

UNIVERSITÀ DEGLI STUDI DI FERRARA

*Percorsi diagnostici innovativi, clinici, laboratoristici, neurosonologici e
di neuroimaging nelle malattie del sistema nervoso*

*SPECT, DATSCAN e PET in
condizioni normali e
patologiche*

Corrado Cittanti

Sezione di Medicina Nucleare

Università degli Studi di Ferrara

Principali settori applicativi della Medicina Nucleare in ambito neurologico

- *Malattie cerebro-vascolari*
- *Demenze*
- *Epilessie*
- *Malattie degenerative*
- *Neoplasie ed infezioni*

Cos'è un "radiofarmaco"?

*"Qualsiasi medicinale che, quando è pronto per l'uso, include uno o più radionuclidi incorporati a scopo sanitario" **

**(Direttiva CEE 89/343, decreto legislativo n° 178)*



Radiofarmaco

Diagnostica

Terapia

Isotopo radioattivo:
diagnosi o terapia

Molecola scelta
opportunamente

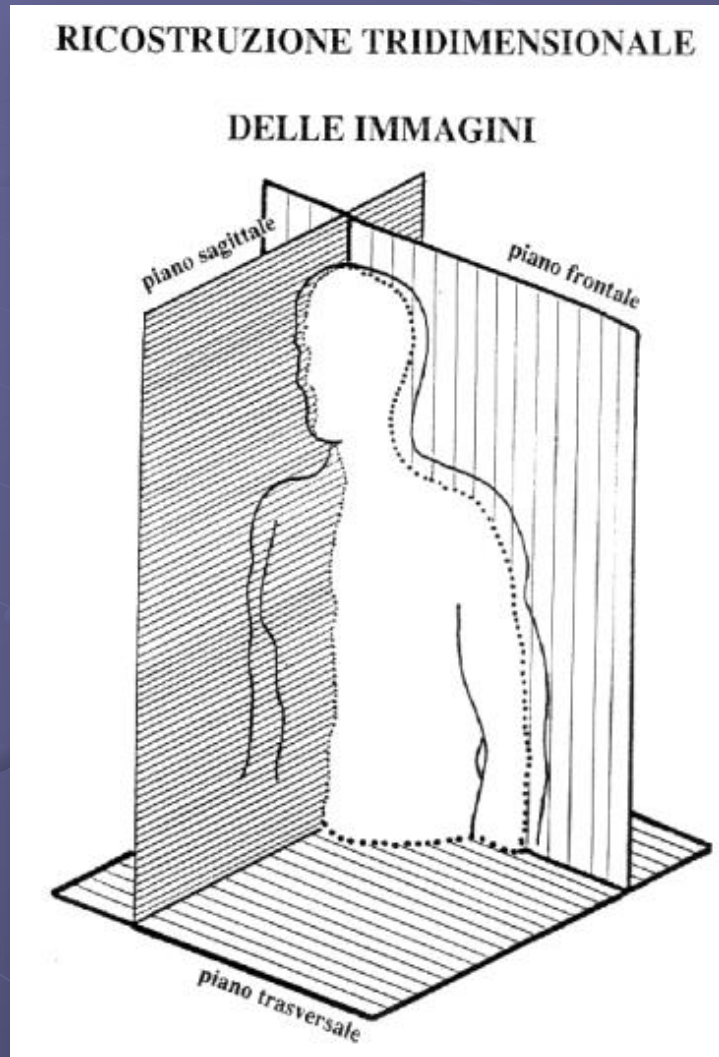


Radiofarmaco

La **localizzazione** dopo somministrazione nei pazienti e le **informazioni diagnostiche** o l'**effetto terapeutico** da essa derivanti sono determinate:

- caratteristiche chimico-fisiche quali il tipo di emissione del radioisotopo, la carica, la lipofilia o la dimensione del complesso radioattivo;
- interazioni con componenti biologici (cellule, membrane, enzimi, recettori).

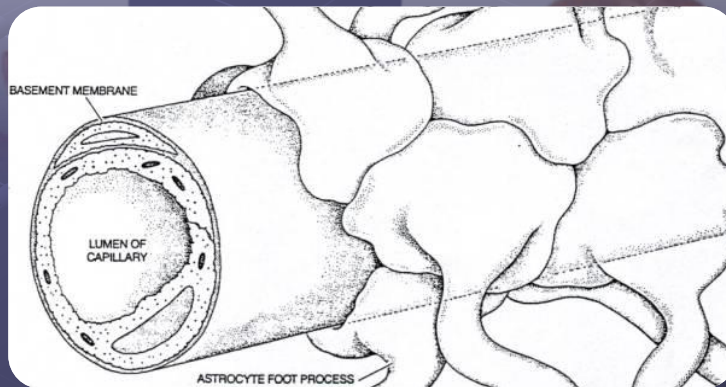
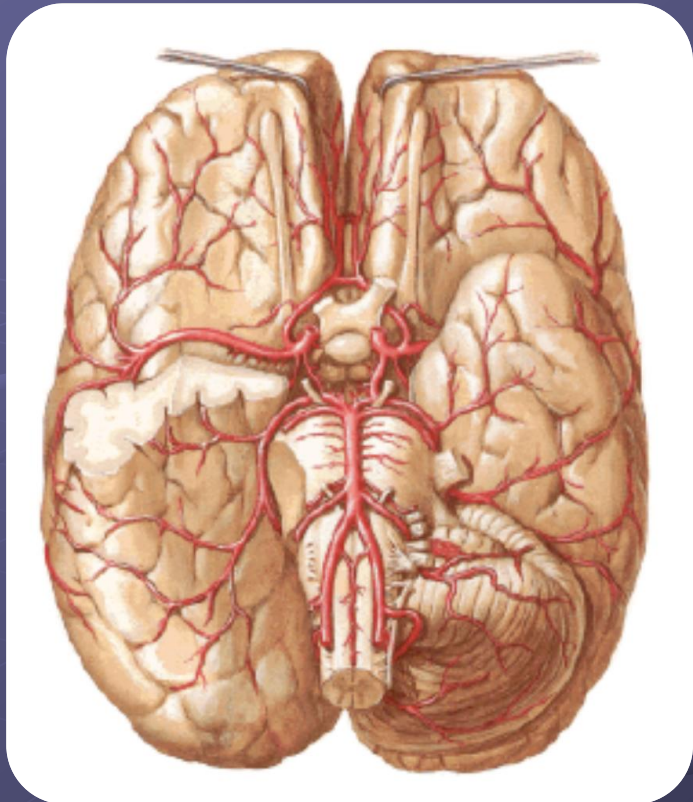
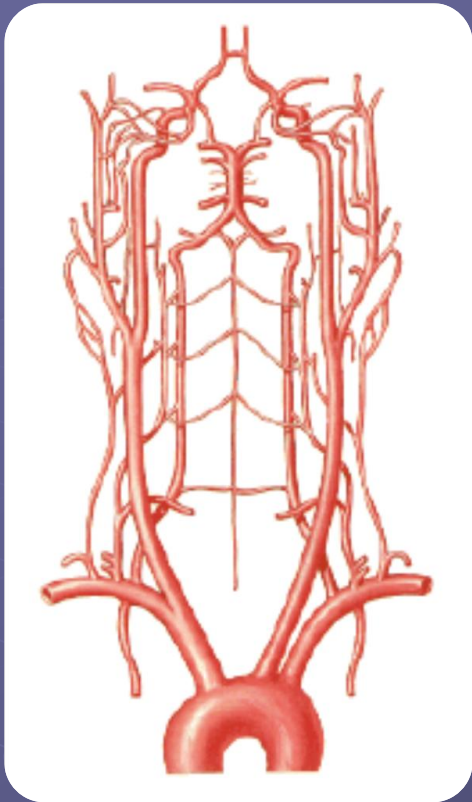
Acquisizione immagini SPECT



Principali categorie di radiofarmaci

- *Traccianti di perfusione*
- *Traccianti recettoriali*
- *Indicatori di lesione*

*Traccianti di
perfusione cerebrale
in SPECT*



Caratteristiche ideali per un tracciante di perfusione cerebrale

- *Distribuzione proporzionale al flusso*
- *Elevata estrazione al primo passaggio*
- *Adeguate tempo di permanenza nel parenchima*
- *Rapida eliminazione dall'organismo*
- *Alto flusso fotonico (range 100-200 KeV)*
- *Bassa dose al paziente*
- *Disponibilità quotidiana*
- *Costi contenuti*

Traccianti SPECT di perfusione

● ^{133}Xe

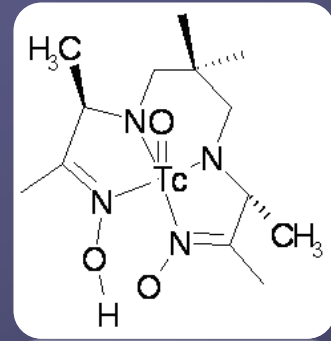
● $^{81\text{m}}\text{Kr}$

● $^{123}\text{I-IMP}$

● $^{99\text{m}}\text{Tc-HMPAO}$

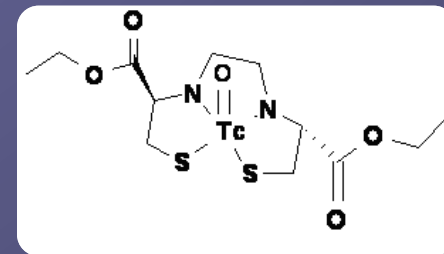
● $^{99\text{m}}\text{Tc-ECD}$

^{99m}Tc -HMPAO



- ^{99m}Tc -**hexam**etilen-**prop**ilen-**am**mino-**oss**ima (esametazina).
- E' un tracciante **neutro**.
- Ha una clearance ematica piuttosto rapida.
- In quanto **lipofilo** attraversa la barriera emato-encefalica.
- All'interno delle cellule neuronali viene trasformato in sostanza **idrofilica** ad opera del **glutathione** tissutale e vi resta, pertanto, intrappolato.
- Eliminazione prevalentemente renale ed intestinale.

^{99m}Tc -ECD



- ^{99m}Tc -N,N' (1,2-etilendil) bis-L-cisteina dietilestere (*bicisato*).
- E' un tracciante *neutro*.
- Ha una clearance ematica piuttosto rapida.
- In quanto *lipofilo* attraversa la barriera emato-encefalica.
- All'interno delle cellule neuronali viene trasformato in sostanza *idrofilica* ad opera delle *esterasi* tissutali e vi resta, pertanto, intrappolato.
- Eliminazione prevalentemente *renale* ed *intestinale*.

^{99m}Tc -HMPAO vs ^{99m}Tc -ECD

(DIFFERENZE FISICO-CHIMICHE E BIOLOGICHE)

	HMPAO	ECD
Preparazione	a temperatura ambiente	a temperatura ambiente
Stabilità	30 minuti	6 ore
Intrappolamento	glutathione	esterasi
Back-diffusion	modesta	minima

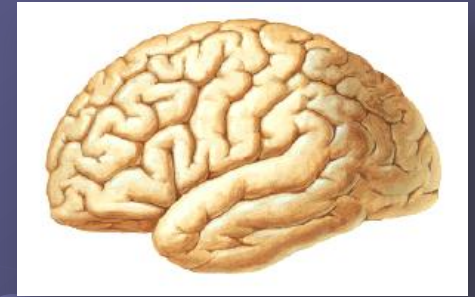
^{99m}Tc -HMPAO vs ^{99m}Tc -ECD

(DIFFERENZE BIODISTRIBUTIVO-CLINICHE)

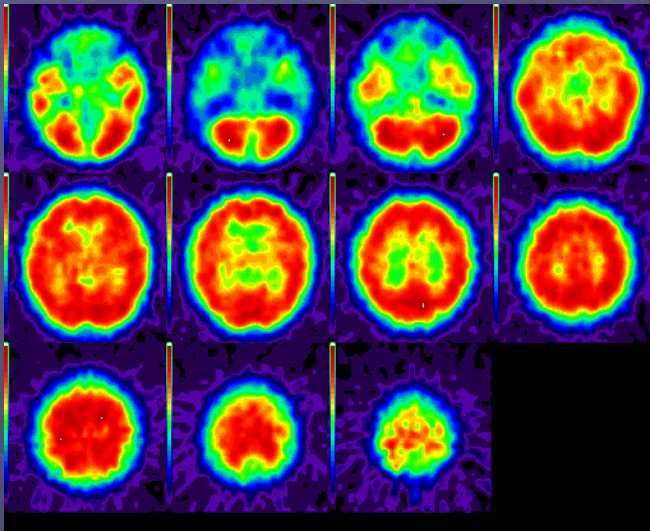
- Studi di confronto della distribuzione regionale dell'HMPAO e dell'ECD hanno dimostrato alcune differenze
 - **ECD**: maggiore fissazione nelle regioni occipitali e parietali;
 - **HMPAO**: maggiore fissazione nelle regioni cerebellari, nuclei della base, talamo, tronco encefalico, lobi temporali.
- Questo comporta differenze delle quali tenere conto in alcuni campi di interesse clinico quali la malattia cerebro-vascolare, l'epilessia in fase inter-critica e la demenza di Alzheimer.

