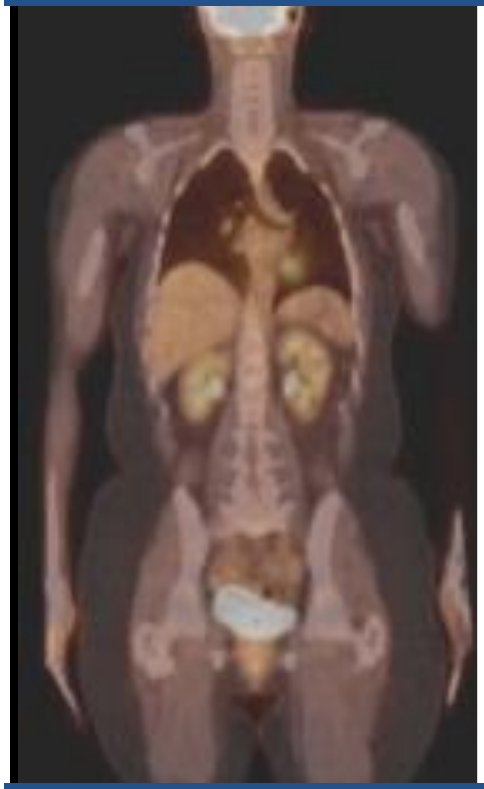


Medicina Nuclear na Oncologia

Juliano J. Cerci
Diretor do Serviço de PET/CT Quanta Diagnóstico
Presidente da Sociedade Brasileira de Medicina Nuclear
CRM 26363 PR

Santos . Out. 2019

O que é um Radiofármaco?

Isótopo Radioativo

Propriedades Físicas

Fármaco

Propriedades Fisiológicas

Radiofármaco

Núcleos

estáveis

com excesso de energia (radioativos)

Excesso de energia

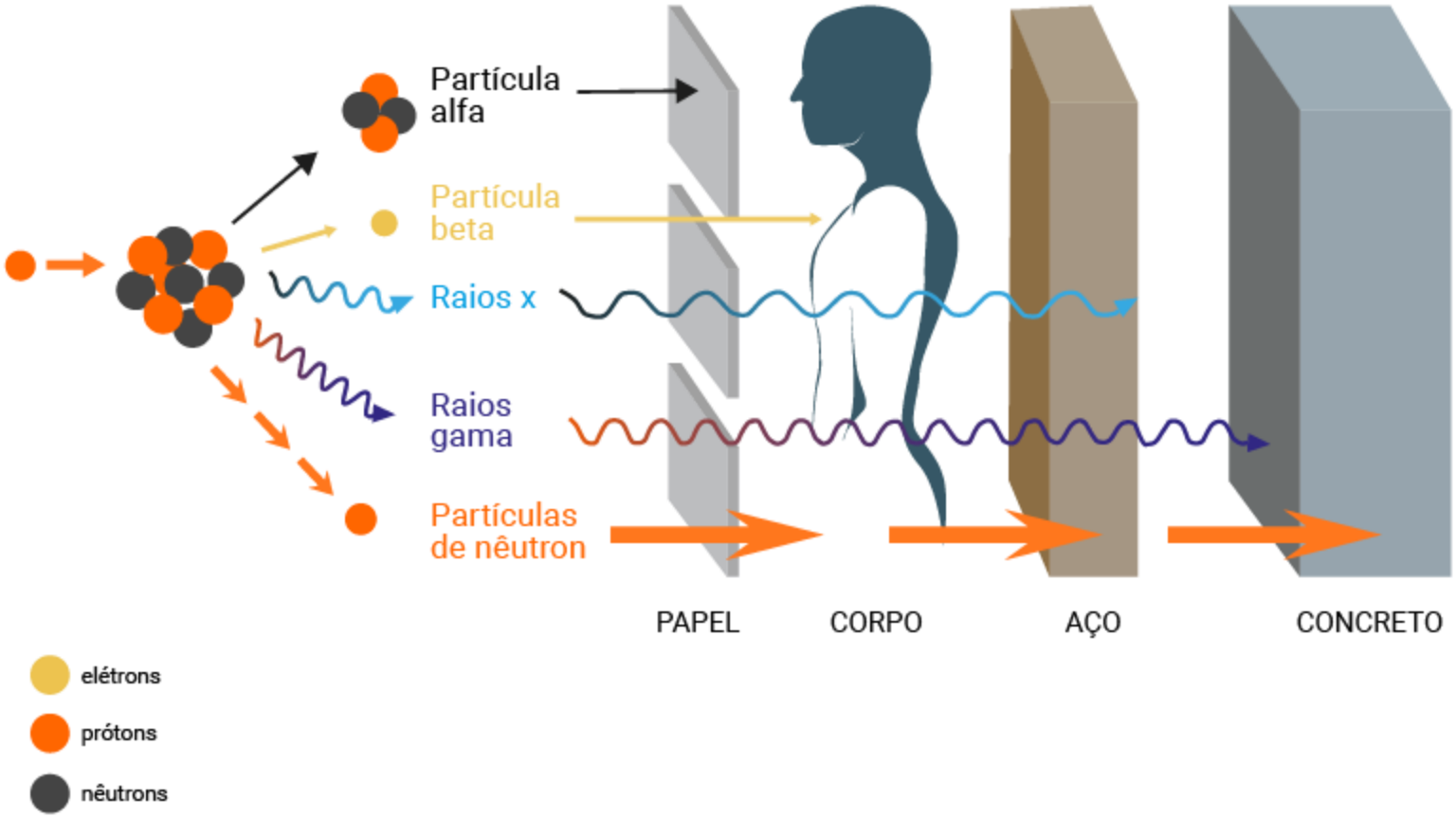
emitida em forma de matéria (partículas)

radiação α

radiação β

emitida em forma de ondas eletromagnéticas

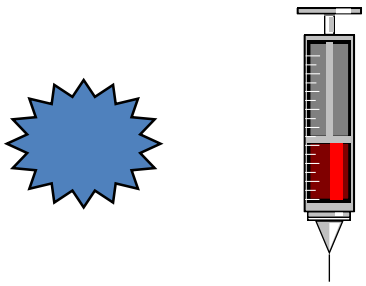
radiação γ

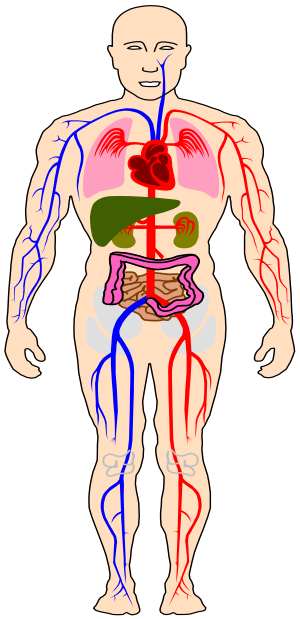

Partícula alfa
Partícula beta
Raios x
Raios gama
Partículas de nêutron
PAPEL
CORPO
AÇO
CONCRETO
elétrons
prótons
nêutrons

Uso médico de radioifármacos

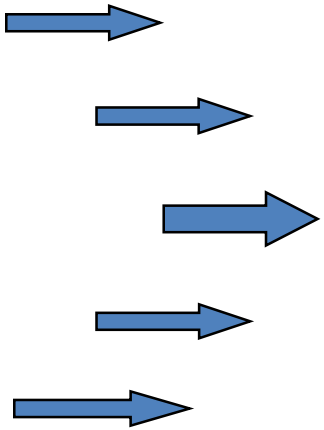
- Diagnósticos por Imagem e *in vitro*
- Terapias e pesquisas intra-operatórias

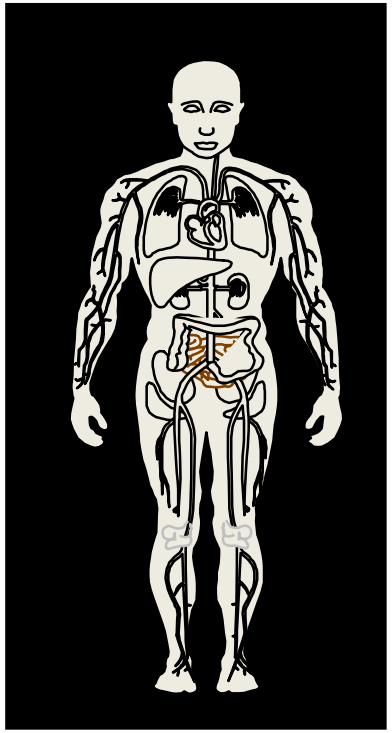
Radiofármaco





Radiação

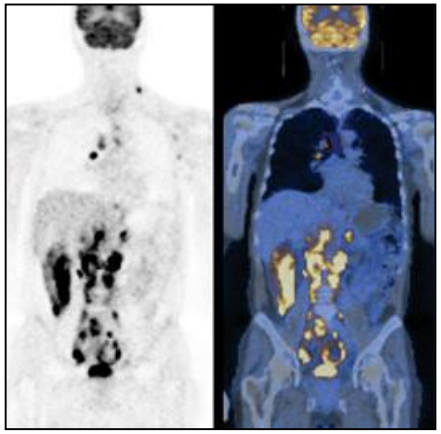


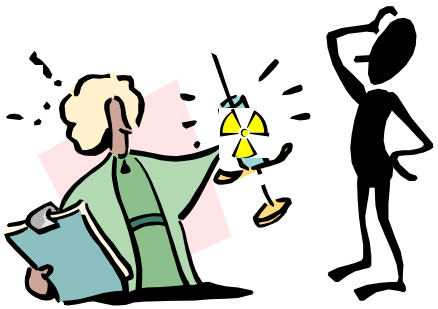


Modalidades de Diagnóstico por Imagem em Medicina Nuclear

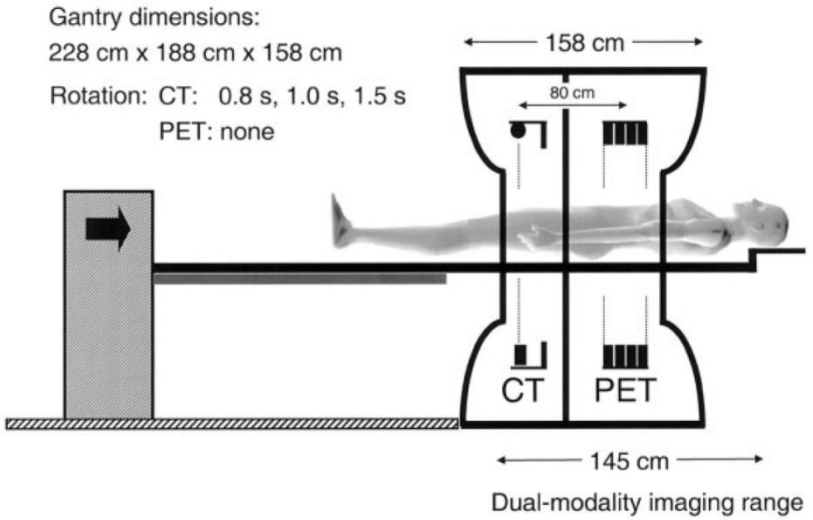
- Cintilografias – Imagens bidimensionais.
- Tomografia por emissão de fóton único ou SPECT - Imagens tridimensionais.
- Tomografia por emissão de pósitrons ou PET - Imagens tridimensionais.

