solicitação adequada de cintilografias de perfusão miocárdica: um aplicativo para suporte a tomada de decisão

Erito Marques de Souza Filho, Eduardo de Oliveira Camara, Caio Mello, Flavio Luiz Seixas, Celine Lacerda de Abreu Soares, Ana Luisa Guedes de Franca e Silva, Fernando de Amorim Fernandes, Claudio Tinoco Mesquita


Cintilografia Miocárdica
Exame de cintilografia de perfusão miocárdica apropriado para o cenário.
Existe consenso geral sobre a vantagem da utilização deste exame, levando-se em consideração os riscos/benefícios.
RETORNAR
OCULTAR RESPOSTAS
Caminho da decisão:
Questionamento:
Selecione o objetivo da consulta:
Resposta:
- Avaliação de Viabilidade / Cardiomiopatia Isquêmica
Questionamento:
Paciente possui grave disfunção de VE conhecida?
INÍCIO
AVALIAÇÃO
ESCORES
INFORMAÇÕES


Cintilografia Miocárdica
Exame de cintilografia de perfusão miocárdica raramente apropriado para o cenário.
Não existe vantagem clara da utilização deste tipo exame, levando-se em consideração os riscos/benefícios. Na maioria dos casos os benefícios não superam os riscos. Caso queira pedí-lo é conveniente documentar o motivo para tal.
RETORNAR
MOSTRAR RESPOSTAS
INÍCIO
AVALIAÇÃO
ESCORES
INFORMAÇÕES


Cintilografia Miocárdica
Exame de cintilografia de perfusão miocárdica pode ser apropriado para o cenário.
Não existe consenso sobre as vantagens da utilização deste tipo exame, levando-se em consideração os riscos/benefícios. É recomendável analisar as condições clínicas e discutir junto ao paciente para a escolha.
RETORNAR
MOSTRAR RESPOSTAS
INÍCIO
AVALIAÇÃO
ESCORES
INFORMAÇÕES

Choosing Wisely
An initiative of the ABIM Foundation

ANS Agência Nacional de Saúde Suplementar

Reunião do Projeto Choosing Wisely Brasil Pacientes

Dra. Martha Oliveira

Rio de Janeiro, 30 de Setembro de 2016

Choosing Wisely
An initiative of the ABIM Foundation

American College of Cardiology
AMERICAN COLLEGE of CARDIOLOGY

Five Things Physicians and Patients Should Question

1. **Don't perform stress cardiac imaging or advanced non-invasive imaging in the initial evaluation of patients without cardiac symptoms unless high-risk markers are present.**

   Asymptomatic, low-risk patients account for up to 45 percent of unnecessary "screening." Testing should be performed only when the following findings are present: diabetes in patients older than 40-years-old; peripheral arterial disease; or greater than 2 percent yearly risk for coronary heart disease events.

2. **Don't perform annual stress cardiac imaging or advanced non-invasive imaging as part of routine follow-up in asymptomatic patients.**

   Performing stress cardiac imaging or advanced non-invasive imaging in patients without symptoms on a serial or scheduled pattern (e.g., every one to two years or at a heart procedure anniversary) rarely results in any meaningful change in patient management. This practice may, in fact, lead to unnecessary invasive procedures and excess radiation exposure without any proven impact on patients' outcomes. An exception to this rule would be for patients more than five years after a bypass operation.

3. **Don't perform stress cardiac imaging or advanced non-invasive imaging as a pre-operative assessment in patients scheduled to undergo low-risk non-cardiac surgery.**

   Non-invasive testing is not useful for patients undergoing low-risk non-cardiac surgery (e.g., cataract removal). These types of tests do not change the patient's clinical management or outcomes and will result in increased costs.

4. **Don't perform echocardiography as routine follow-up for mild, asymptomatic native valve disease in adult patients with no change in signs or symptoms.**

   Patients with native valve disease usually have years without symptoms before the onset of deterioration. An echocardiogram is not recommended yearly unless there is a change in clinical status.

5. In response to new science showing that complete revascularization of all significantly blocked arteries leads to better outcomes in some heart attack patients, the American College of Cardiology (ACC) has withdrawn its Choosing Wisely recommendation that patients and caregivers examine whether this practice is truly necessary.