Tecnica di esecuzione

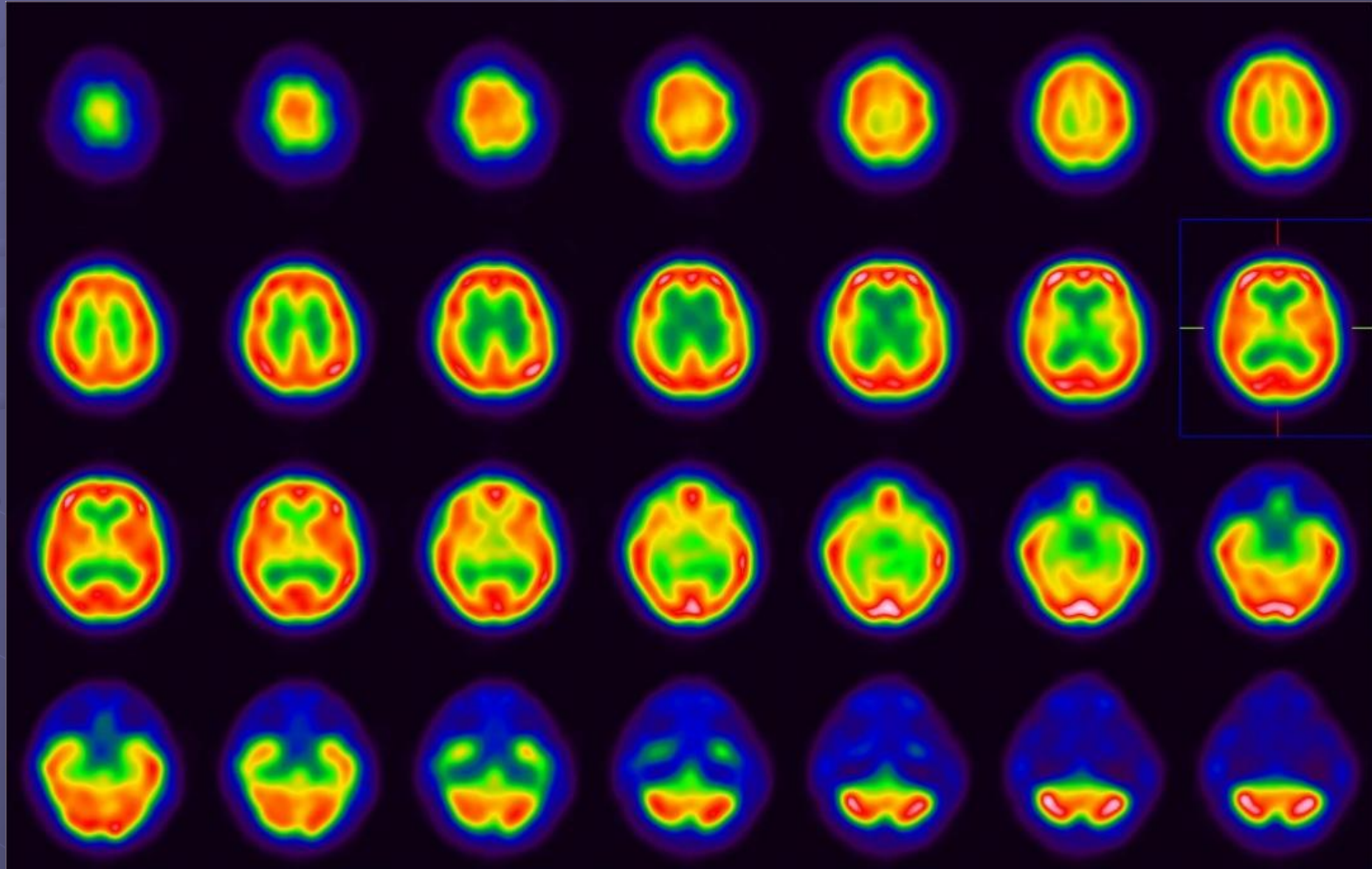
- **Premedicazione** del paziente mediante butterfly e soluzione fisiologica in fleboclisi in stanza buia ed insonorizzata;
- **preparazione** del materiale radioattivo e sua somministrazione e.v. (740-925MBq);
- A 30'-45' **acquisizione** di studio SPECT su 360° con zoom in acquisizione (collimatori HR o Fan Beam) della durata di circa 25 minuti;
- **refertazione**: studio comparativo delle immagini scintigrafiche con quelle ottenute con indagini 3D di imaging morfologico (TC e/o RM).



45' - 60'

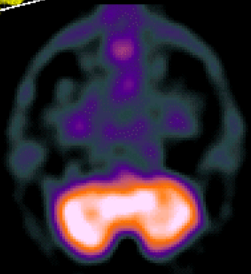


SPECT cerebrale con ^{99m}Tc -ECD (quadro normale)



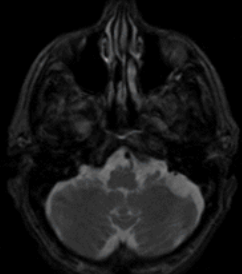
Adult Human Brain

01



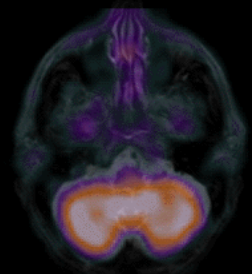
HMPAO SPECT

Brigham and Women's Hospital



T2 MRI

NORMAL ANATOMY

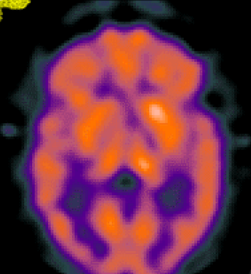


OVERLAY

Harvard Medical School

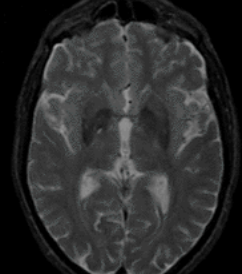
Adult Human Brain

10



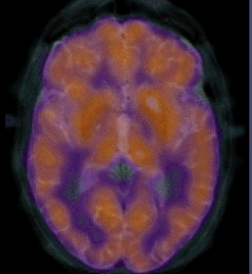
HMPAO SPECT

Brigham & Women's Hospital



T2 MRI

NORMAL ANATOMY

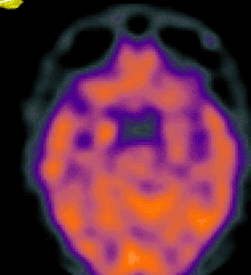


OVERLAY

Harvard Medical School

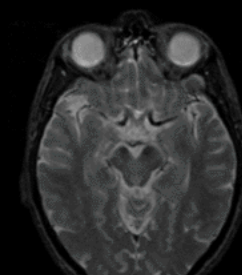
Adult Human Brain

07



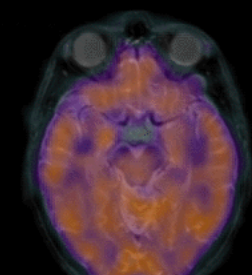
HMPAO SPECT

Brigham and Women's Hospital



T2 MRI

NORMAL ANATOMY



OVERLAY

Harvard Medical School

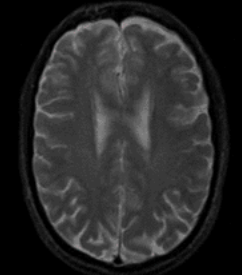
Adult Human Brain

16



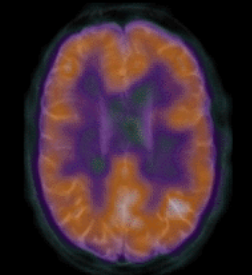
HMPAO SPECT

Brigham & Women's Hospital



T2 MRI

NORMAL ANATOMY



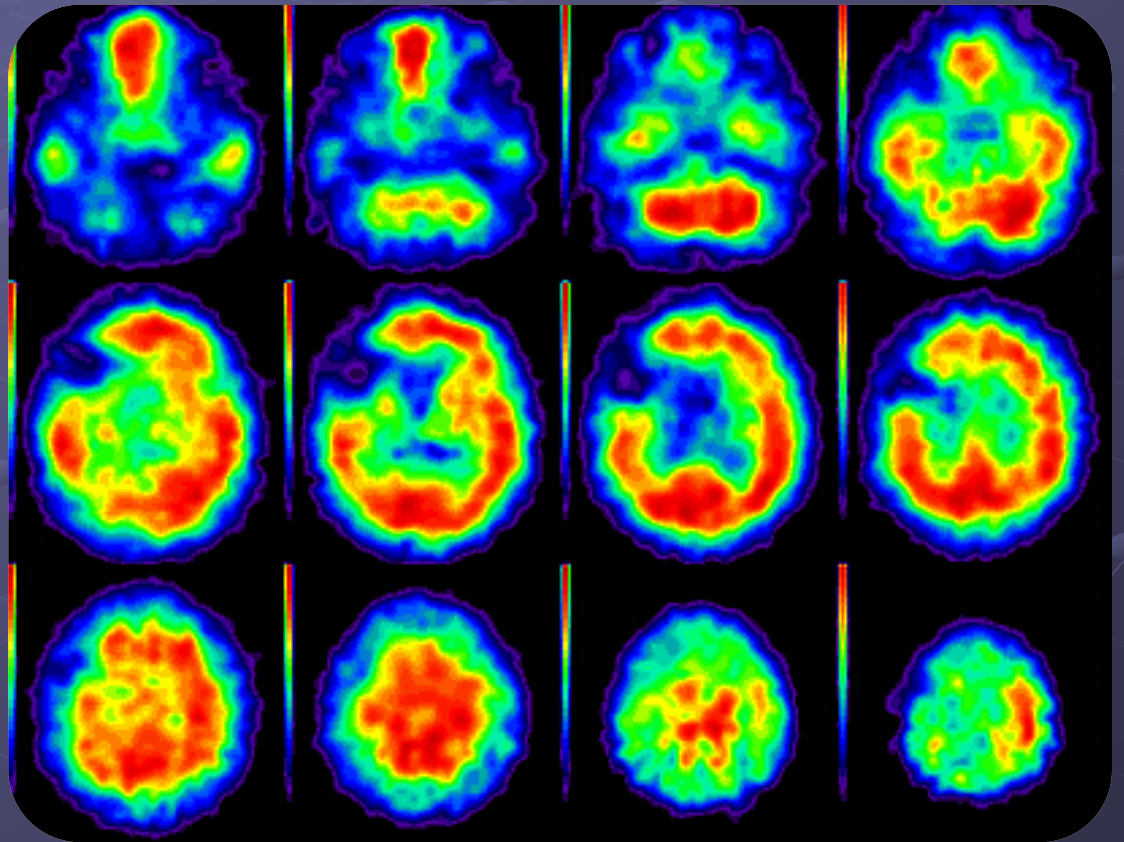
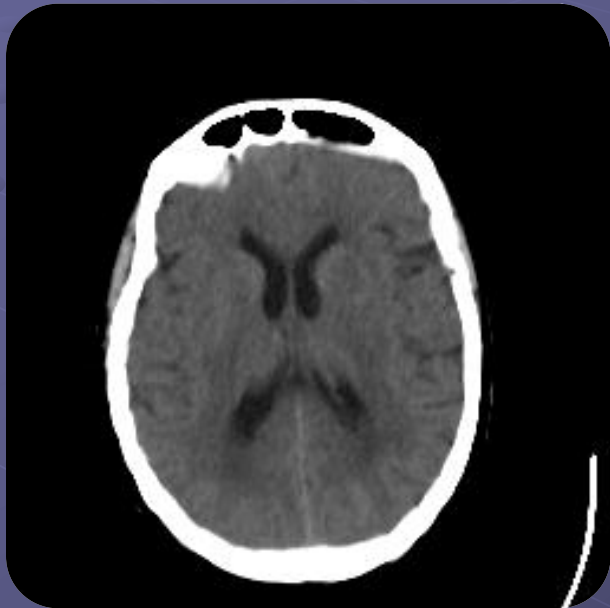
Overlay

Harvard Medical School

Principali settori applicativi

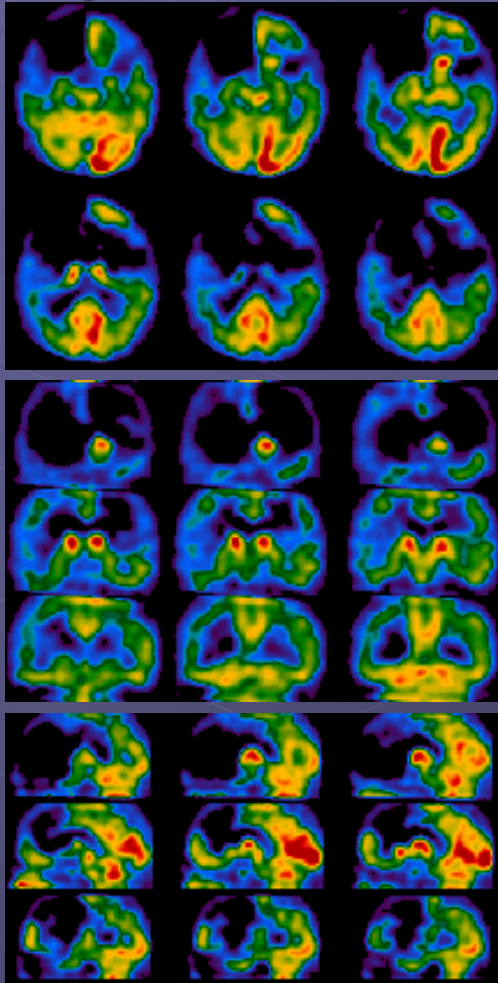
- *Malattie cerebro-vascolari*
- *Demenze*
- *Epilessie*
- *Malattie degenerative*
- *Neoplasie ed infezioni*