Tomografia por Emissão de Pósitron

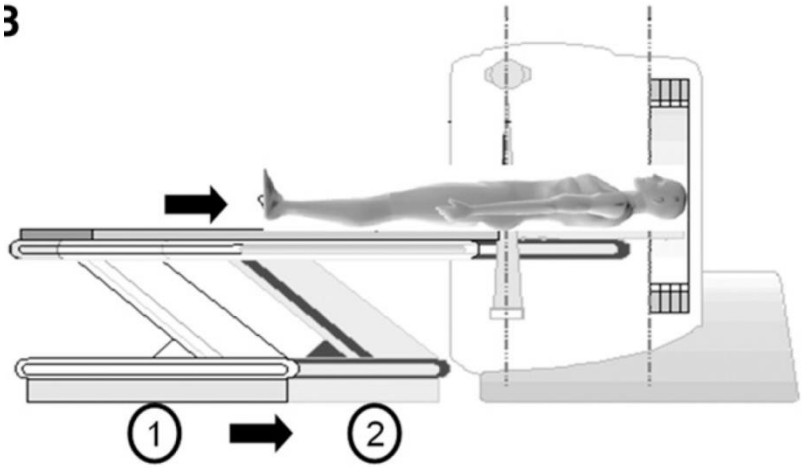




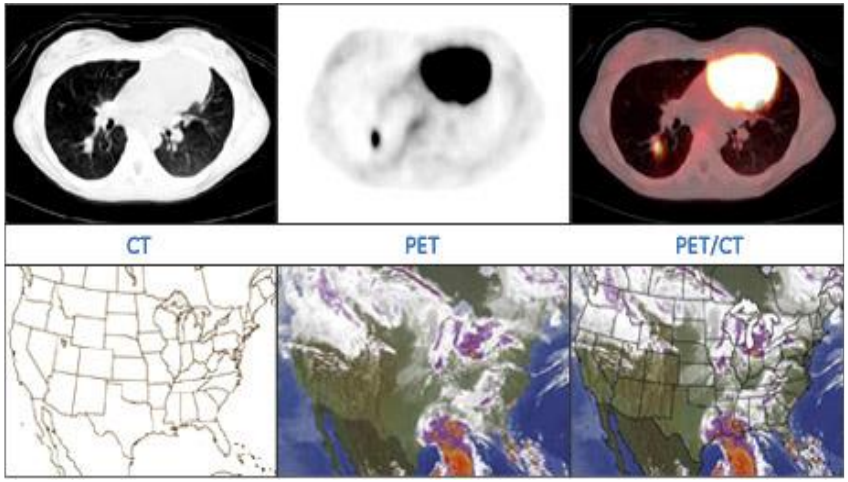
PET/CT



Dual-modality imaging range

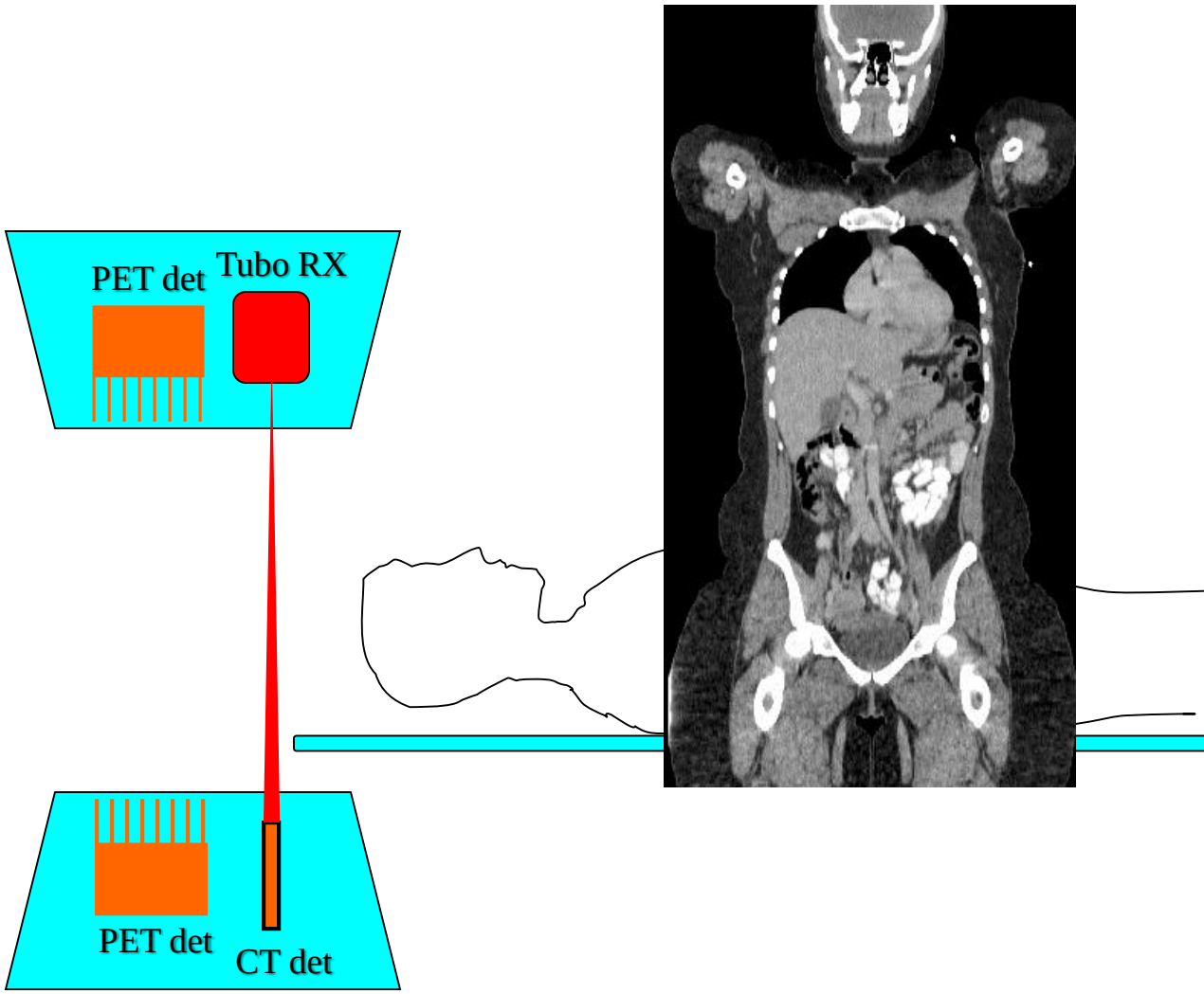


Variable cantilever point; dual positions



Protocolo PET/CT

MSCT
(20 segundos)

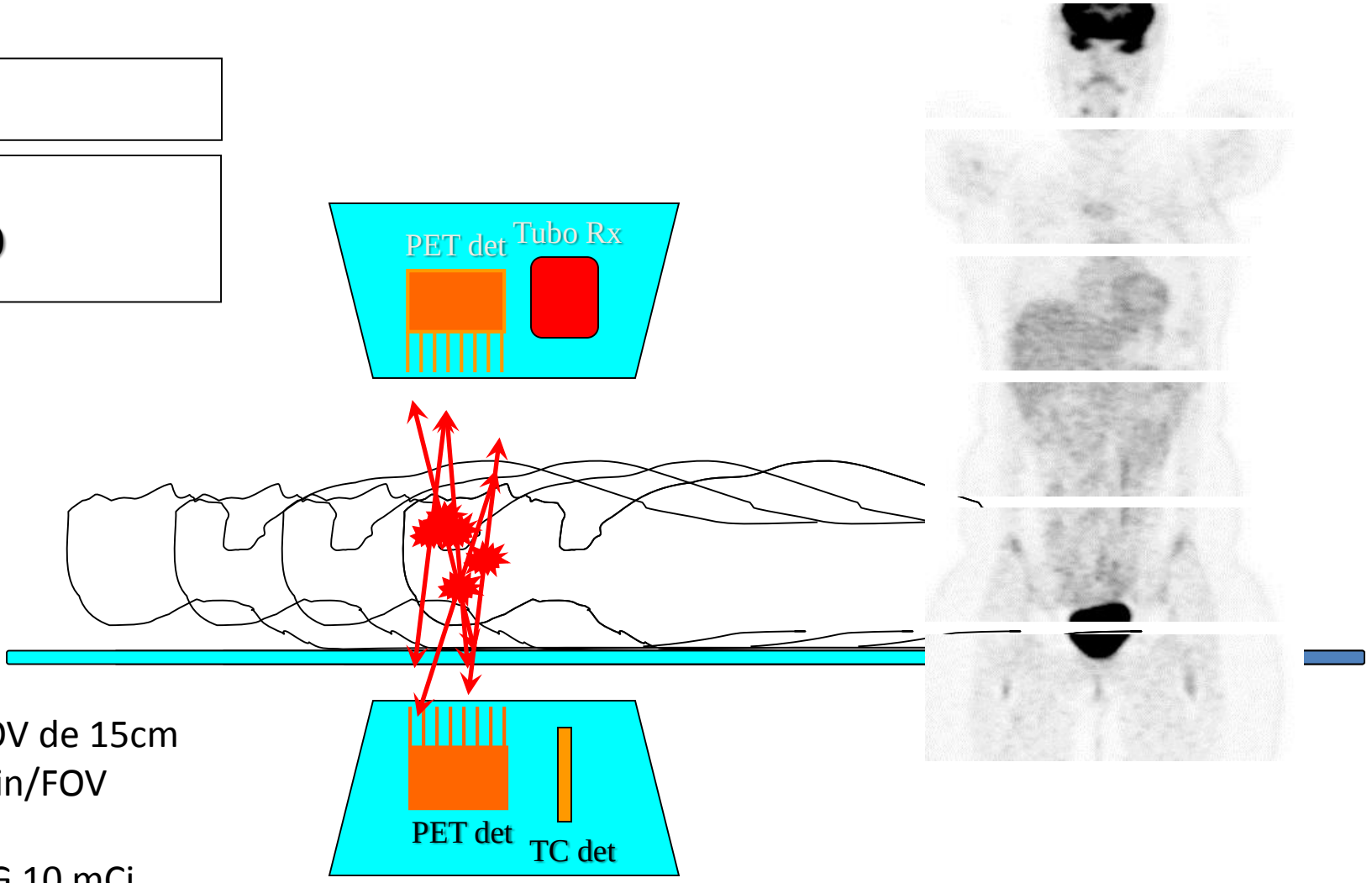


Courtesy of Dr. Osama Mawlawi & Tinsu Pan, MDA

Protocolo PET/CT

MSCT

PET scan
(10-35 min)



- 5 a 8 FOV de 15cm
- 1 a 5 min/FOV

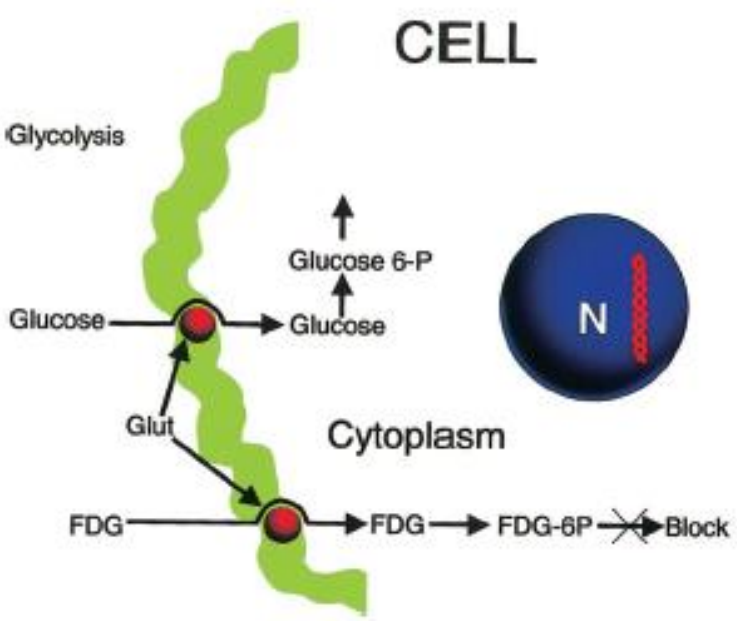
DOSE FDG 10 mCi
(0.14-0.22 mCi/Kg)

Courtesy of Dr. Osama Mawlawi & Tinsu Pan, MDA

PET-FDG em Oncologia

As células tumorais malignas possuem alta concentração de FDG comparada às células normais ou tumores benignos.