   To read the complete statement from ACC on this recommendation please visit:
   http://www.cardiosource.org/news-media/media-center/news-releases/2014/09/choosing-wisely-statement.aspx

BRA2014003
BRAZIL
National Project IAEA
2016-2017

Supporting Quality Management Audits in Nuclear Medicine Practices (QUANUM) in Brazil

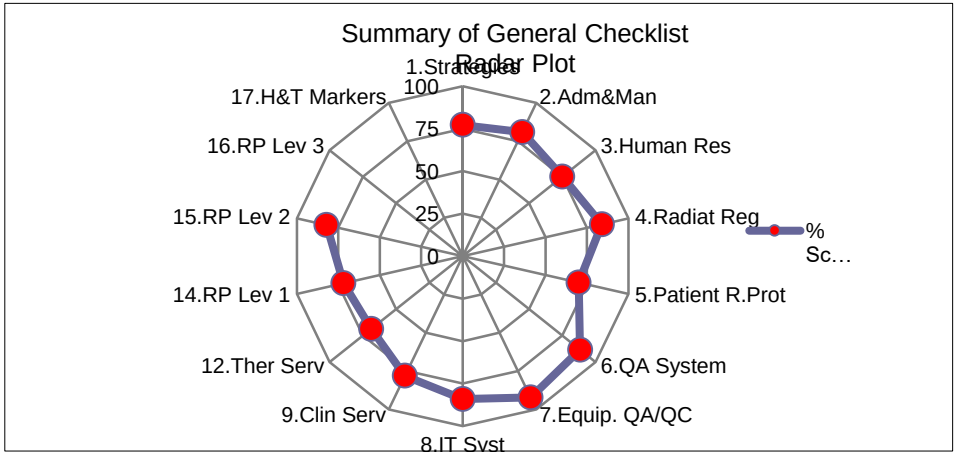
Claudio Tinoco Mesquita, MD, PhD.
Professor of Medicine and Chief of Nuclear Medicine Section
Universidade Federal Fluminense

Treinamento de auditores brasileiros QUANUM

Report Title:	QUANUM Audit
Host Institution	**Hospital Universitário Clementino Fraga Filho**
Project Number:	EX- BRA 6027-180695
Project Title:	Strengthening Quality Assurance in Nuclear Medicine
Name of Experts:	Leonel Torres, Teresa Massardo, Claudio T. Mesquita, Isabela C. Silverio, Fabio F. Ribeiro, Renata C. M. Felix, Tiago R. Jahn, Fernando A. Fernandes, Thaiana V. Cordeiro, Artus C. Andermann, Thalita G.N. Camila, Carlos Vitor Braga.
Dates of Mission:	March 18 to 22, 2019
Counterpart:	Maria Carolina Landesmann (Head of the Nuclear Medicine Service)

Universidade Federal Fluminense

UFRJ



RADIATION PROTECTION AND NM EQUIPMENT

4.9	Are there appropriate health surveillance procedures for the exposed workers, in accordance with the local regulatory body?	2 - Partially conform or partially implemented	

To coordinate with the General Manager of AP Hospital to implement a regular survillance programme for NM staff.

7.5	In the case of gamma cameras: have detailed acceptance tests been performed and the most relevant planar performance parameters been recorded?	2 - Partially conform or partially implemented	
7.6	In the case of SPECT systems: have detailed acceptance tests been performed and the most relevant tomographic performance parameters been recorded?	2 - Partially conform or partially implemented	
7.9	Are the results of acceptance tests and initial performance assessment used to establish baseline reference values for routine QA/QC?	2 - Partially conform or partially implemented	

To rescue the results of the whole set of acceptance tests in order to use them as reference values, otherwise to establish references values from the available information.

Continuous Improvement

7.14	Are the most relevant planar/SPECT parameters regularly checked, reviewed and recorded, including trend analysis: uniformity, spatial resolution, COR, SPECT performance, as well as other parameters considered critical in the internal QA programme?	4 - Fully conform or fully implemented	

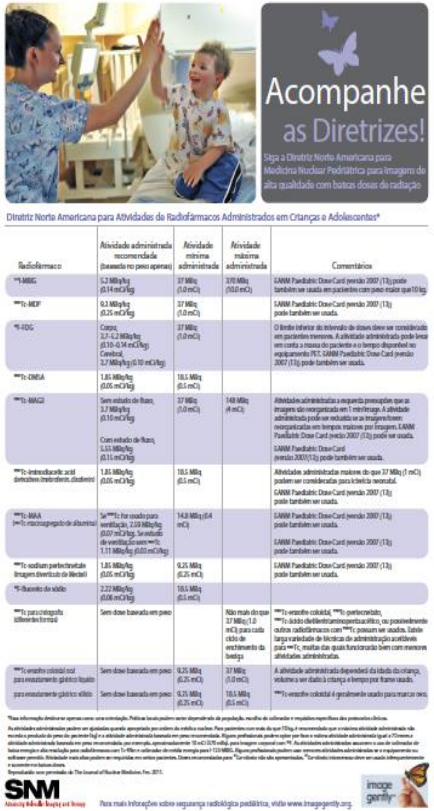
Sporadic test of SPECT total performance has been done due to a lack of Phantom for this porpuse
→ Acquire such a tool and test regularly TP.