SPECT cerebrale con ^{99m}Tc -HMPAO (sospetto ictus cerebri in 2^a ora)

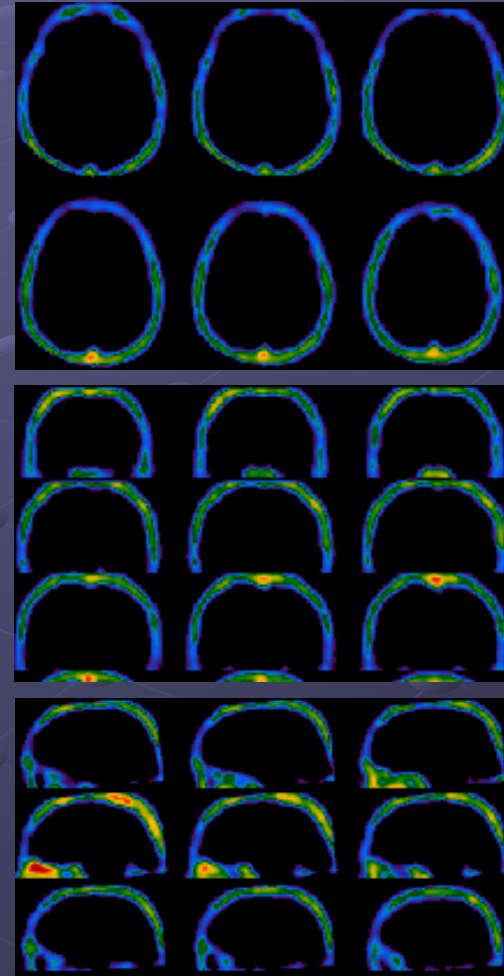


SPECT cerebrale con ^{99m}Tc -HMPAO (morte cerebrale)

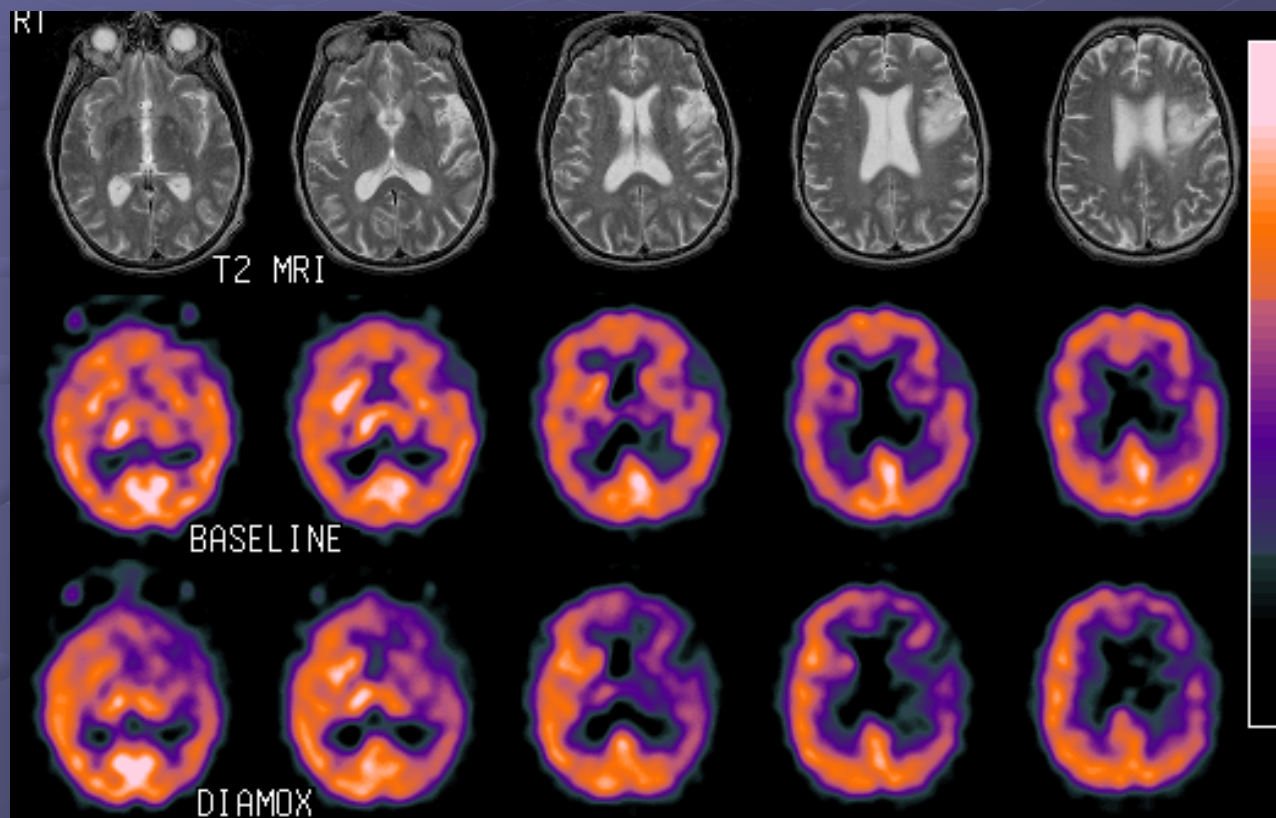
post-ictus



morte cerebrale



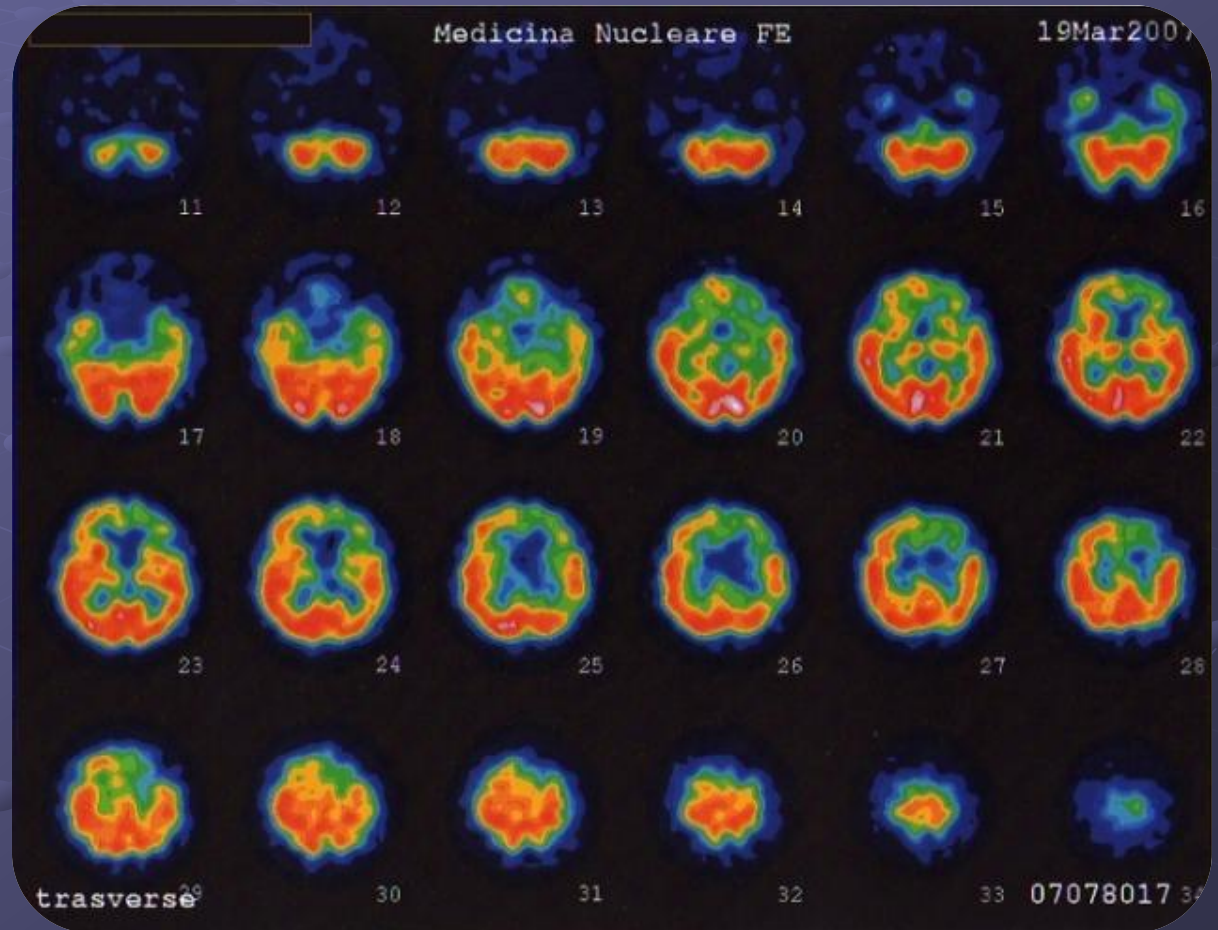
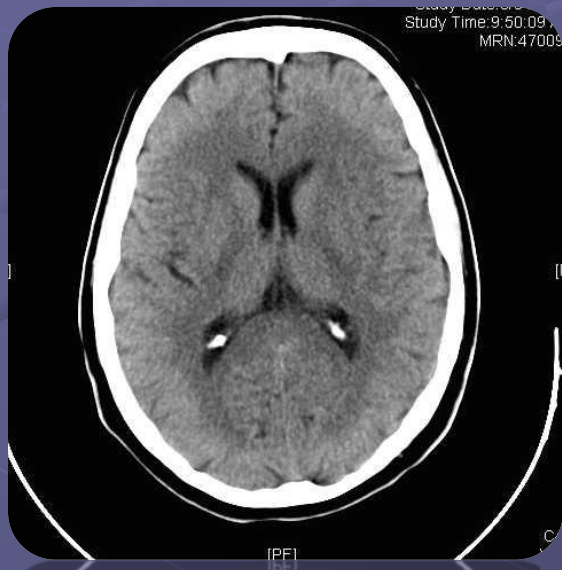
SPECT cerebrale con ^{99m}Tc -HMPAO: valutazione della riserva di flusso cerebrale con acetazolamide (diamox)



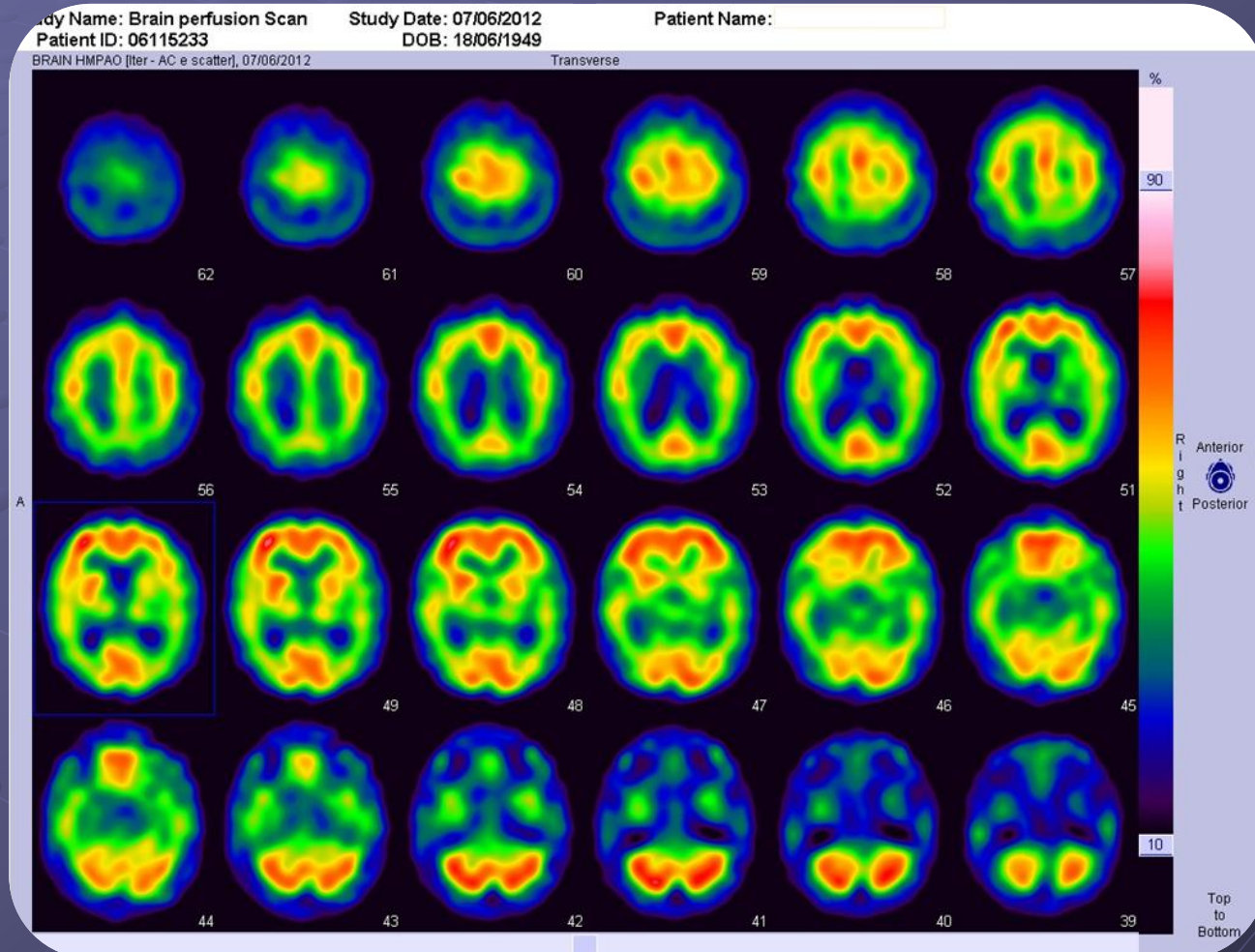
Principali settori applicativi

- *Malattie cerebro-vascolari*
- *Demenze*
- *Epilessie*
- *Malattie degenerative*
- *Neoplasie ed infezioni*