- Número aumentado de proteínas transportadora de glicose (Gluts)
- Aumento dos níveis de enzimas glicolíticas



FDG-PET/CT no Câncer

- Estadiamento inicial
- Avaliação de Resposta
- Suspeita de recaída

ESTADIAMENTO INICIAL

JOURNAL OF CLINICAL ONCOLOGY | SPECIAL ARTICLE

Recommendations for Initial Evaluation, Staging, and Response Assessment of Hodgkin and Non-Hodgkin Lymphoma: The Lugano Classification

Bruce D. Cheson, Richard I. Fisher, Sally F. Barrington, Franco Cavalli, Lawrence H. Schwartz, Emanuele Zucca, and T. Andrew Lister

Bruce D. Cheson, Georgetown University Hospital, Lombardi Comprehensive Cancer Center, Washington, DC; Richard I. Fisher, Fox Chase Cancer Center, Philadelphia, PA; Sally F. Barrington, St

See accompanying article doi: 10.1200/JCO.2013.53.5229

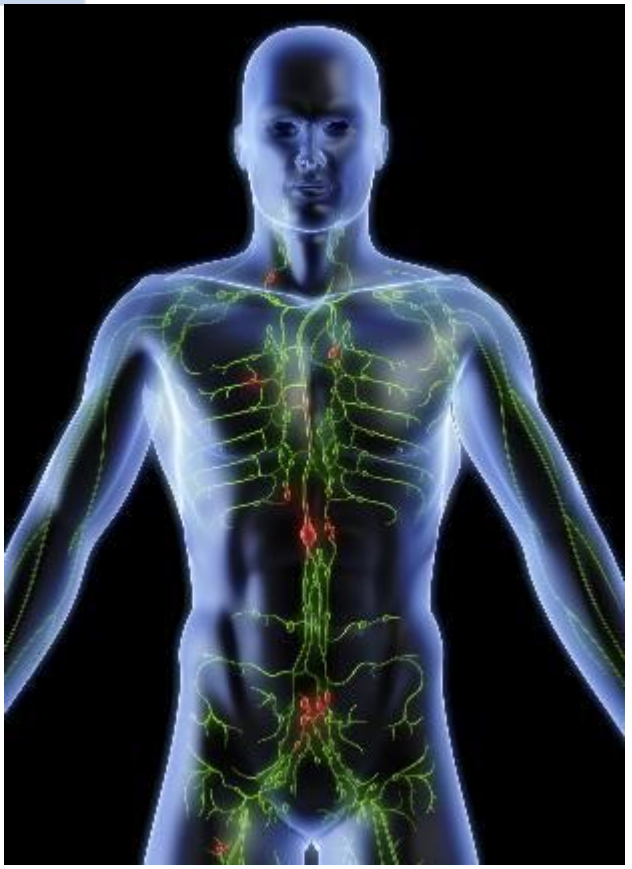
A B S T R A C T

Table 2. Revised Staging System for Primary Nodal Lymphomas

Stage	Involvement	Extranodal (E) Status
Limited		
I	One node or a group of adjacent nodes	Single extranodal lesions without nodal involvement
II	Two or more nodal groups on the same side of the diaphragm	Stage I or II by nodal extent with limited contiguous extranodal involvement
II bulky*	II as above with "bulky" disease	Not applicable
Advanced		
III	Nodes on both sides of the diaphragm; nodes above the diaphragm with spleen involvement	Not applicable
IV	Additional noncontiguous extralymphatic involvement	Not applicable

NOTE. Extent of disease is determined by positron emission tomography–computed tomography for avid lymphomas and computed tomography for nonavid histologies. Tonsils, Waldeyer's ring, and spleen are considered nodal tissue.

*Whether stage II bulky disease is treated as limited or advanced disease may be determined by histology and a number of prognostic factors.



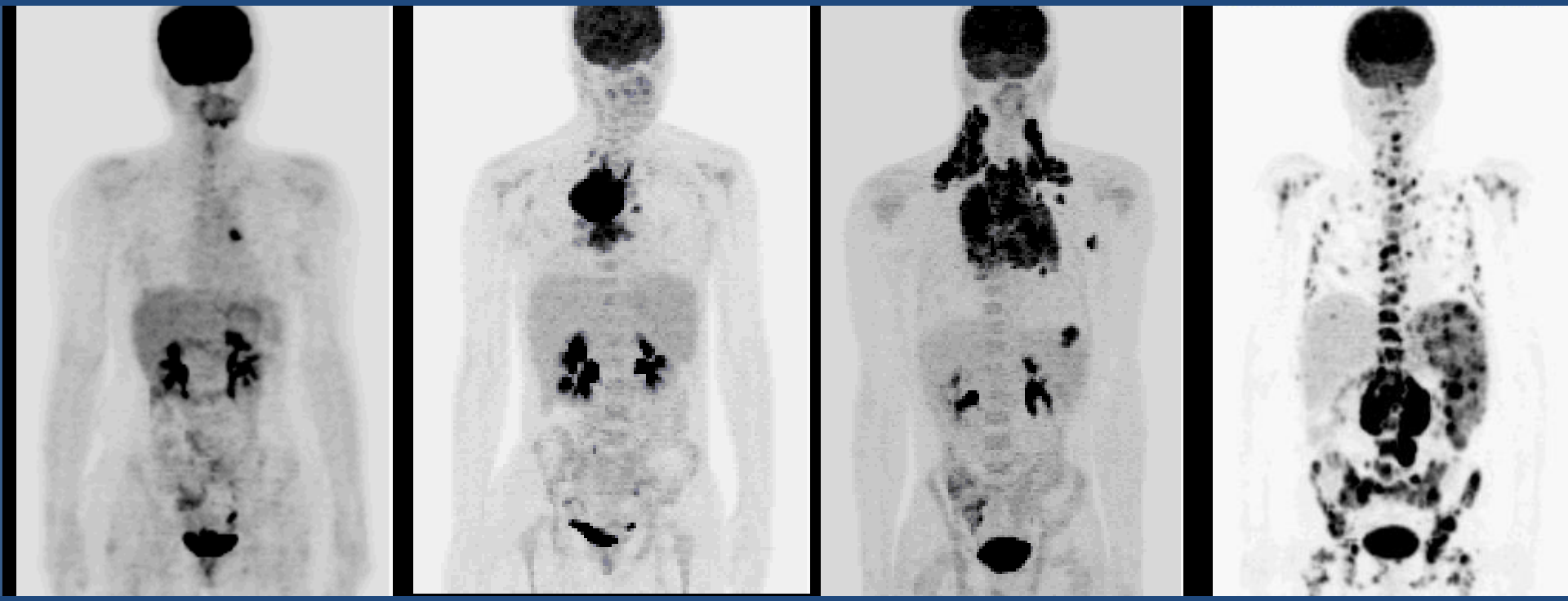
Estadiamento

ESTADIO I – Acometimento de um único linfonodo ou uma única cadeia linfonodal;

ESTÁDIO II - Acometimento de duas ou mais cadeias linfonodais não contíguas do mesmo lado do diafragma;

Estádio III - Acometimento de duas ou mais cadeias linfonodais ou baço, em ambos os lados do diafragma;

Estádio IV - Acometimento extranodal, mais freqüentemente pulmão, fígado, ossos e medula óssea.



Acervo do autor

PET/CT em Linfomas

• PET altera o estadio inicial em 20%-30% e muda a conduta em cerca de 10%-15% dos casos.

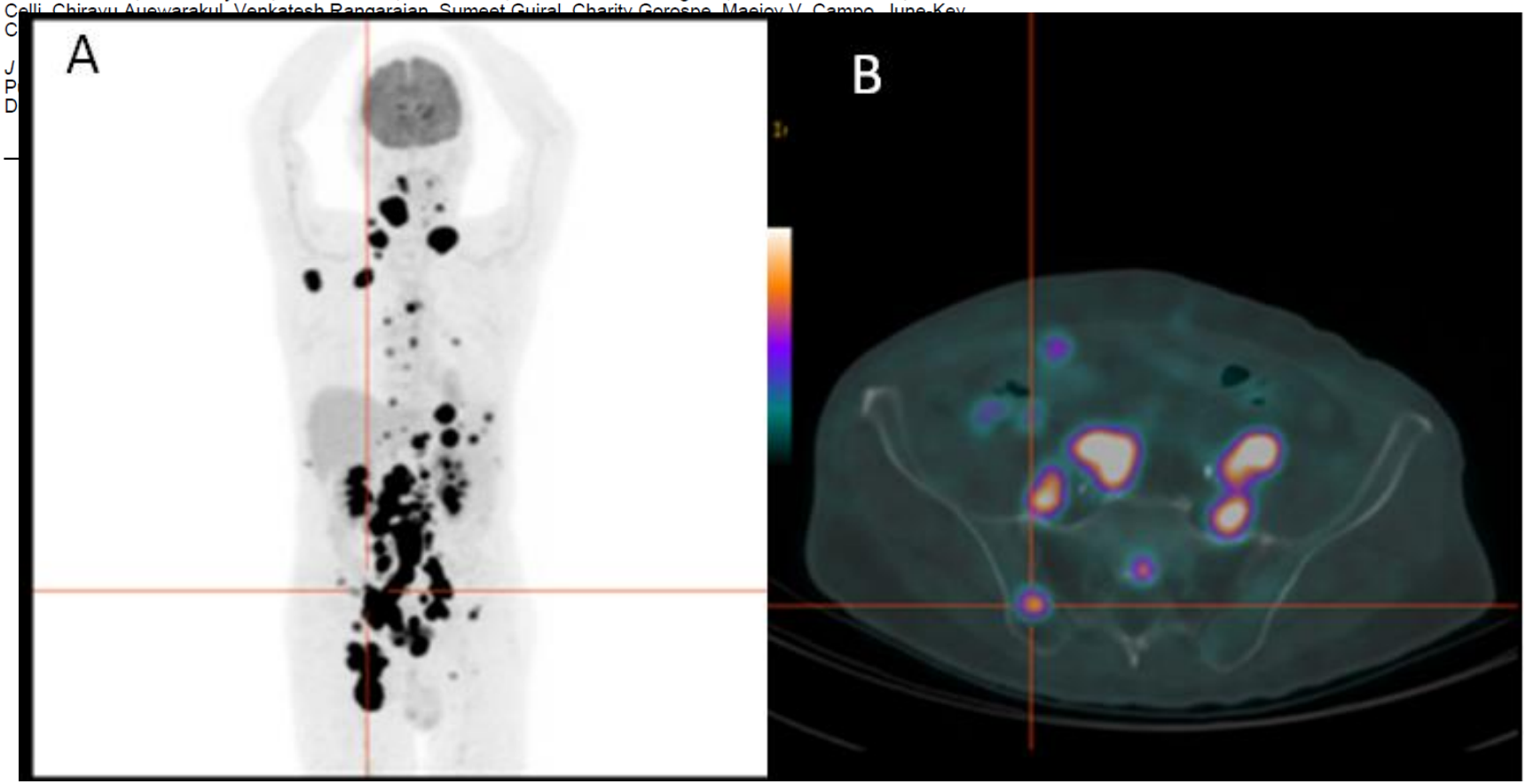
• Estadiamento acurado é importante para evitar o supertratamento de estadios precoces e subtratamento de estadios mais avançados.

Depas G, et al. Eur J Nucl Med Mol Imaging. 2005 Jan;32(1):31-8.
Riad R, et al. Eur J Nucl Med Mol Imaging. 2009 Sep 15.
Cheson BD. *J Clin Oncol* 10;29(14):1844-1854, 2011.