4.10	Is protective clothing (e.g. gloves, syringe shields, handling tongs, etc.) available?	3 - Largely conform or largely implemented	

It is suggested to use the syringe shielding in order to decrease the radiation exposure of technologies

Melhoria das práticas

- Conhecer as dosimetrias dos protocolos
- Fazer auditorias e adotar boas práticas
- Image Gently
- Aumentar o uso dos critérios de adequação
- Aplicativos para conscientização de profissionais e pacientes



Chemo-radiotherapy?

Treatments historically governed by activity administered:

100 mCi radioiodine for thyroid ablation

200 mCi radioiodine for thyroid therapy

200 mCi Y-90 microspheres for treatment of liver metastases

200 mCi I-131 mIBG for neuroendocrine tumours

200 mCi x 4 for Y-90 DOTATATE of neuroendocrine tumours

200 mCi x 4 for Lu-177 DOTATATE for neuroendocrine tumours

200 mCi x 4 for Lu-177 PSMA for bone metastases

50 kBq/kg x 6 for Ra-223 for bone metastases

People are different

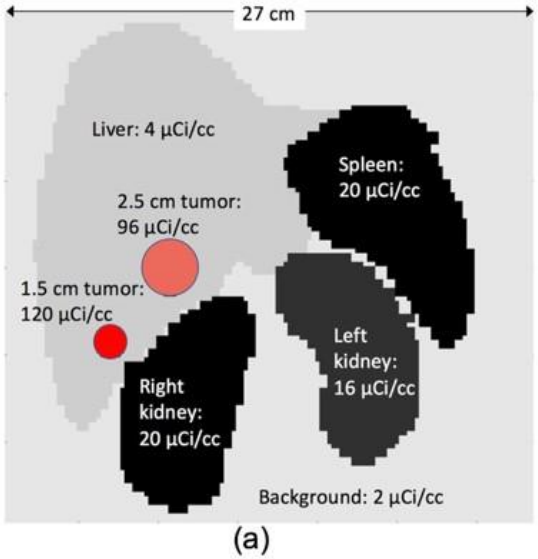
Biokinetics vary from patient to patient affecting uptake and retention
Radiosensitivities vary affecting response to treatment

Absorbed doses from fixed activities of I-131 NaI and Ra-223 vary by ~1 order of magnitude for organs at risk and 2 orders of magnitude for target volumes

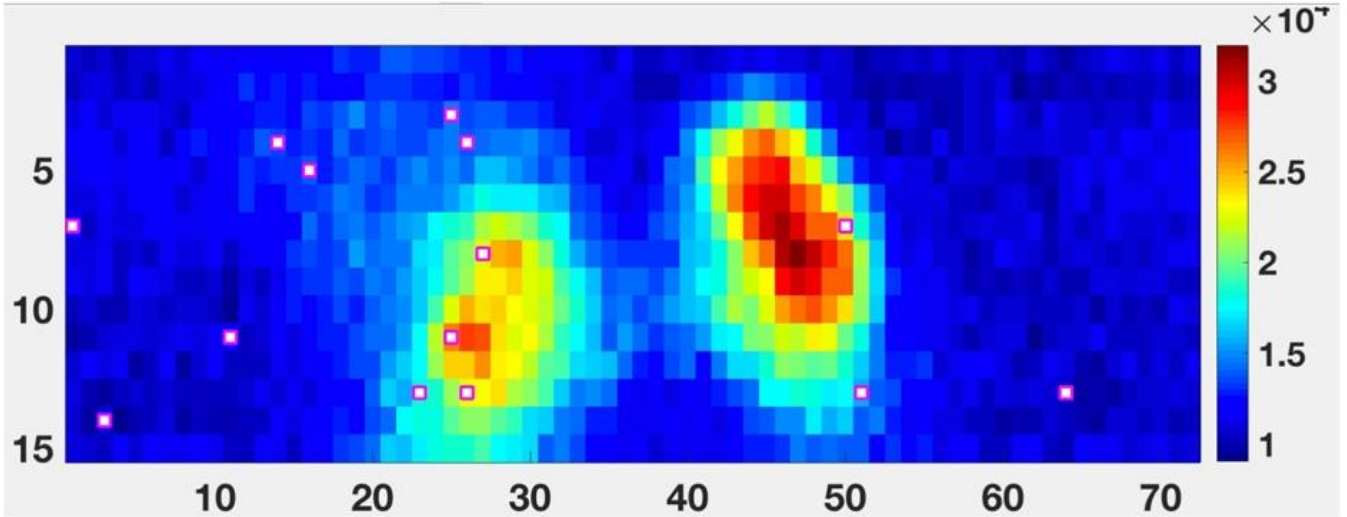
I-131 NaI for DTC (mGy / MBq)	Ra-223 for bone metastases (mGy / MBq)
Red marrow: Bianchi (2012) 0.04 – 0.4	Red marrow: Chittenden (2015) 177-994
Metastatic lesions: Kolbert (2007) 0.03 – 2.6	Lesions: Pacilio (2016) 0.9 – 8.9
Salivary glands: Jentzen (2006) 0.2 - 1.2	Kidneys: Chittenden (2015) 2-15
Thyroid remnants: Minguez (2016) 0.2 - 160	Bone surfaces Chittenden (2015) 2331 – 13118