SPECT cerebrale con ^{99m}Tc -ECD (demenza frontale)

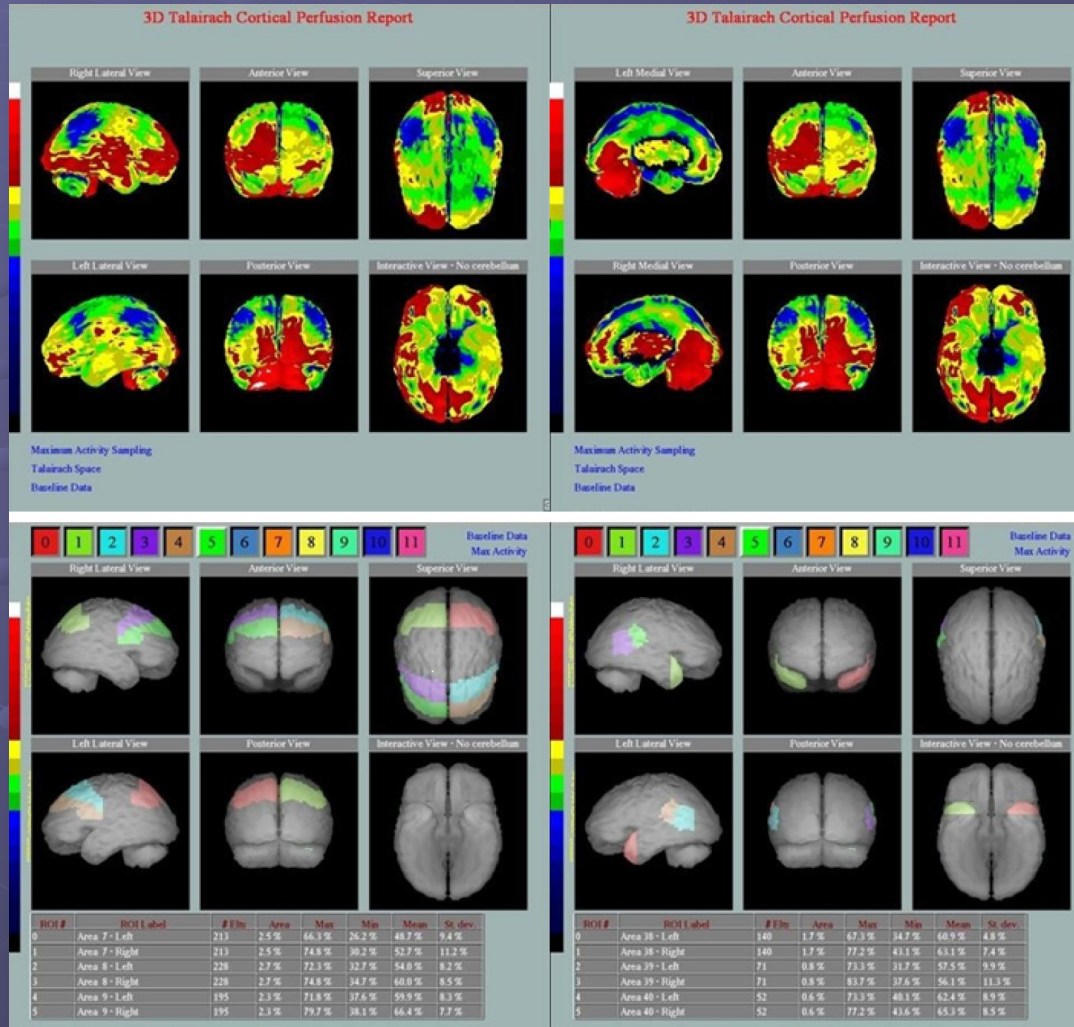


SPECT cerebrale con ^{99m}Tc -HMPAO (Morbo di Alzheimer)



NeuroGam

(analisi automatica 3D basata sul voxel)

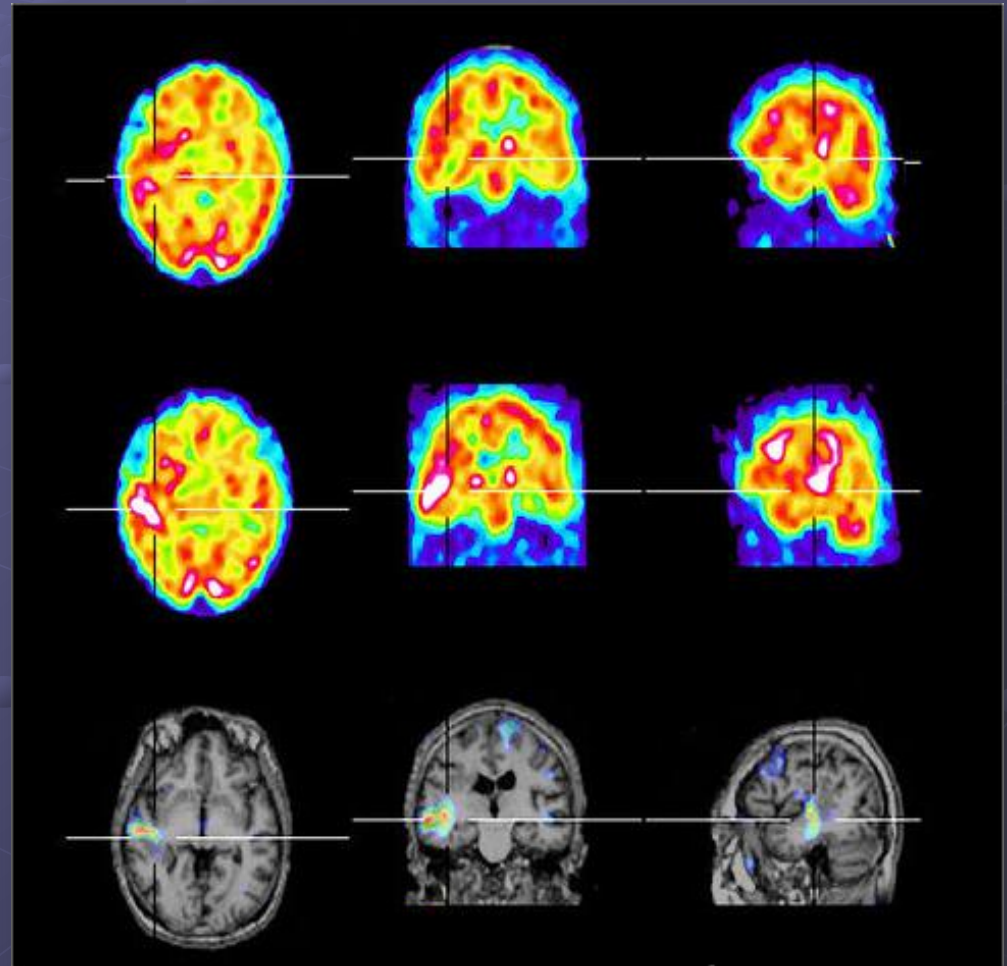


Principali settori applicativi

- *Malattie cerebro-vascolari*
- *Demenze*
- *Epilessie*
- *Malattie degenerative*
- *Neoplasie ed infezioni*

SPECT cerebrale con ^{99m}Tc -ECD (epilessia)

Fase inter-ictale



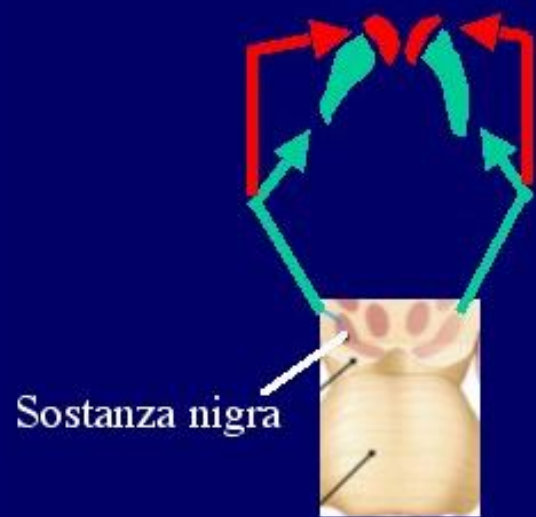
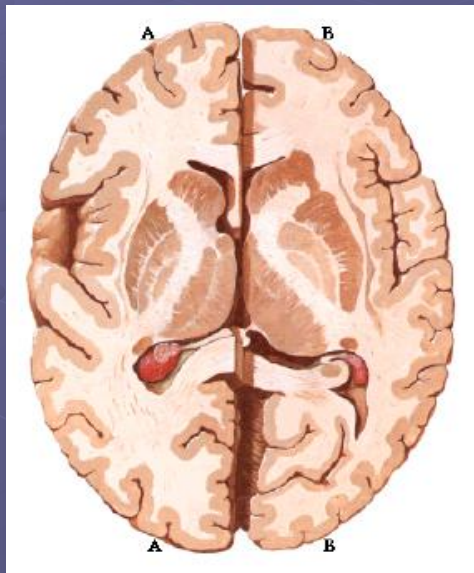
Fase ictale

*Traccianti
recettoriali cerebrali
in SPECT*

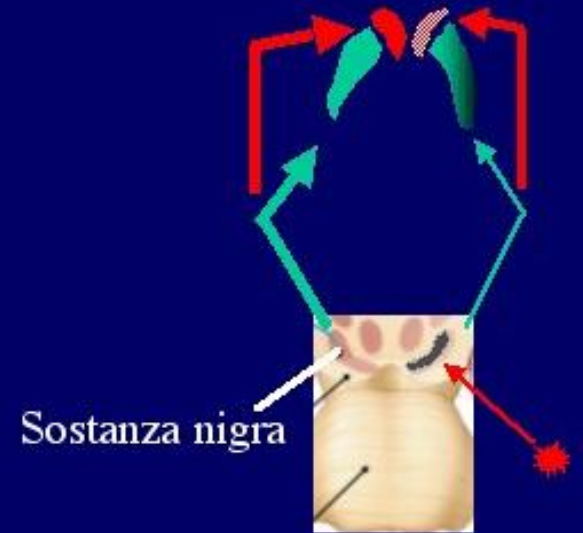
Principali settori applicativi

- *Malattie cerebro-vascolari*
- *Demenze*
- *Epilessia*
- *Malattie degenerative*
- *Neoplasie ed infezioni*