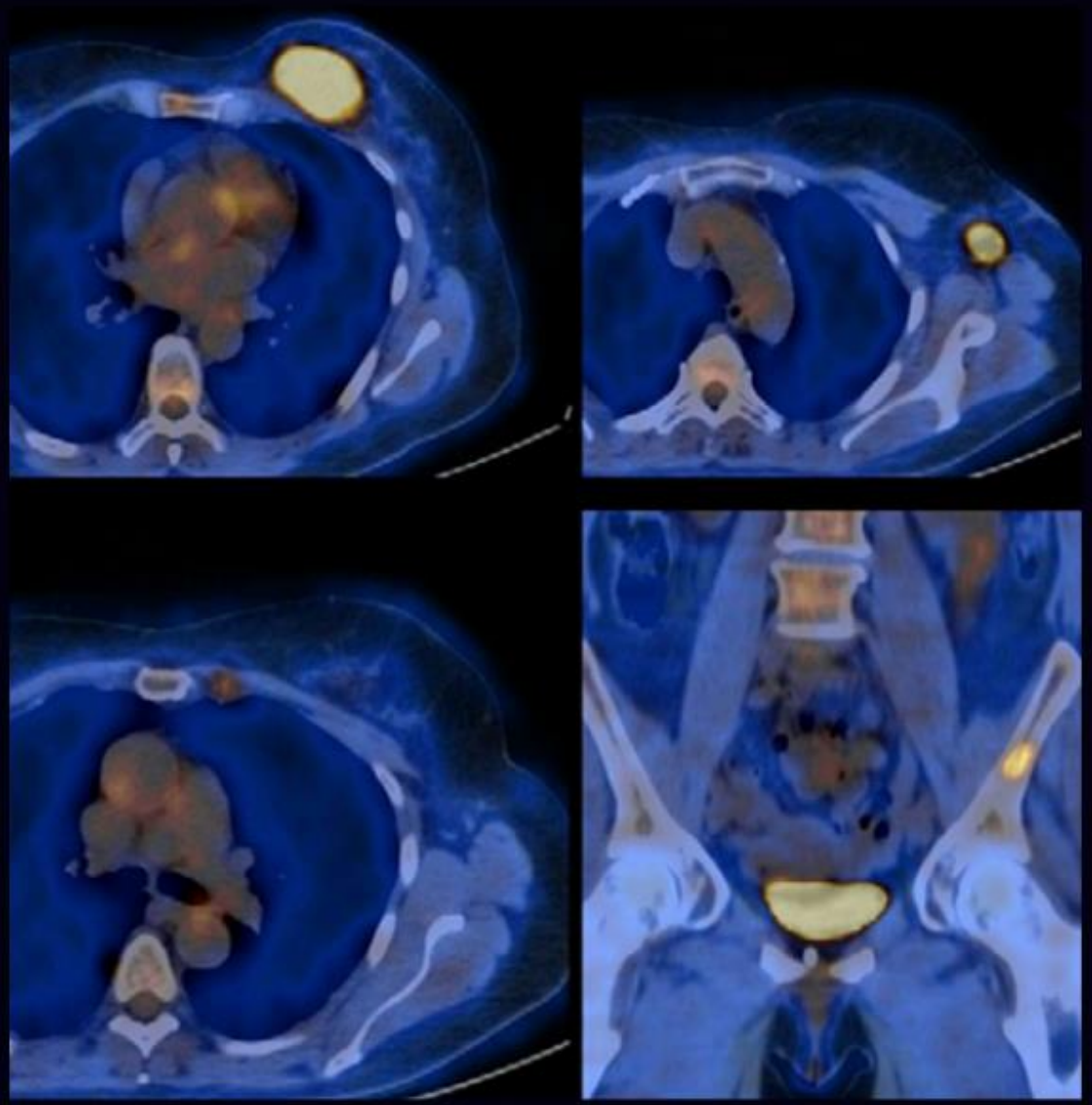
JNM The Journal of NUCLEAR MEDICINE

Combined PET and Biopsy Evidence of Marrow Involvement Improves Prognostic Prediction in Diffuse Large B-Cell Lymphoma

Juliano J. Cerci, Tamás Györke, Stefano Fanti, Diana Paez, José Cláudio Meneghetti, Francisca Redondo, Monica Celli, Chirayu Auewarakul, Venkatesh Rangarajan, Sumeet Guiral, Charity Gorospe, Maciey V. Campo, June-Key C



Male, 62 y.o. patient with DLBCL.
(A) multiple areas of focal FDG-uptake in bone marrow. FDG-PET/CT axial image
(B) focal uptake in right iliac crest (crossing red lines). Marrow histology: no DLBCL.



T3N2M0 → T3N3bM1

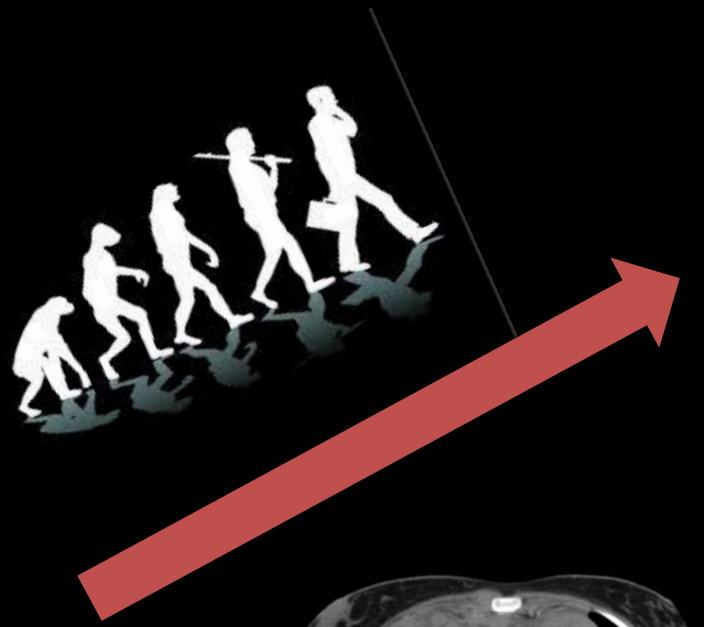
AVALIAÇÃO DE RESPOSTA

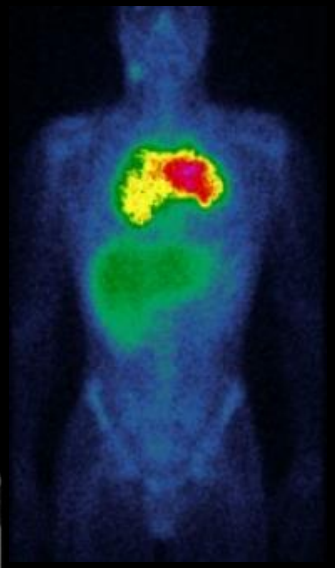
Pcte sexo masculino, 29 anos, LNH burkitt

4 ciclo

2 ciclo

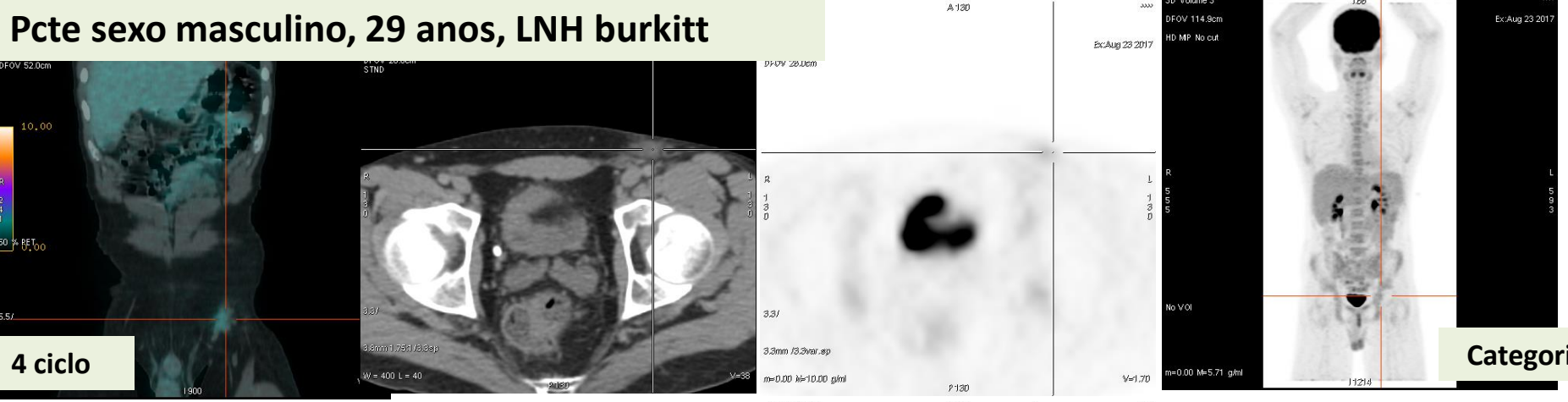
Inicial





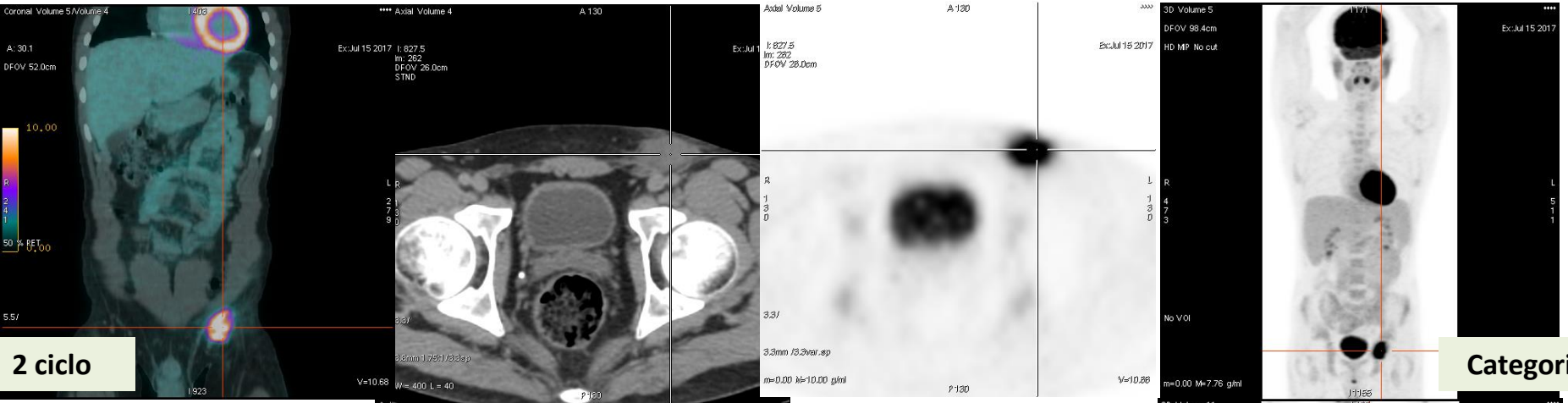

PA

Pcte sexo masculino, 29 anos, LNH burkitt



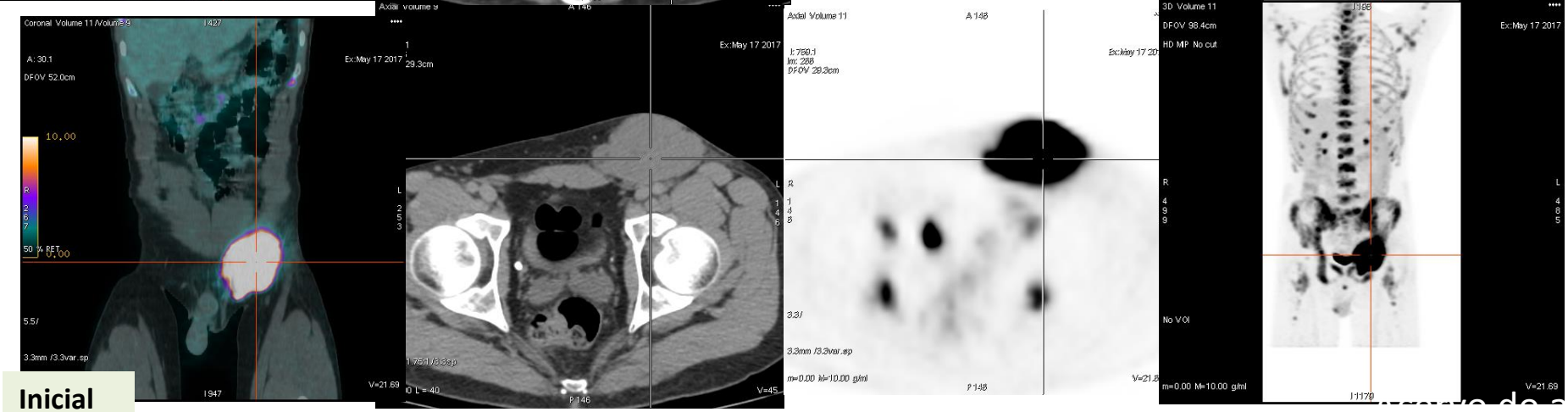
4 ciclo

Categoria 3



2 ciclo

Categoria 5



Inicial

JOURNAL OF CLINICAL ONCOLOGY SPECIAL ARTICLE

Recommendations for Initial Evaluation, Staging, and Response Assessment of Hodgkin and Non-Hodgkin Lymphoma: The Lugano Classification

Bruce D. Cheson, Richard I. Fisher, Sally F. Barrington, Franco Cavalli, Lawrence H. Schwartz, Emanuele Zucca, and T. Andrew Lister

Bruce D. Cheson, Georgetown University Hospital, Lombardi Comprehensive Cancer Center, Washington, DC; Richard I. Fisher, Fox Chase Cancer Center, Philadelphia, PA; Sally F. Barrington, St

See accompanying article doi: 10.1200/JCO.2013.53.5229

A B S T R A C T

VOLUME 25 · NUMBER 5 · FEBRUARY 10 2007

JOURNAL OF CLINICAL ONCOLOGY SPECIAL ARTICLE

Revised Response Criteria for Malignant Lymphoma

Bruce D. Cheson, Beate Pfistner, Malik E. Juweid, Randy D. Gascoyne, Lena Specht, Sandra J. Horning, Bertrand Coiffier, Richard I. Fisher, Anton Hagenbeek, Emanuele Zucca, Steven T. Rosen, Sigrid Stroobants, T. Andrew Lister, Richard T. Hoppe, Martin Dreyling, Kensei Tobinai, Julie M. Vose, Joseph M. Connors,

From the Division of Hematology/

J Clin Oncol. 1999 Apr;17(4):1244.