ICR

Wearable Technology to Personalize Lu-177-DOTATATE Therapy for NETs

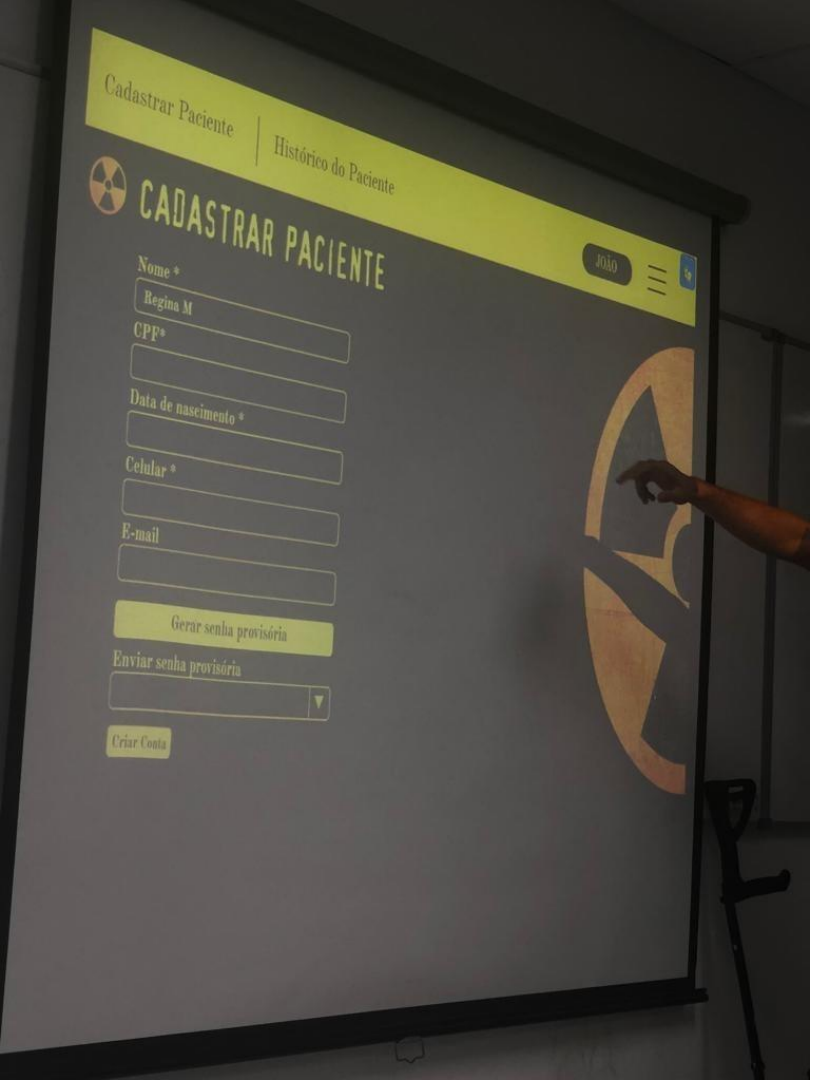


(a)



(b)

Aplicativos para controles de dose



Obrigado!