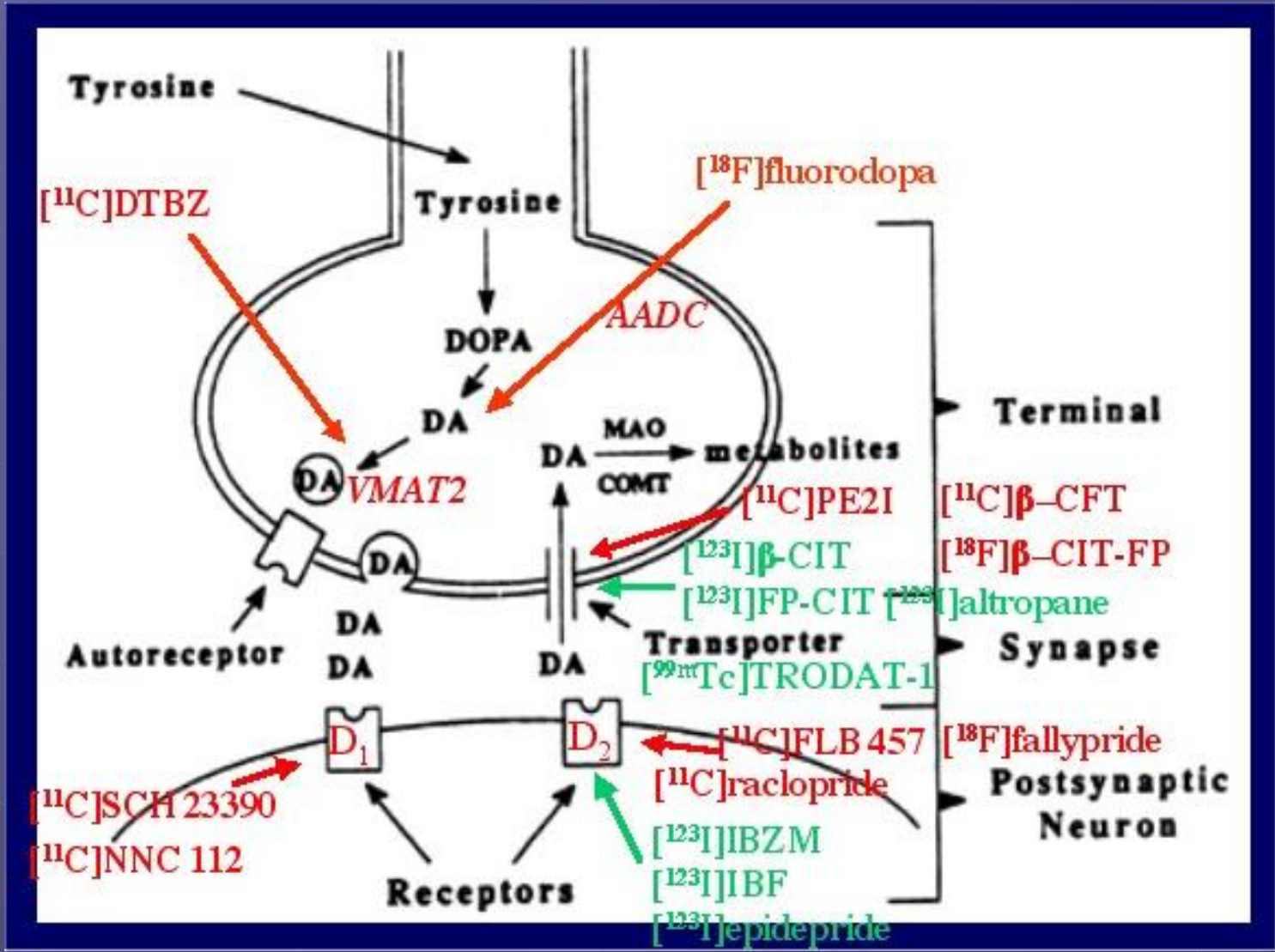
Degenerazione nigro-striatale



Normale



Parkinson

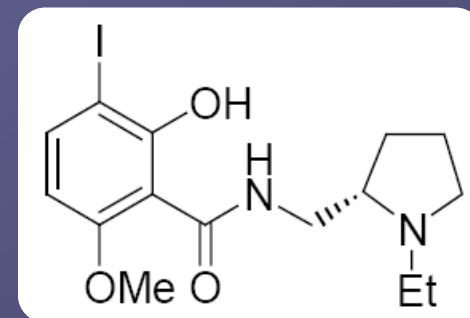


Traccianti SPECT recettoriali

● ^{123}I -IBZM

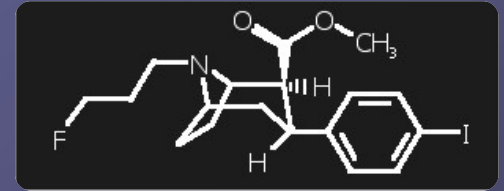
● ^{123}I -Ioflupano (DaTSCAN)

^{123}I -IBZM



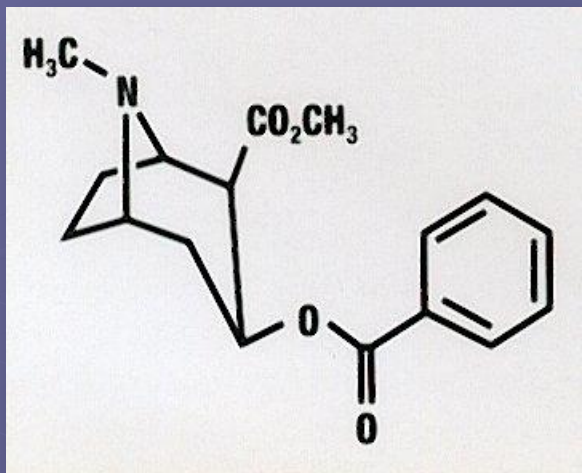
- ^{123}I -iodobenzamide.
- E' un tracciante lipofilico dotato di affinità selettiva per i recettori D2 della dopamina.
- Si lega alle proteine circolanti ma ha una clearance ematica piuttosto lenta.
- Circa il 4% della attività iniettata si localizza nel cervello mentre la rimanente parte viene convertita in metaboliti idrofilici.
- La sostanza si fissa ai recettori D2 delle strutture nigro-striatali senza essere modificata.

^{123}I -Ioflupano

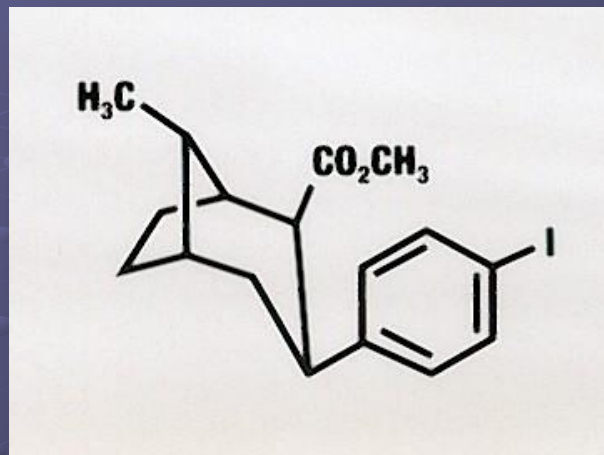


- ^{123}I -ioflupano (**DaTSCAN**).
- E' un tracciante **lipofilico** analogo della cocaina che si lega selettivamente ai trasportatori della dopamina (**DAT**).
- Ha una **clearance** ematica molto **rapida** con immediato uptake cerebrale (**7%** a 10').
- Circa il **30%** della attività presente a livello cerebrale si localizza nello **striato**.
- La sostanza è eliminata per via **renale** (60%) ed **intestinale** (15%).

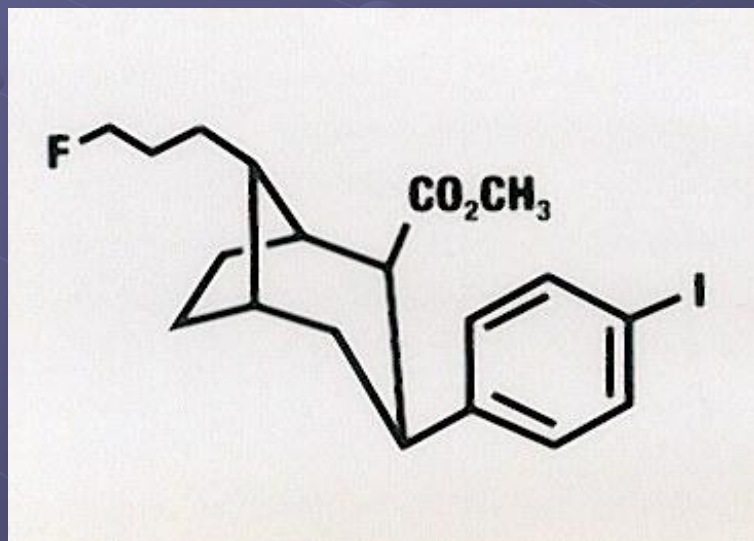
Cocaine



¹²³I β-CIT



¹²³I-FP-CIT *



2-β-carbomethoxy-3-β-(4-iodo phenyl)-tropane

*Fluoropropil-beta-carbometossi-iodofenil-nortropano

Ioflupano, **DaTSCAN®**, GE Healthcare

INFORMAZIONI PER IL PAZIENTE:
SPECT CEREBRALE CON ¹²³I-IOFLUPANO (DATSCAN)

PERCHÈ È IMPORTANTE FARE QUESTO ESAME? Per capire se i Suoi sintomi sono dovuti ad un danno delle strutture profonde del cervello che controllano varie attività del suo corpo tra le quali il movimento o se, invece, essi sono dovuti ad altre cause non necessariamente legate a malattie del cervello. Riconoscere il vero problema consentirà al Suo medico di gestirLa nel modo migliore e di darLe la più corretta terapia, se necessaria.

COME SI ESEGUE? Si tratta di un particolare tipo di "fotografia" del Suo cervello.

1. Le verrà iniettata in vena una sostanza chiamata radiofarmaco (non è un mezzo di contrasto), priva di effetti collaterali ma debolmente radioattiva. Questa si andrà lentamente a fissare in specifiche zone del Suo cervello permettendoci di capire se tali strutture funzionano bene o meno bene.
2. Dopo l'iniezione dovrà attendere per un tempo di circa 3-4 ore, assolutamente necessario per una buona riuscita dell'esame.
3. Trascorso questo tempo Lei sarà accompagnata/o nella stanza di registrazione e verrà sdraiata/o sul lettino di una speciale apparecchiatura (gamma camera) per effettuare le "fotografie" del Suo cervello.
4. La registrazione delle immagini durerà circa 40 minuti: è fondamentale che in questo intervallo di tempo Lei rimanga assolutamente immobile sul lettino altrimenti tali immagini risulteranno scarsamente leggibili. Per aiutarLa in questo Le verrà posta una apposita fascia attorno al capo.

QUALCHE REGOLA DA SEGUIRE:

Prima dell'esame:

- Nei giorni precedenti l'indagine Lei è invitato ad assumere il perclorato di potassio (Pertreid) secondo lo schema che Le è stato fornito al momento della prenotazione.
- Non è necessario che Lei resti a digiuno la mattina dell'indagine. Tuttavia Le chiediamo di evitare di prendere dalla sera prima sostanze stimolanti quali thè, caffè ed alcool e, possibilmente, astenersi dal fumo.
- Può essere indicata anche la sospensione di alcuni farmaci (vedi lista) per la quale, se necessario, non esiti a consultare il proprio medico di riferimento.
- La invitiamo poi a portarsi appresso ogni documentazione in Suo possesso utile all'indagine, in particolare le visite degli specialisti neurologi e la TAC o la risonanza magnetica del cervello, se le ha eseguite.
- È, infine, necessario segnalare al personale del reparto un Suo eventuale stato di gravidanza in atto.

Dopo l'esame e per tutta la giornata:

- eviti contatti stretti e prolungati con donne in gravidanza e bambini piccoli;
- beva ed urini frequentemente per eliminare più rapidamente il radiofarmaco.

FARMACI DA SOSPENDERE 24 ORE PRIMA DELL'ESAME

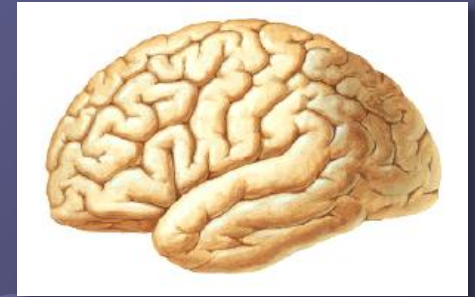
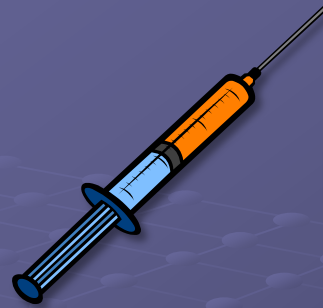
Anfetamina, benztropina, bupropione, (CORZEN; QUOMEM; ZYBAN), cocaina, mazindolo, metilfedinato, fentermina, sertralina (SERAD, TATIG, ZOLOFT); clomipramina (ANAFRANIL; CLORMIPRAMINA), fluoxetina (ALIANFIL, FLUOREXEN, FLUOXIN, IBIXETIN, NOVALBAC, PROZAC, AZUR, CLEXICOR, DEPREZEN, DIESAN, FLOTINA, XEREDIEN), desimipramina (NORTIMIL), imipramina (TOFRANIL), trimipramina (SURMONTIL), amitriptilina (ADEPRIL, LAROXIL, TRIPTIZOL), noritriptilina (NORITEN), dosulepina (PROTIADEN), maprotilina (LUDIOMIL), citalopram (ELOPRAM, PRAMEXYL; SEROPRAM), paroxetina (DAPAROX, EUTIMIL, SEREUPIN, SEROXAT), fluvoxamina (DUMIROX, FEVARIN, MAVERAL), escitalopram (CIPRALEX, ENTACT)

Farmaci che NON interferiscono significativamente con l'esame

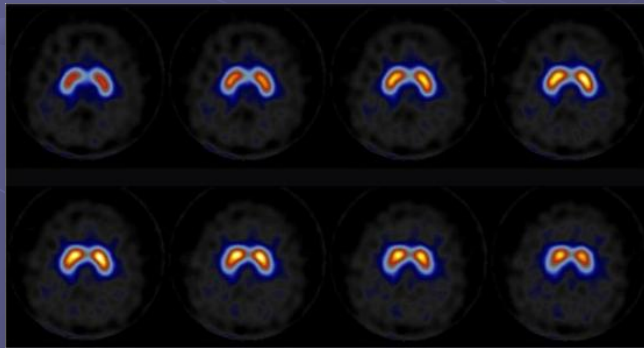
Amantadina (MANTADAN), benzexolo, budipina, levodopa (LEVOMET, MADOPAR, SINEMET), metoprololo (METOPROLOLO, LOPRESOR, SELOKEN), pergolide (NOPAR, NOPAR STARTER), primidone (MYSOLINE), propranololo (INDERAL), selegilina (EGIBREN, JUMEX, SELECOM, SELEGILINA, DOROM, SELEDAT, XILOPAR), triesifenidile (ARTANE), pramipexolo (MIRAPEXIN), ropinirolo (REQUIP)