Report of an international workshop to standardize response criteria for non-Hodgkin's lymphomas. NCI Sponsored International Working Group.

Cheson BD[1], Horning SJ, Coiffier B, Shipp MA, Fisher RI, Connors JM, Lister TA, Vose J, Grillo-López A, Hagenbeek A, Cabanillas F, Klippensten D, Hiddemann W, Castellino R, Harris NL, Armitage JO, Carter W, Hoppe R, Canellos GP.

Author information

Erratum in
J Clin Oncol 2000 Jun;18(11):2351.

PET2 negativo (1,2 e 3)

Pcte sexo masculino, 48 anos

Estadiamento
EC*: IV (Pulmão)
IPI: >5

2 ciclo Qt
PET negativo

* Estádio clínico

Pacientes com bom prognóstico

Acervo do autor

PET2 positivo (4 e 5)

Paciente ♂, 26 a com diagnóstico de LH.

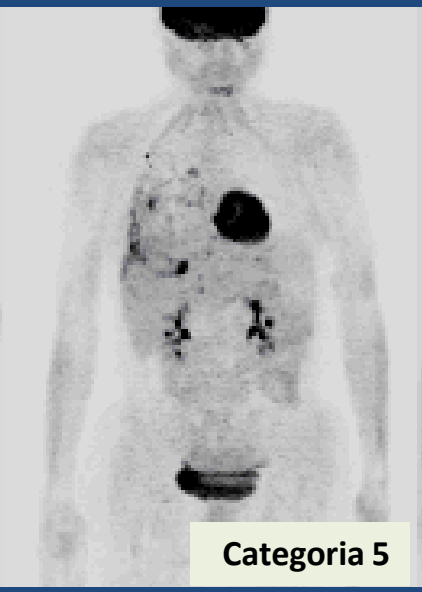
Estadiamento
EC: III
IPS: 2

2 ciclos ABVD
PET2 +

Paciente com pior prognostico

Acervo do autor

Pcte sexo feminino, 34 anos



Estadiamento
ECC: IV
BxMO: -

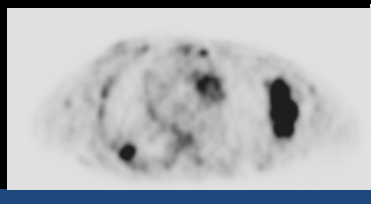
2 ciclo ABVD
PET +
Res parc

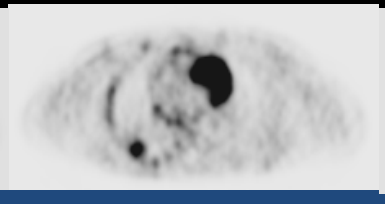
4 ciclo ABVD
PET +
Aus resp

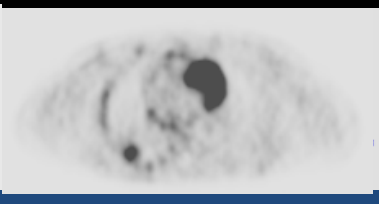
8 ciclo ABVD
PET +
Progressão

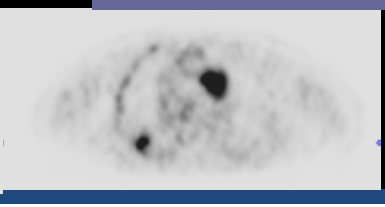
Após 1 mês
Tto TB

Bx: TB









Acervo do autor

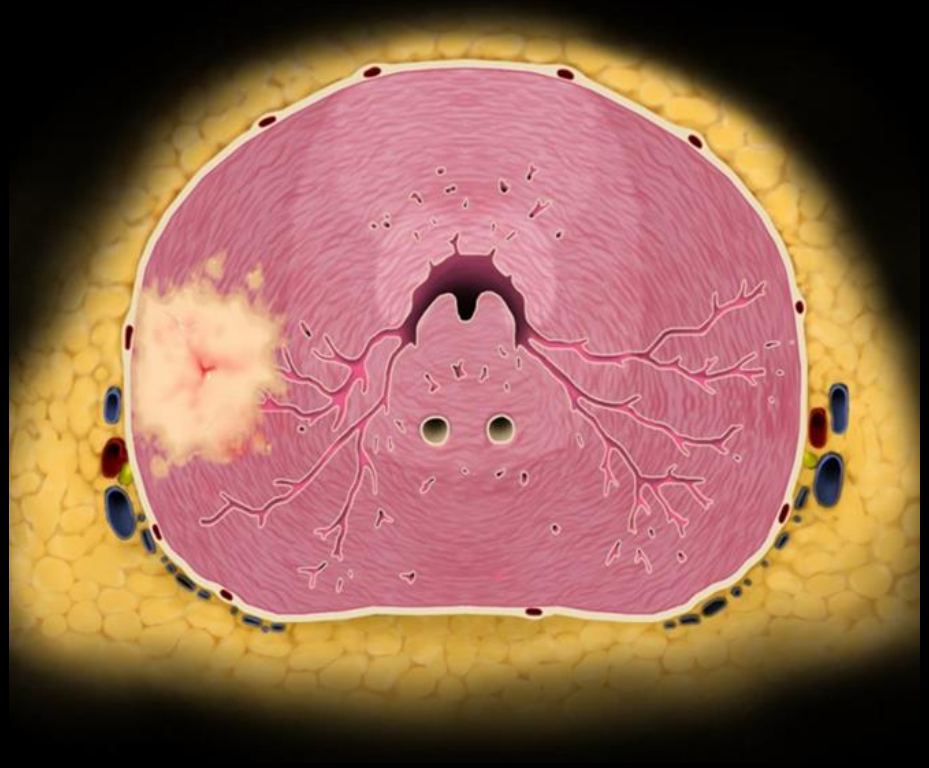
CÂNCER DE PRÓSTATA

- 2º câncer mais comum em homens a nível mundial (1º: pulmão)
- ~100% sobrevida / 5 anos (doença locorregional)
- >300.000 mortes em 2012 em todo o mundo
- Risco:

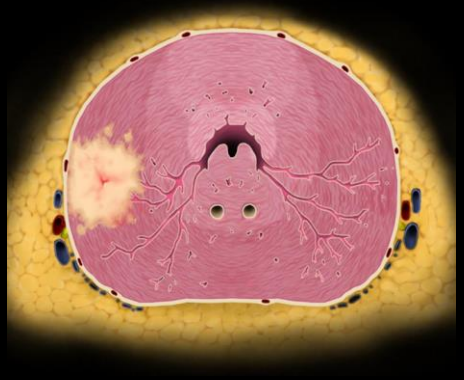
  → **IDADE**

  → **Hx FAMILIAR**

  → **POPULAÇÃO NEGRA**



Merriel SWD, Funston G, Hamilton W. Prostate Cancer in Primary Care. Adv Ther. 2018;35(9):1285–1294. doi:10.1007/s12325-018-0766-1



TRATAMENTO COM INTENÇÃO CURATIVA

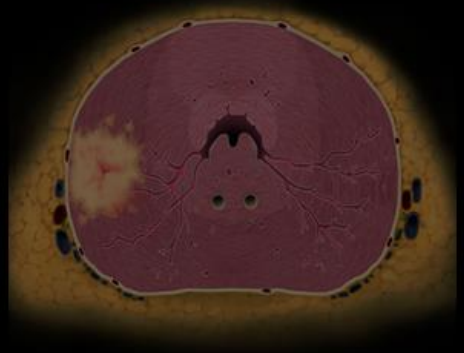
CIRURGIA

RADIOTERAPIA

TEMPO

DOENÇA CONTROLADA

DOENÇA NÃO CONTROLADA



TRATAMENTO COM INTENÇÃO CURATIVA

CIRURGIA

RADIOTERAPIA

~20-30%

~60%

TEMPO

DOENÇA CONTROLADA

DOENÇA NÃO CONTROLADA

RECIDIVA BIOQUÍMICA

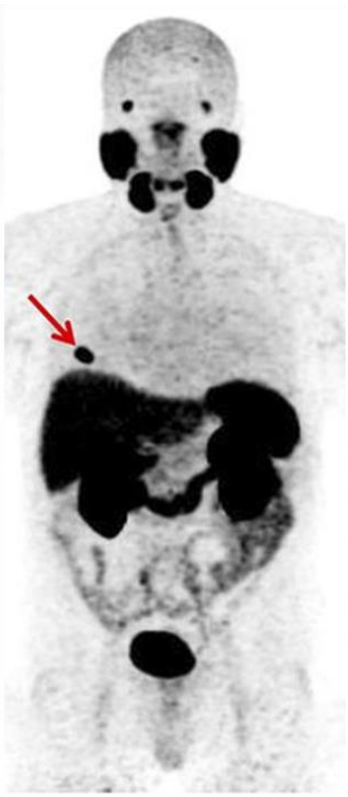
PSA ≥ 0,2 ng/mL em duas medidas consecutivas