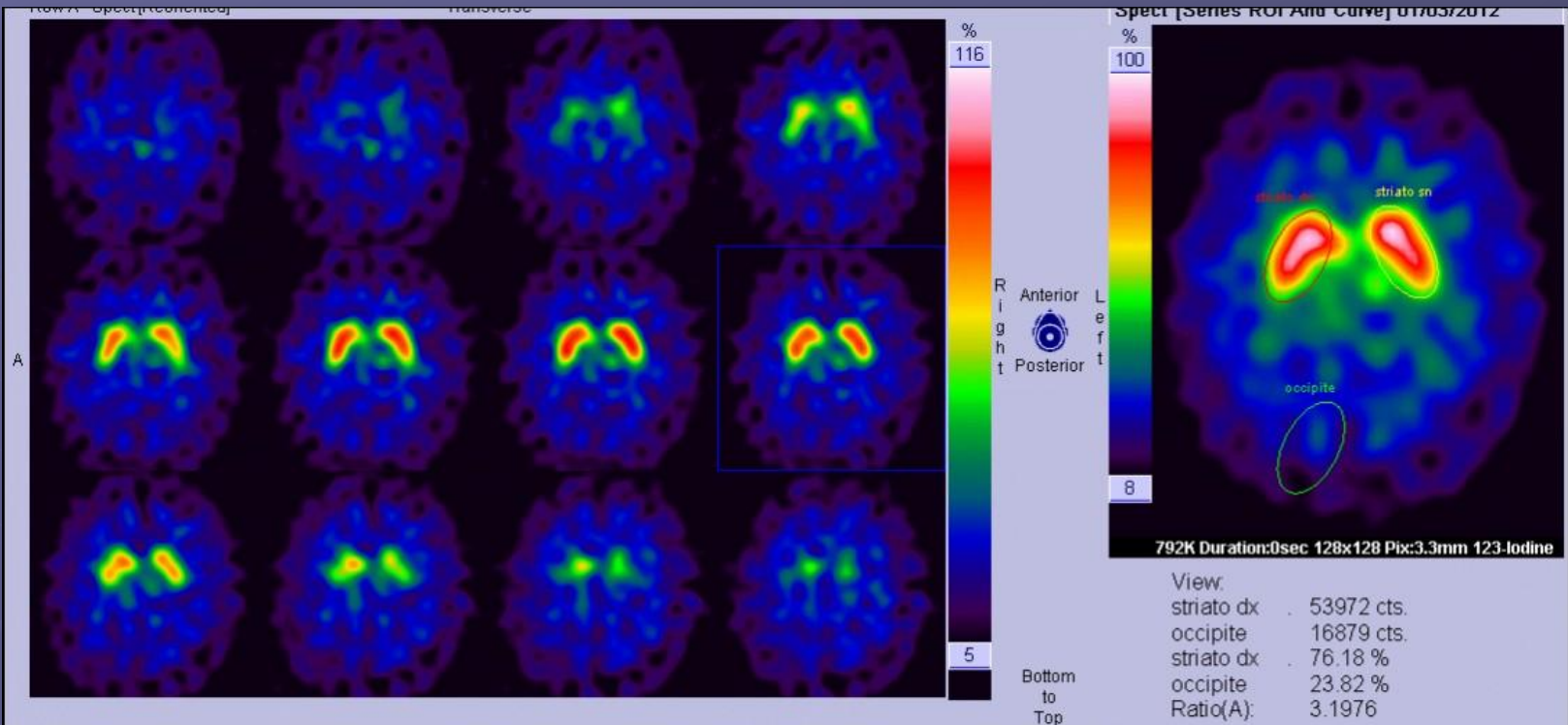
Tecnica di esecuzione

- **Premedicazione** del paziente mediante butterfly;
- **somministrazione** e.v del tracciante arrivato tramite corriere (da 111 a 185 MBq);
- dopo circa 3 ore si procede ad **acquisizione** di studio SPECT su 360° con zoom in acquisizione (collimatori HR o Fan Beam) della durata di circa 40 minuti;
- **refertazione**: studio semiquantitativo della localizzazione del tracciante in corrispondenza dei nuclei della base mediante normalizzazione a ROI di riferimento e/o a data-base di normalità.



3-6 ore





Spect [Series ROI And Curve] 01/03/2012 - Image1

Frame Name	Statistic	Frame	striato dx	striato sn	occipite
Frame1	Avg	48.35	666.32	670.56	185.46
	Max	978.00	957.00	978.00	305.00
	Med	16.00	660.00	641.00	181.00
	Min	0.00	360.00	434.00	76.00
	Pix	16384	81	81	91
	Size(mm ²)	177953.86	879.78	879.78	988.39
	Std	100.72	166.15	151.91	61.69
	Tot	792150.00	53972.00	54315.00	16879.00
	Var	10144.40	27606.37	23076.20	3805.65

File Test Settings

Coronal

slice zoom pitch thick

81 3.7x 0° 1

Sagittal

slice zoom roll thick

80 3.7x 0° 1

Axial

slice zoom yaw thick

63 4.0x 0° 1

Look Up Tables
GE_color

Save CACP

Process Iterations 5

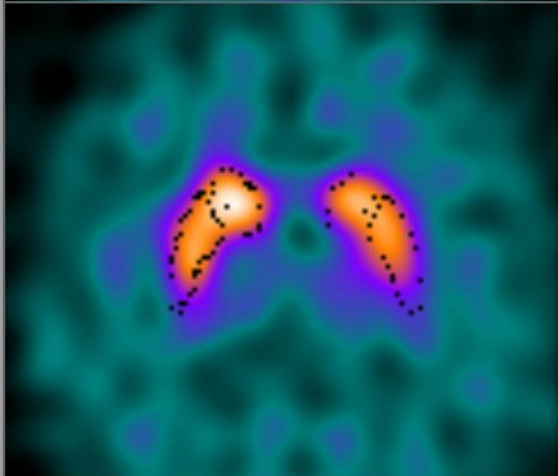
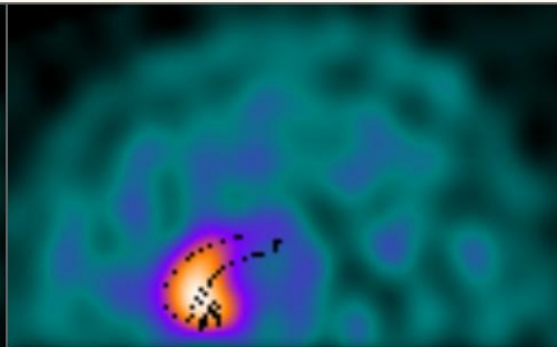
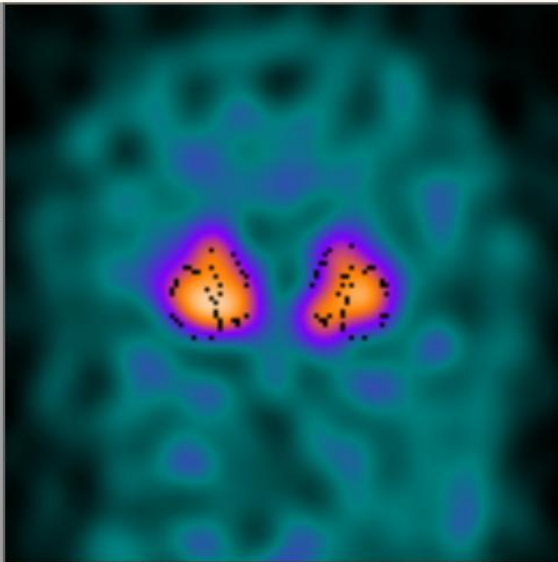
Process

Save Match

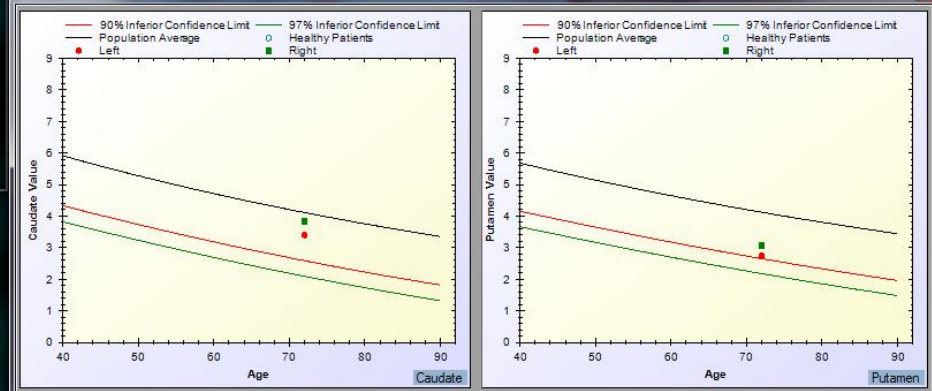
Region Counting	Left	Right	%
Caudate	13.18	14.50	12%>Left
Caudate/Background	3.40	3.84	
Putamen	11.21	12.19	11%>Left
Putamen/Background	2.74	3.07	
Putamen/Caudate	0.81	0.80	

Background Counting

Voxels Total	9325.37	Details..
Total Counting	27938.74	
Counting per voxel	3.00	Report



Counting Details



Left Hemisphere Counting		Background Counting		Right Hemisphere Counting	
Caudate Counting (LC)	13.18	Total Number of Voxels (VS)	9325.37	Caudate Counting (RC)	14.50
Caudate Counting - Background (LCB)	3.40	Total Counting (CT)	27938.74	Caudate Counting - Background (RCB)	3.84
Putamen Counting (LP)	11.21	Counting Mean in Background Area ($M = \frac{CT}{VS}$)	3.00	Putamen Counting (RP)	12.19
Putamen Counting - Background (LPB)	2.74	Caudate		Putamen Counting - Background (LPB)	3.07
Putamen Counting - Background (LR)	0.81	Putamen		Putamen Counting - Background (RR)	0.80
Caudate Counting - Background		Caudate activity 12% higher on Right hemisphere		Caudate Counting - Background	
		Putamen activity 11% higher on Right hemisphere			

Display normal subjects

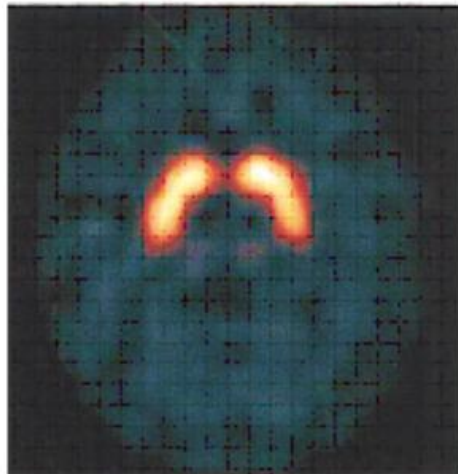
Report Close

Morbo di Parkinson: diagnosi differenziale

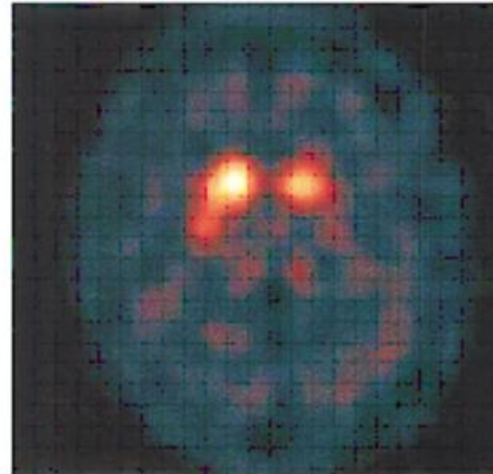
- *Tremore essenziale*
- *Parkinsonismi secondari*
- *Atrofia multisistemica (MSA)*
- *Paralisi sopranucleare progressiva (PSP)*
- *Degenerazione cortico-basale (CBD)*
- *Malattia da corpi di Lewy (LBD)*
- *Demenze*
- *Malattie ereditarie*

DATSCAN – Analisi visiva

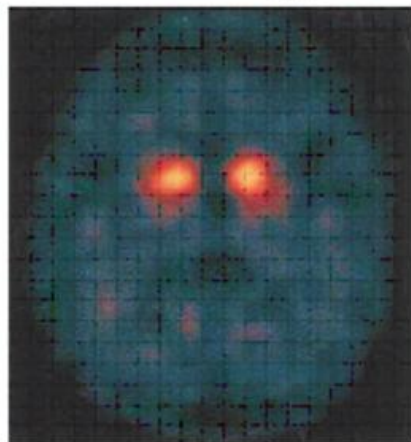
Normal



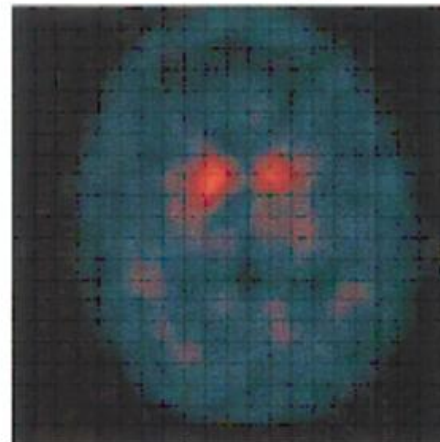
Abnormal type 1



Abnormal type 2



Abnormal type 3

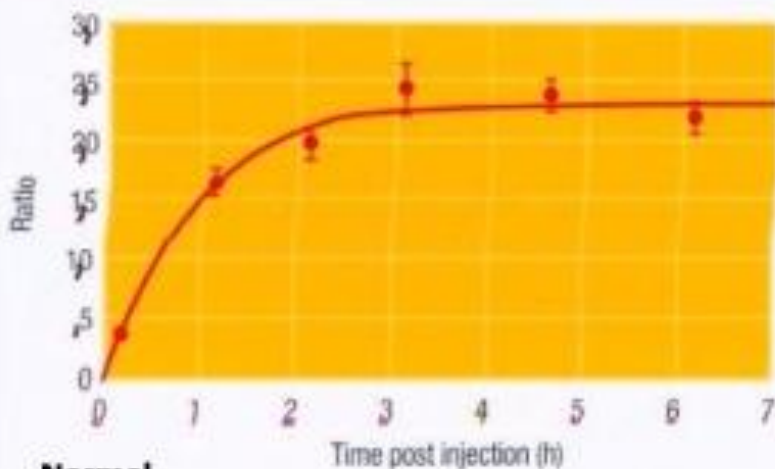


Diagnosi differenziale Parkinsonismo - Tremore essenziale

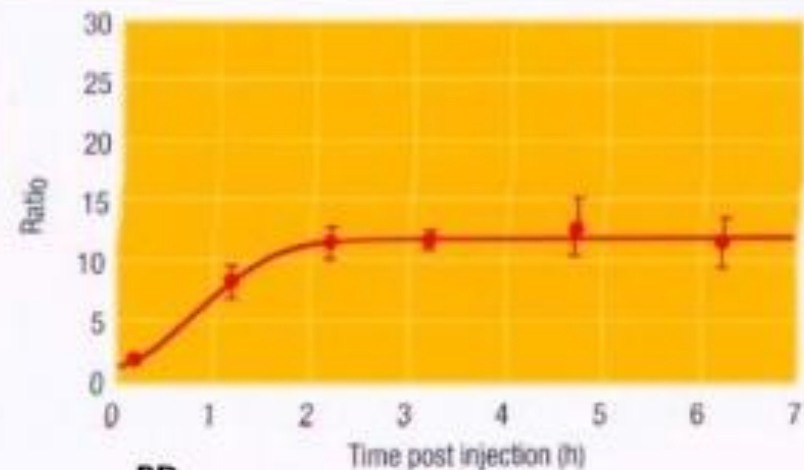
^{123}I -Ioflupano



Cinetica cerebrale dello ^{123}I -Ioflupano

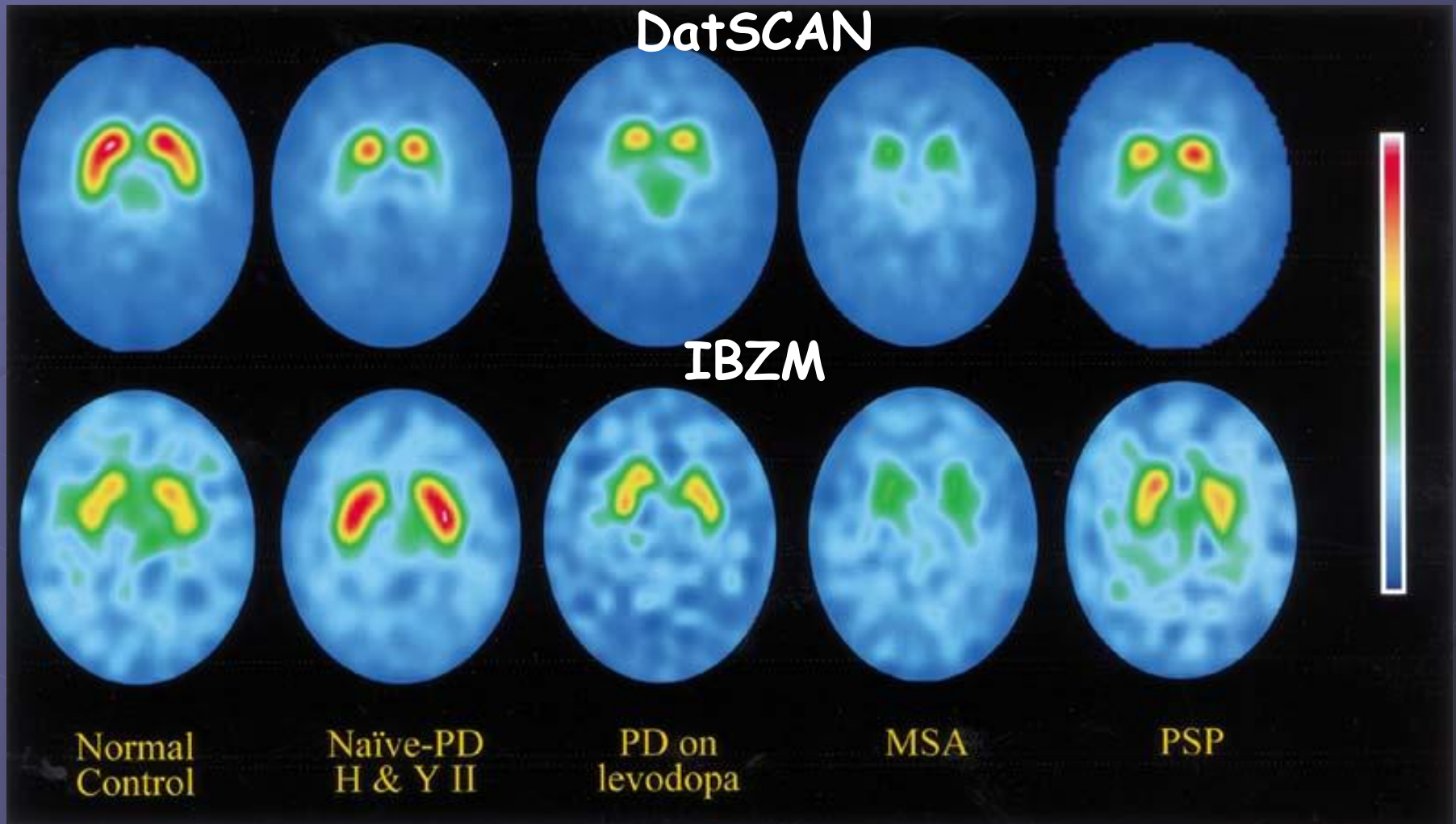


Normal



PD

DaT & D2 nei Parkinsonismi



Kim YJ et al. Combination of Dopamine Transporter and D2 Receptor SPECT in the Diagnostic Evaluation of PD, MSA, and PSP. *Movement Disorders* Vol. 17, No. 2, 2002, pp. 303-312

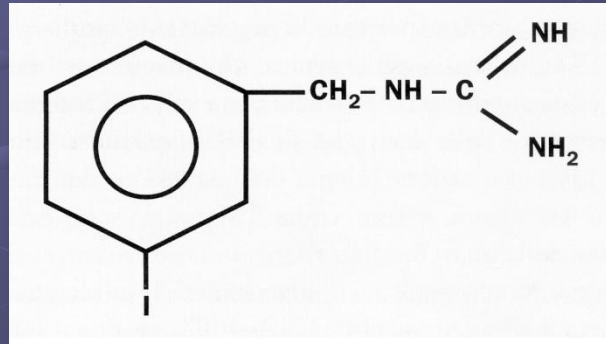
Traccianti recettoriali

● ^{123}I -MIBG cardiaca

...un paradosso?!!!

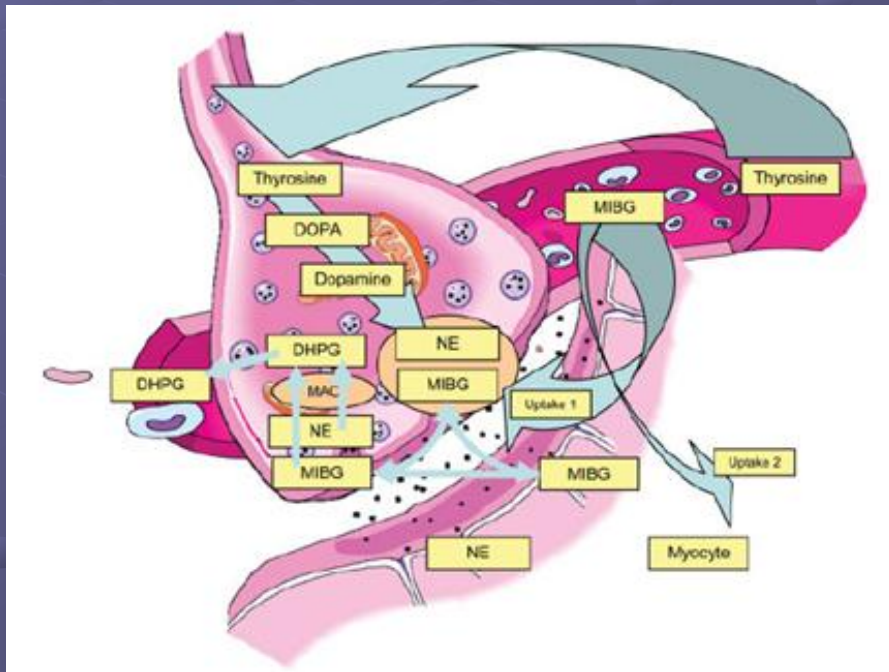
^{123}I -MIBG

- La **metaiodo-benzilguanidina** è un analogo della guanitidina (precursore delle **catecolamine**) ed esplica un meccanismo di blocco funzionale dei neuro-trasmettitori adrenergici in sede post-gangliare.



- La sua ritenzione è alterata nel trattamento con disipramina e resperpina, nella denervazione simpatica, nell'ischemia acuta e cronica e nelle **cardiomiopatie dilatative**.

^{123}I -Metaiodobenzylguanidine Scintigraphy in Parkinson's Disease and Related Disorders



Movement Disorders

Vol. 24, Suppl. 2, 2009, pp. S732–S741

© 2009 Movement Disorder Society

Olivier Rascol, MD, PhD^{1*} and Ludwig Schelosky, MD²

Importance of ^{123}I -Metaiodobenzylguanidine Scintigraphy/Single Photon Emission Computed Tomography for Diagnosis and Differential Diagnostics of Parkinson Syndromes

Wolfgang H. Jost^a Kelly Del Tredici^c Christian Landvogt^b Stefan Braune^d

Conclusion

MIBG scintigraphy may be considered a valid procedure for distinguishing idiopathic Parkinson syndrome from aPS and for differentiating Lewy body dementia from Alzheimer's disease.

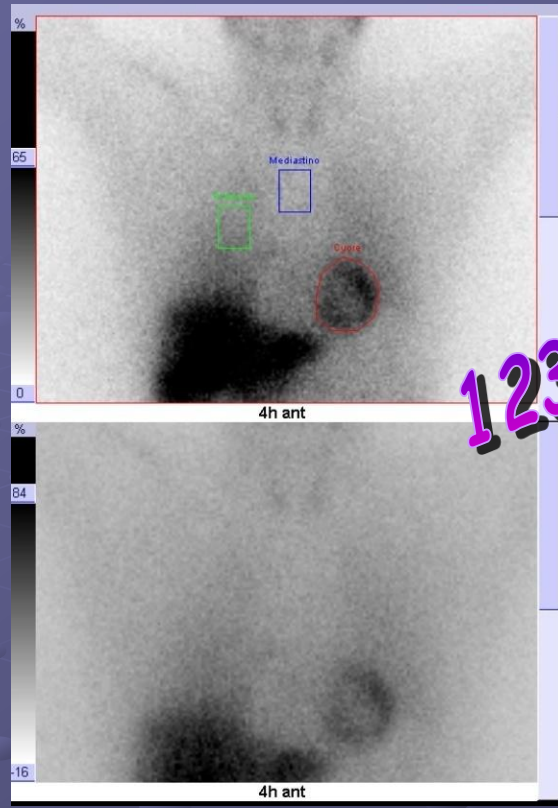
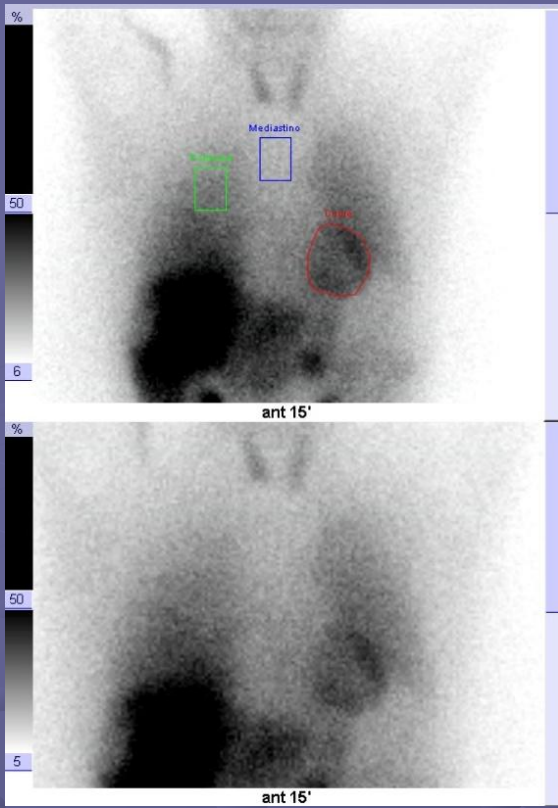
Provided cardiac disease is not present, the method displays a very high degree of sensitivity and a high degree of specificity for the following disorders: idiopathic PD, DLB, pure autonomic failure, and REM sleep behavior disorder.