^{68}Ga-PSMA

^{68}Ga-PSMA 11

Afshar et al, EJNMMI 2013

^{68}Ga-PSMA I&T



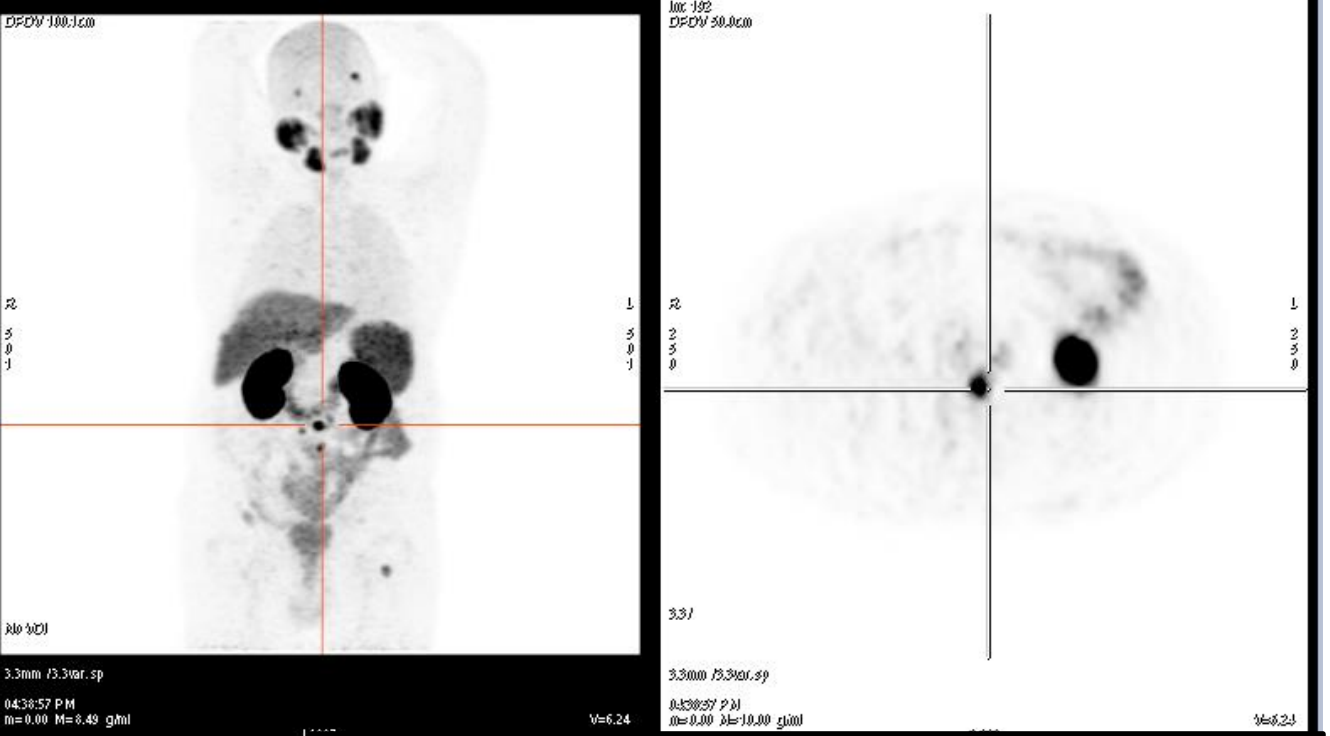
Herrmann et al, JNM 2015

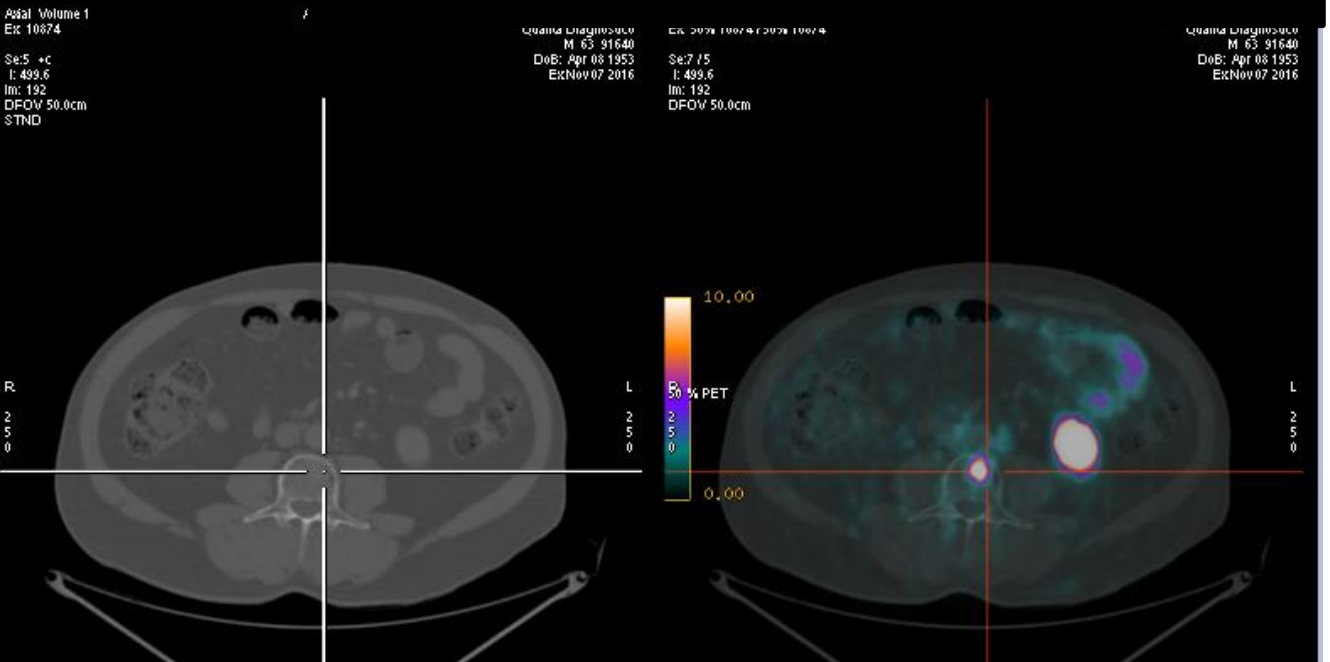
Aplicações chaves

- Falha bioquímica
- Estadiamento inicial
- *Planejamento de terapia e avaliação de resposta*

Sinônimos (PSMA-11):

HBED, HBED-CC, PSMAHBED, Glu-urea-Lys(Ahx)-HBED-CC, PSMA-HBED-CC or ProstaMedix™



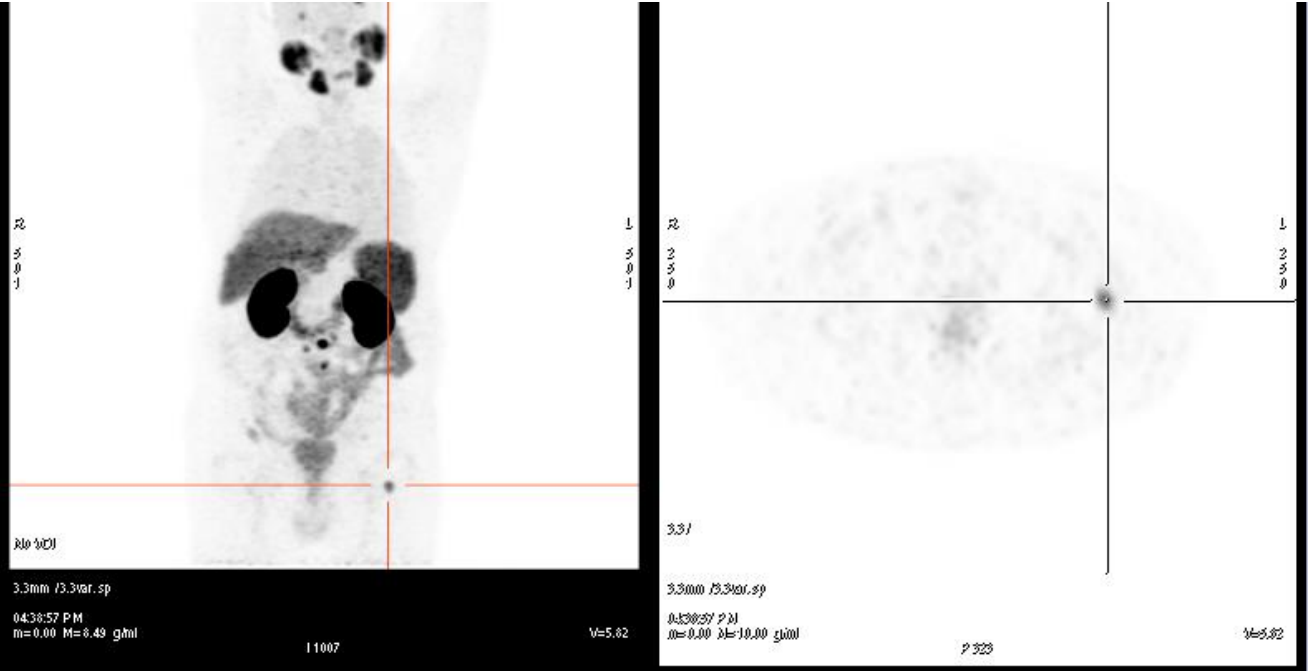


59 anos,

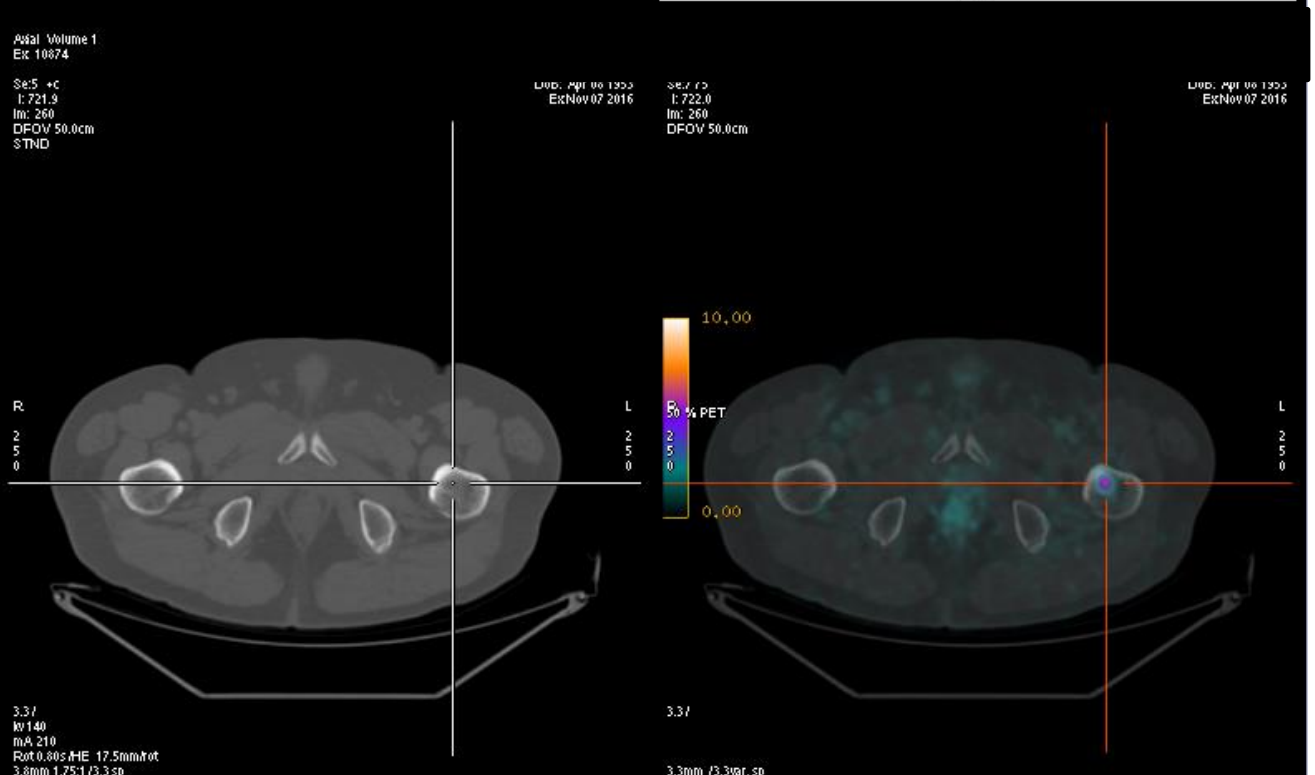
Ca de prostata

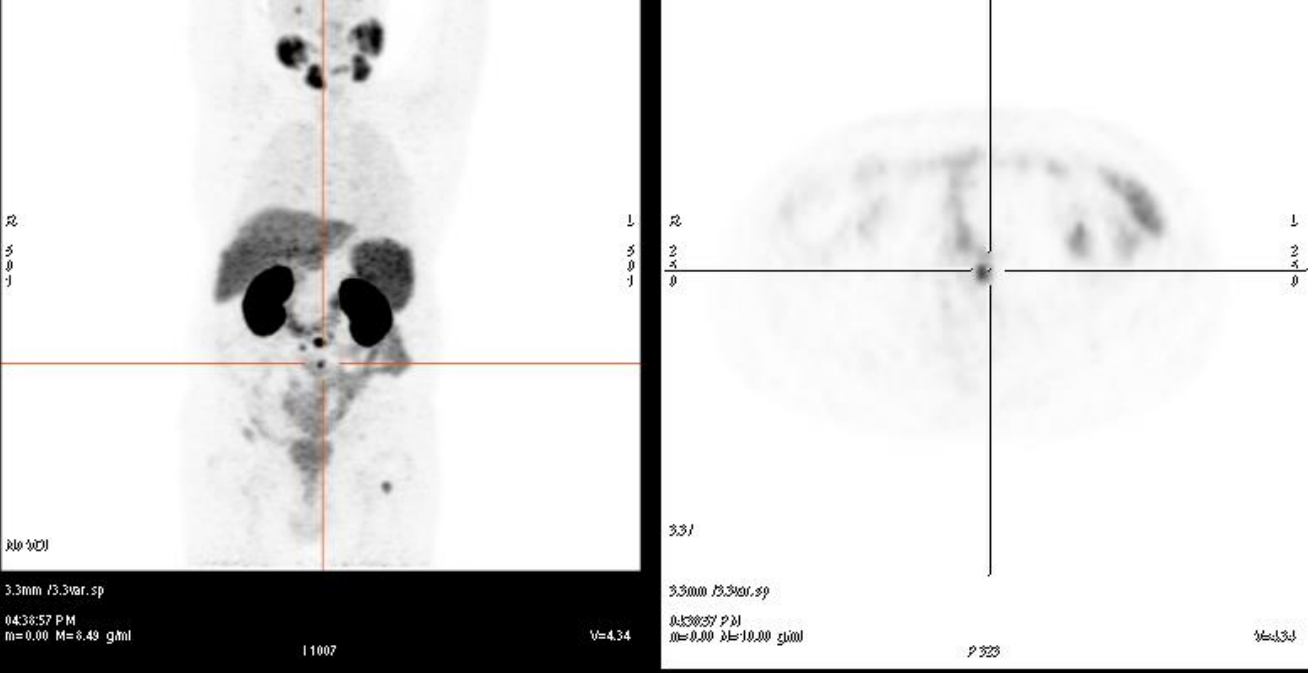
G: 4+4

PSA 0.4 ng/Ml


R
L
No VOI
3.3mm /3.3var.sp
04:38:57 PM
m=0.00 M=8.49 g/ml
V=5.82
I 1007

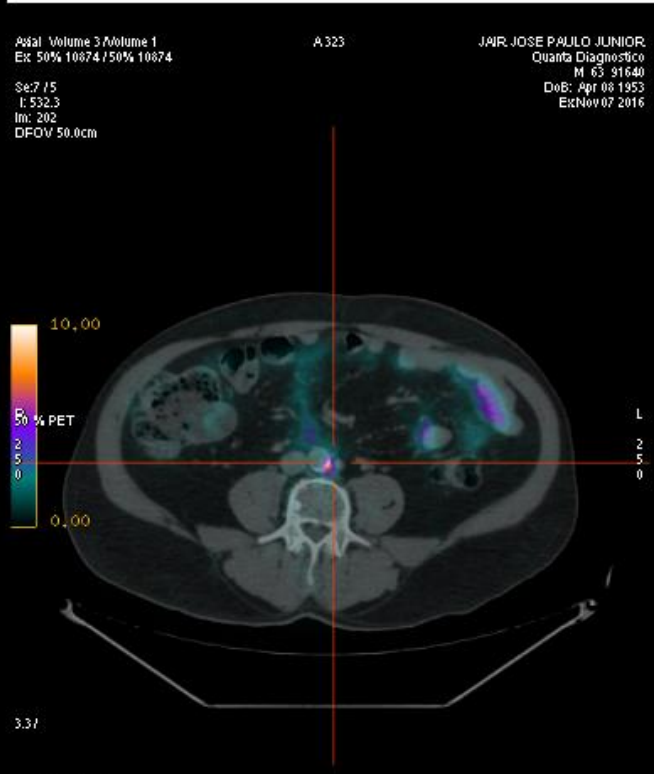
R
L
3.3mm /3.3var.sp
V=5.82

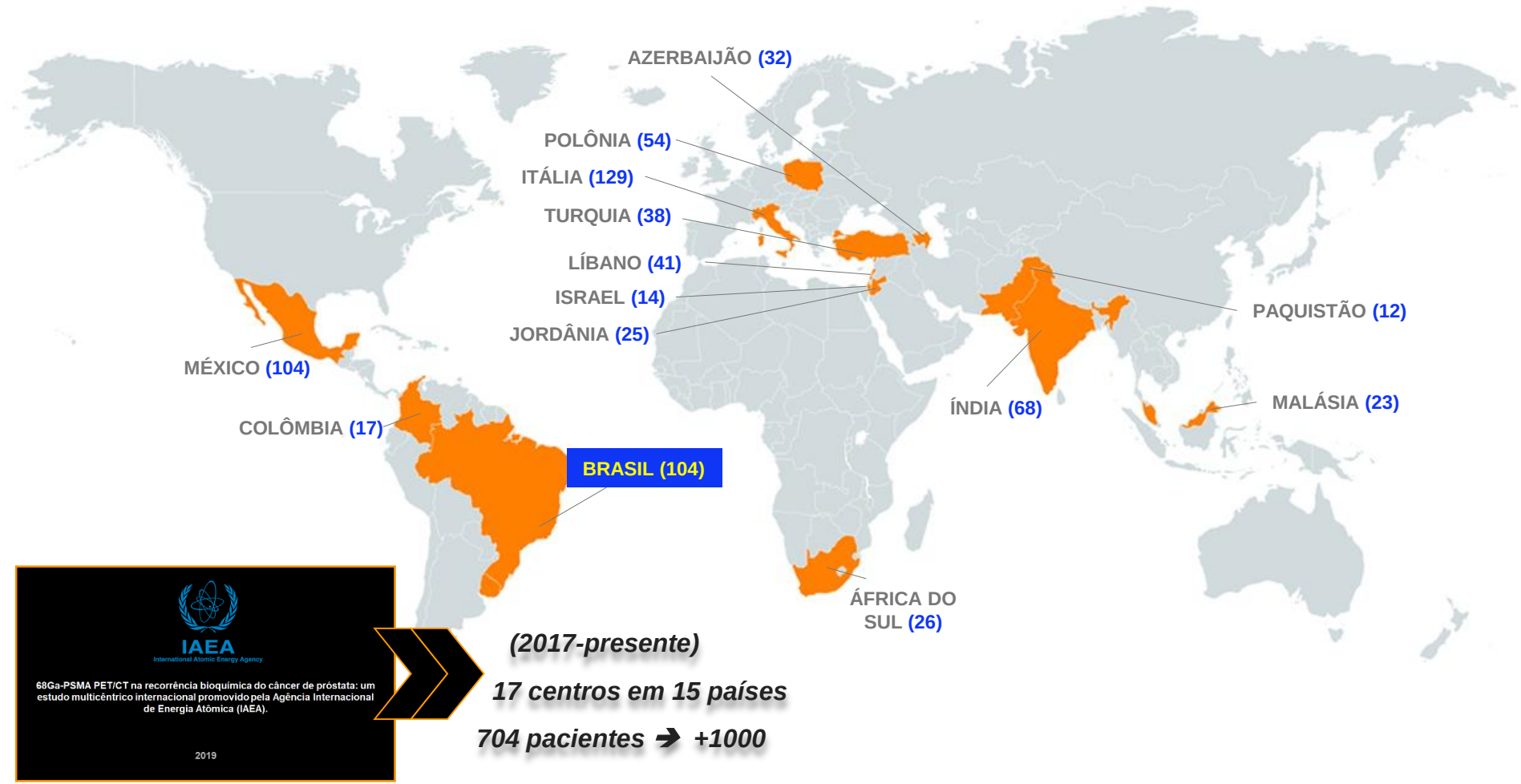

Axial Volume 1
Ex: 10874
Se:5 +c
I: 721.9
Im: 260
DFOV 50.0cm
STND
ExcNov 07 2016
R
L
3.3
kv 140
mA 210
Rot 0.80s /HE 17.5mm/rot
I: 722.0
Im: 260
DFOV 50.0cm
ExcNov 07 2016
10.00
% PET
0.00
3.3mm /3.3var.sp


R
L
3.3mm /3.3var.sp
04:38:57 PM
m=0.00 M=8.49 g/ml
V=4.34
I 1007

R
L
3.3mm /3.3var.sp
V=4.34
P 323


Axial Volume 1
Ex: 10874
A 323
JAIR JOSE PAULO JUNIOR
Quanta Diagnostico
M 63 91640
DoB: Apr 08 1953
ExtNov 07 2016
Se:5 +c
I: 532.3
Im: 202
DFOV 50.0cm
STND
R
L
3.3/
kv 140
mA 210


Axial Volume 3/Volume 1
Ex: 50% 10874 / 50% 10874
A 323
JAIR JOSE PAULO JUNIOR
Quanta Diagnostico
M 63 91640
DoB: Apr 08 1953
ExtNov 07 2016
Se:7 /5
I: 532.3
Im: 202
DFOV 50.0cm
10.00
% PET
0.00
L
3.3/



IAEA
International Atomic Energy Agency

68Ga-PSMA PET/CT na recorrência bioquímica do câncer de próstata: um estudo multicêntrico internacional promovido pela Agência Internacional de Energia Atômica (IAEA).

2019

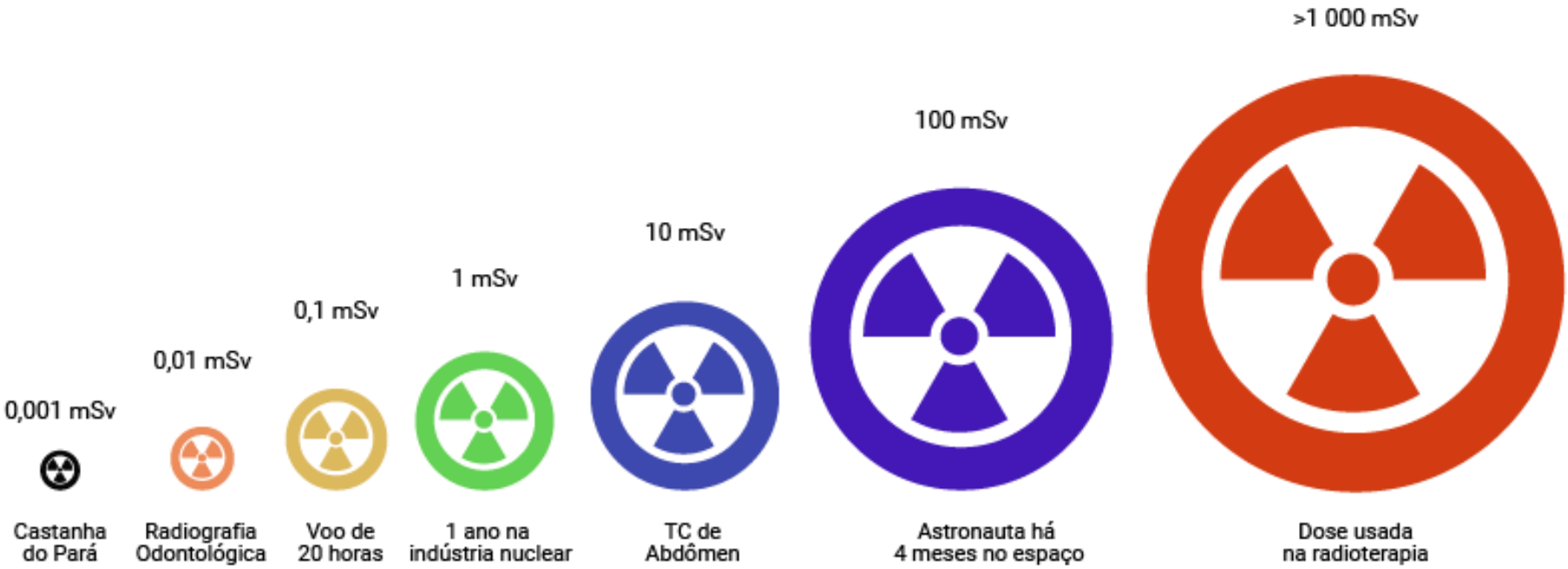
(2017-presente)

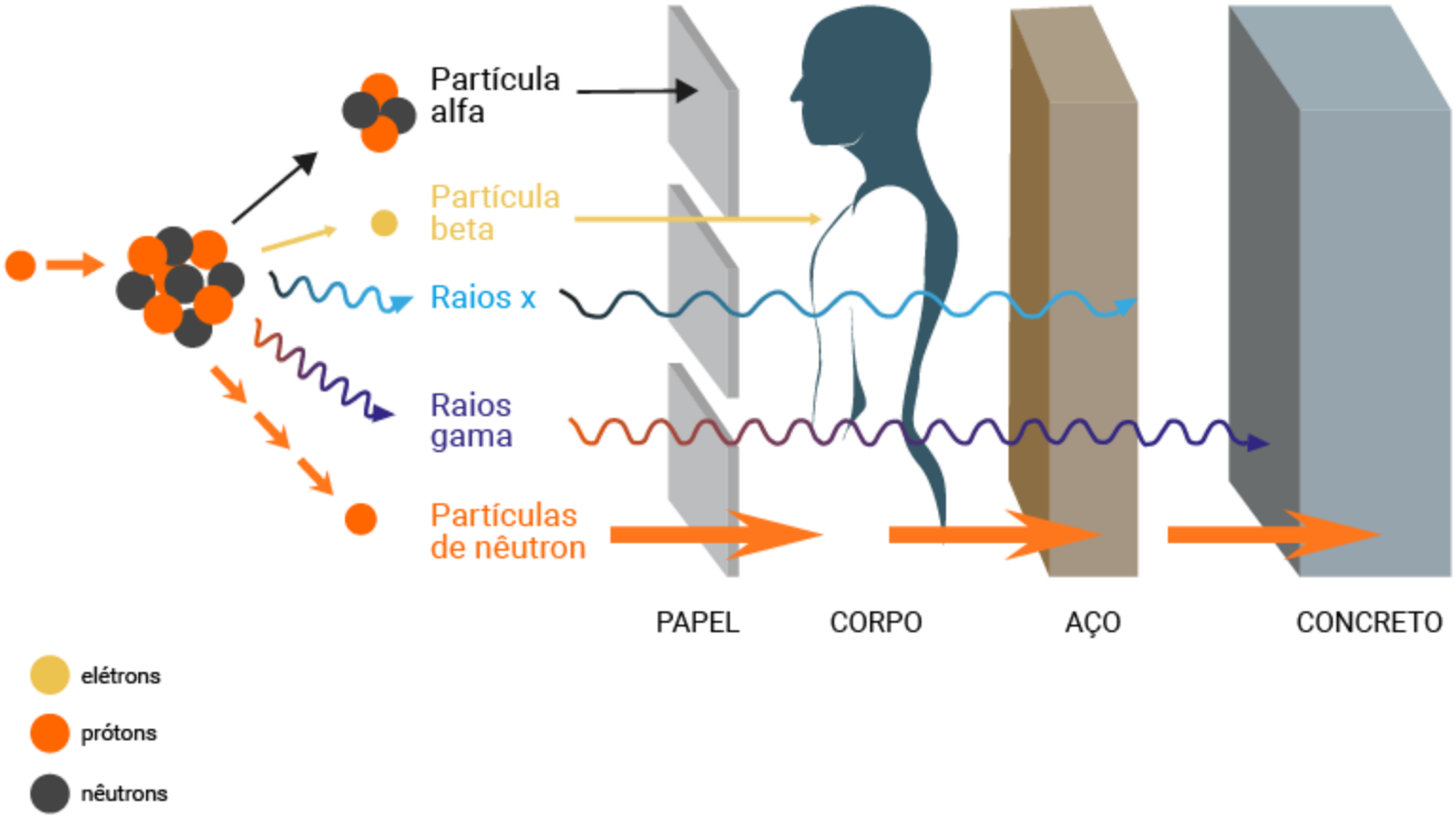
17 centros em 15 países

704 pacientes ➔ +1000

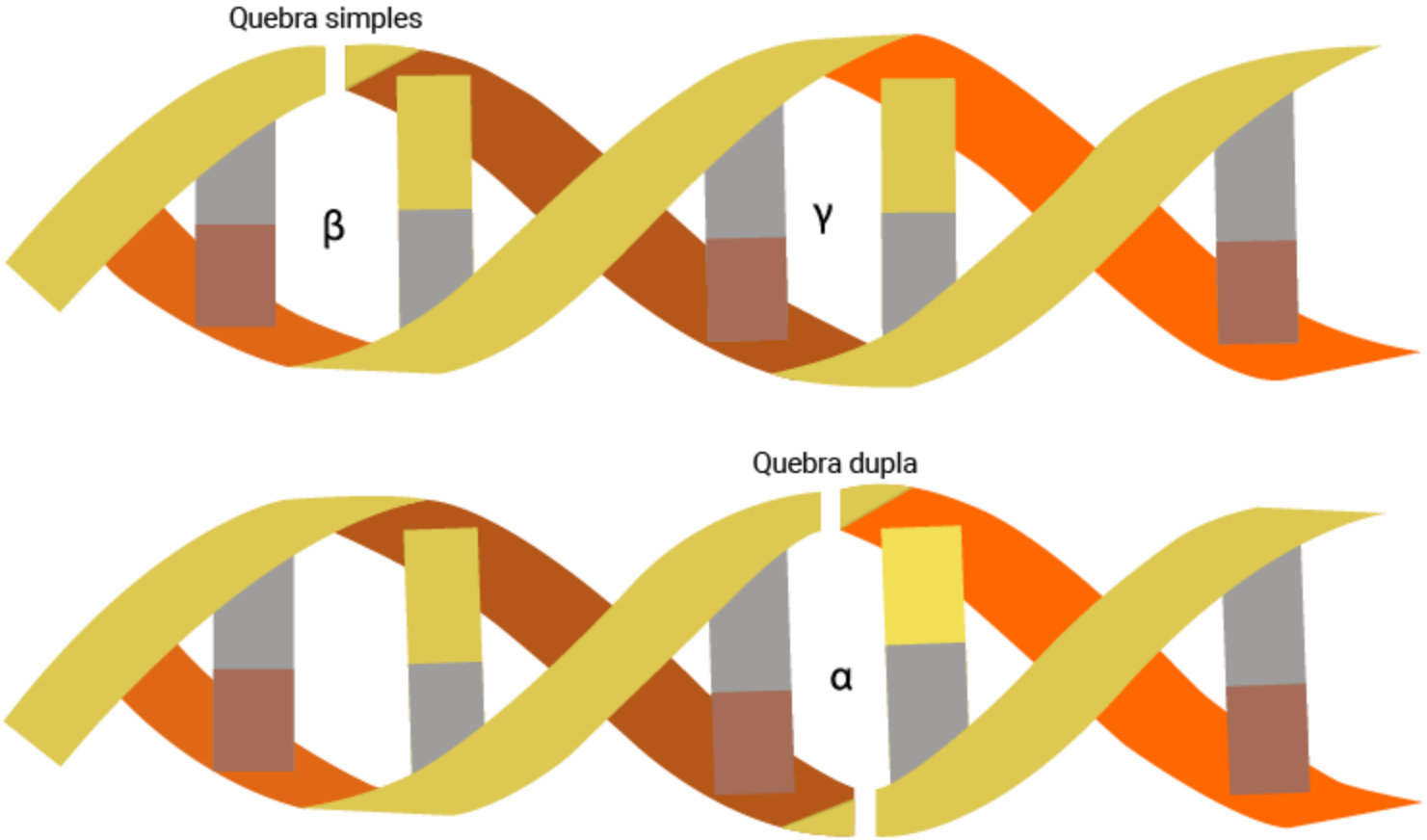
- Avaliação pioneira do PET/CT PSMA em escala **multicêntrica global**
- Grande número de pacientes (**+ 1000**)

→ IMPACTO NO MANEJO CLÍNICO...


0,001 mSv
Castanha do Pará
0,01 mSv
Radiografia Odontológica
0,1 mSv
Voo de 20 horas
1 mSv
1 ano na indústria nuclear
10 mSv
TC de Abdômen
100 mSv
Astronauta há 4 meses no espaço
>1 000 mSv
Dose usada na radioterapia

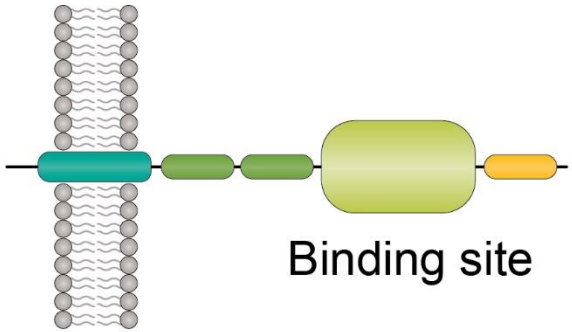

Partícula alfa
Partícula beta
Raios x
Raios gama
Partículas de nêutron
PAPEL
CORPO
AÇO
CONCRETO
elétrons
prótons
nêutrons

EFEITOS DA RADIAÇÃO NO DNA

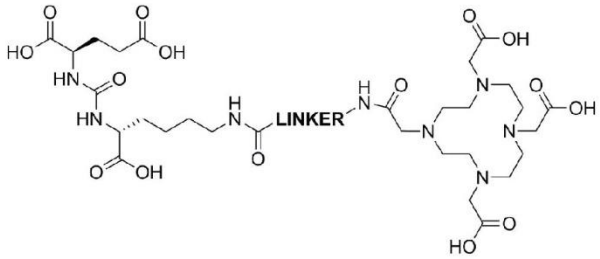


α = partícula alfa, β = particula beta e γ = raios gama.

Teranóstico



Binding site



Tumor

Target

Ligand

^{68}Gallium for PET imaging

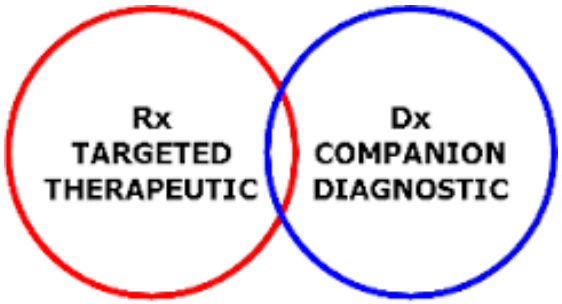
^{177}Lutetium for treatment

Prostate Specific Membrane Antigen (PSMA)

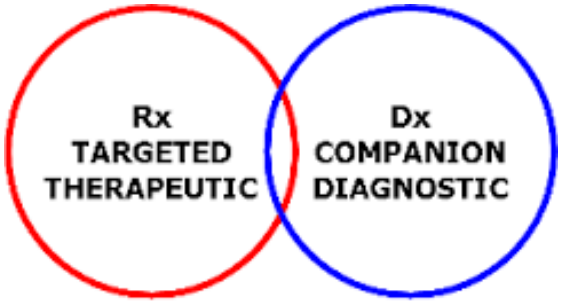
Somatostatin Receptor (SSTR)

^{177}Lu-PSMA: Radioligand Therapy (RLT)

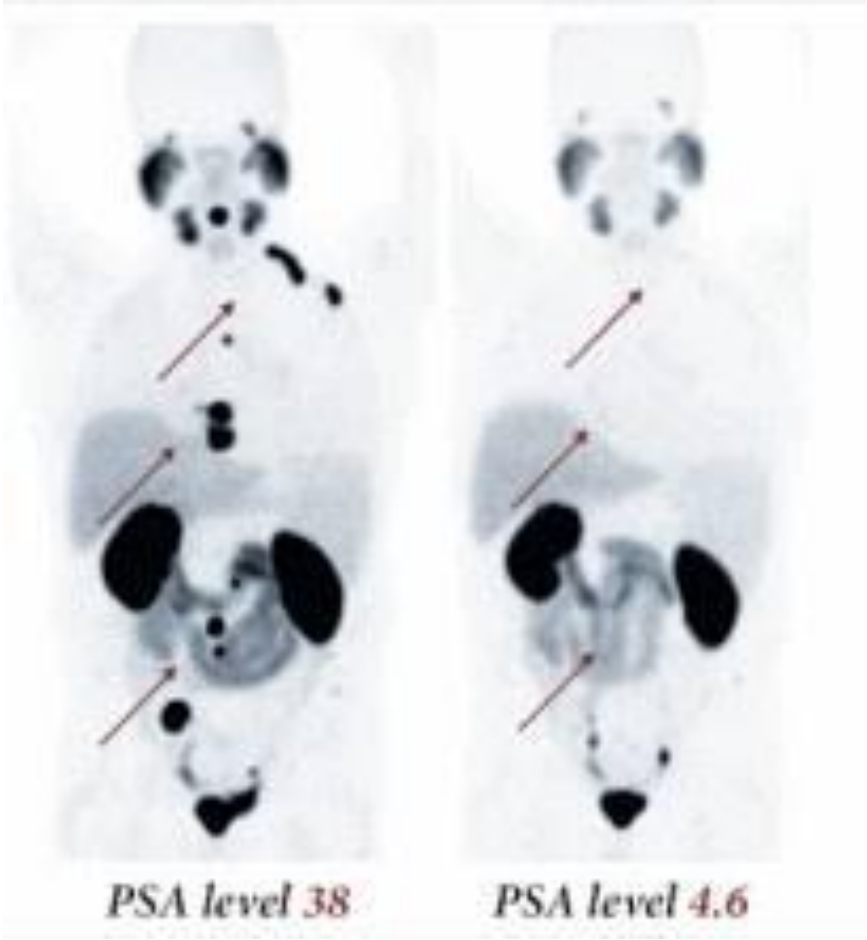
Teranóstico



THERANOSTICS
The merging of drug therapy and diagnostics to advance personalised medicine



THERANOSTICS
The merging of drug therapy and diagnostics to advance personalised medicine



Conclusões

- Medicina Nuclear tem forte relação com a Oncologia
- Auxilia na definição da extensão da doença
- Impacta na definição do tratamento e na avaliação da resposta
- Papel importante também no tratamento.

Obrigado!

julianocerci@quantamn.com.br