The fact that the sensitivity in Hoehn and Yahr stage 1 is not sufficient is currently the greatest problem facing clinicians because the method is still inappropriate for purposes of early diagnosis. Its chief asset, however, lies in its ability to distinguish IPS from aPS and DLB from other forms of dementia.

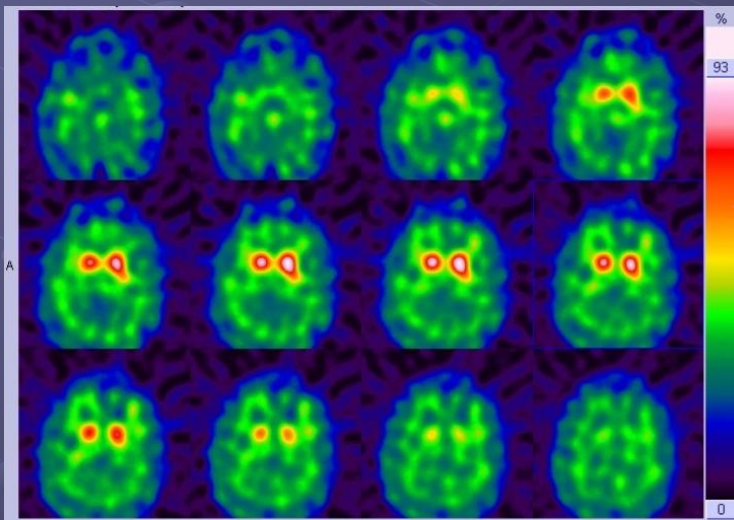


Neurodegenerative Dis 2010;7:341-347

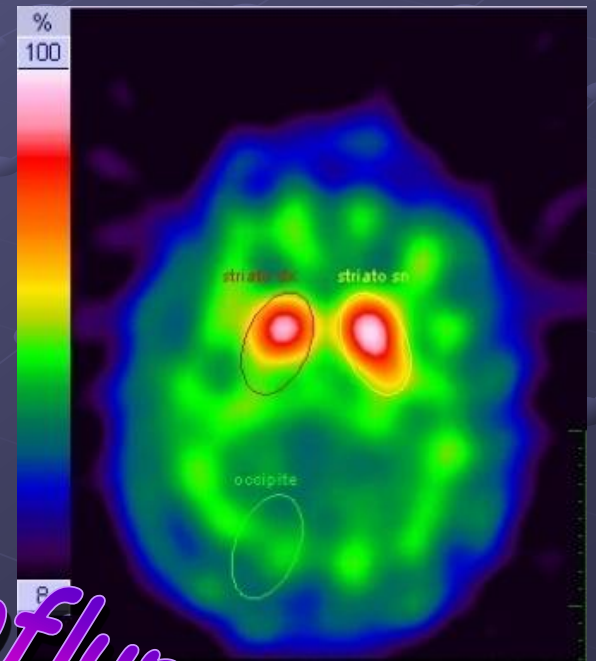
Caso clinico 1



123I-MIBG

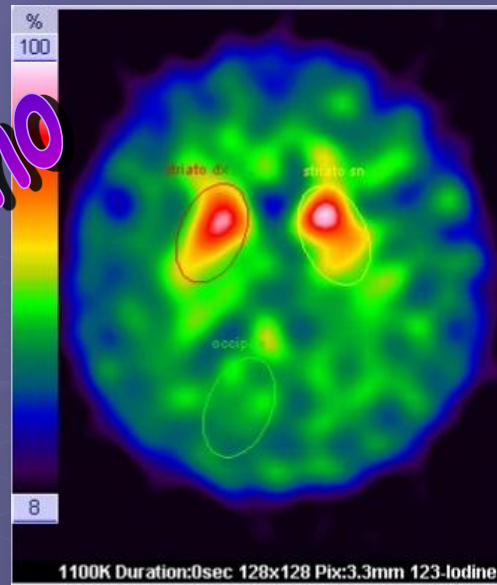


123I-ioflupano

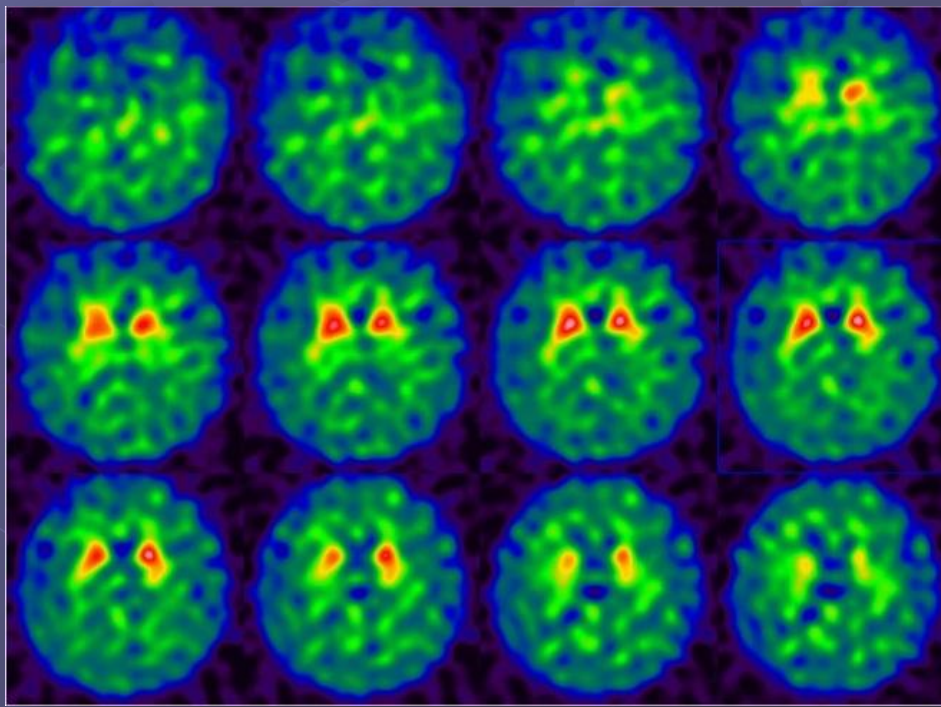
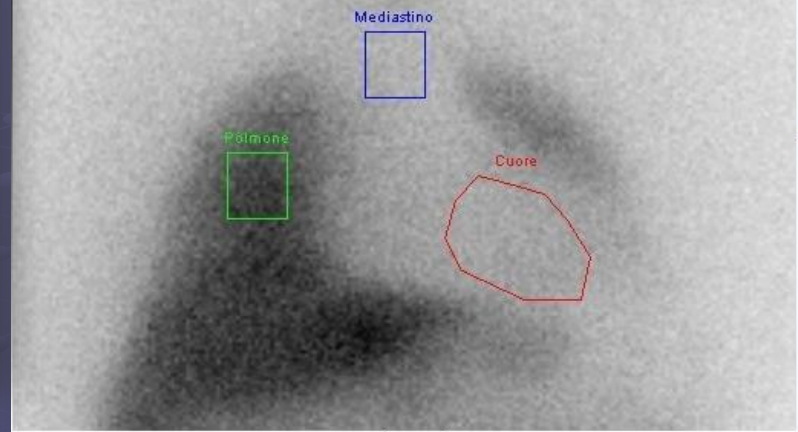


Caso clinico 2

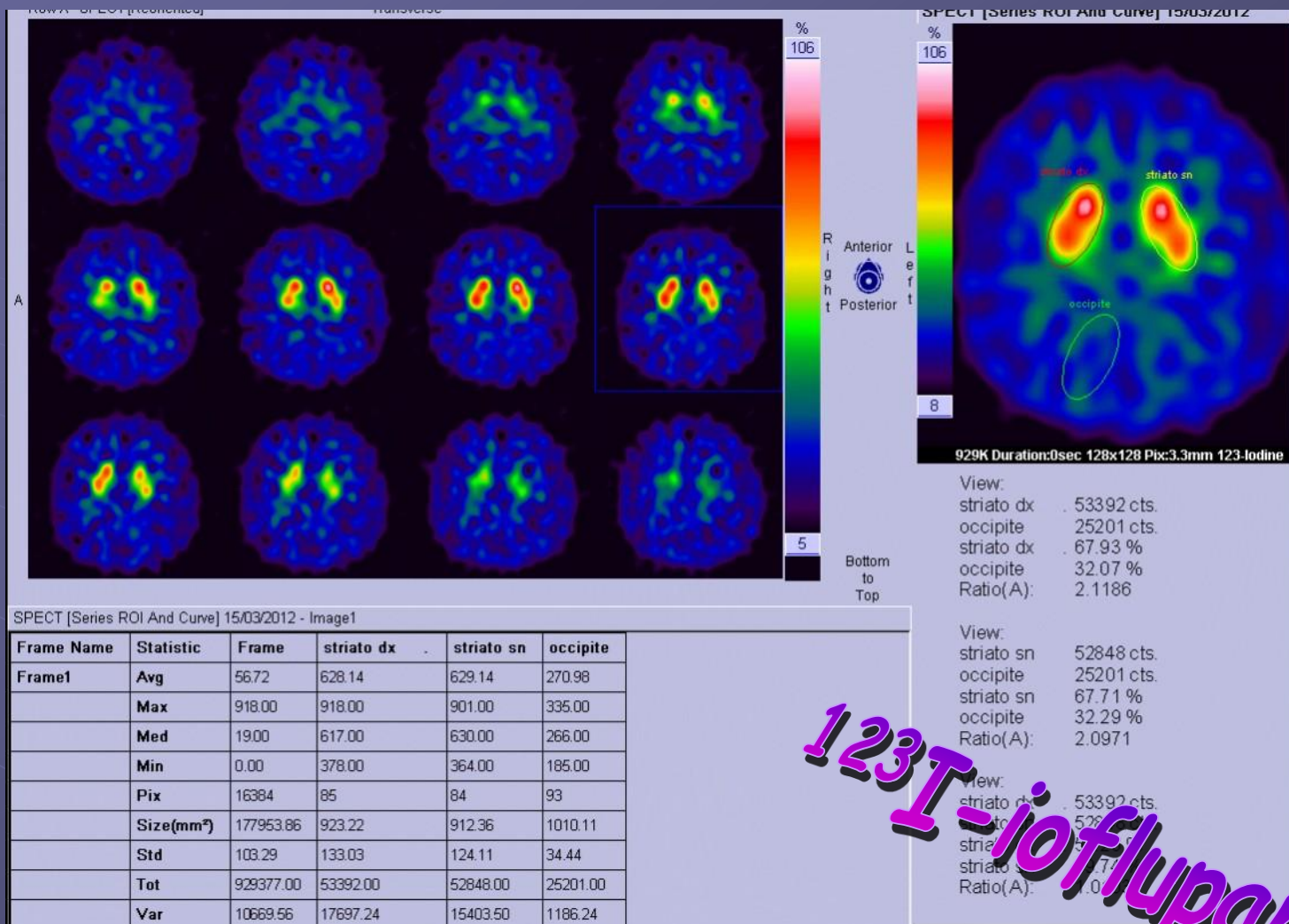
¹²³I-ioflupano



Clinical: FSAZ005942
dy Desc: SC. GLOBALE CORPOREA CON MIBG (MEDULLOSURRENALICA)
es Desc: SAVE_SCREEN
16/1958
00-1 >



Caso clinico 3



123I-ioflupano

Tabella riassuntiva

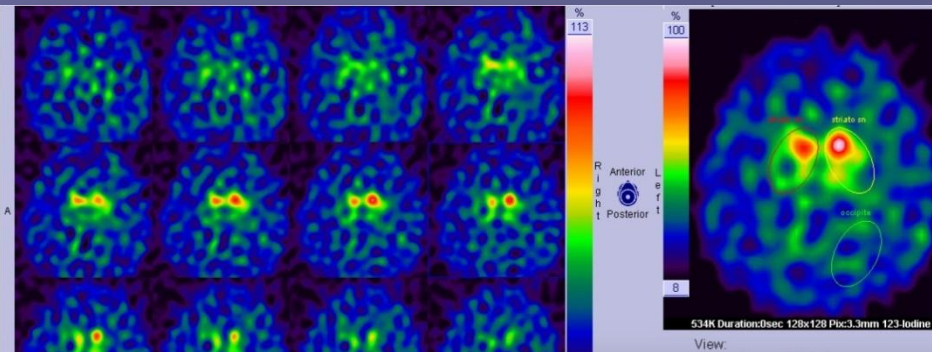
	PD	LBD	PSP	MSA	CBD	AD	FTD	ET
¹²³ I-ioflupano	+	+	+	+	+	-	-	-
¹⁸ F- e ¹¹ C-DOPA	+	+	+	+	+	-	-	-
¹¹ C-raclopride e ¹²³ I-IBZM	-	-	+	+	+	-	-	-
^{99m} Tc-ECD e ^{99m} Tc-HMPAO	+	+	+	+	+	+	+	-
¹⁸ F-FDG	+	+	+	+	+	+	+	-
¹²³ I-MIBG	+	+	-	-	-	-	-	-

PD = malattia di Parkinson; LBD = demenza a corpi di Levy; PSP = paralisi sopranucleare progressiva; MSA = atrofia multisistemica; CBD = degenerazione cortico-basale; AD = demenza di Alzheimer; FTD = demenza fronto-temporale; ET = tremore essenziale.

Caso clinico 4

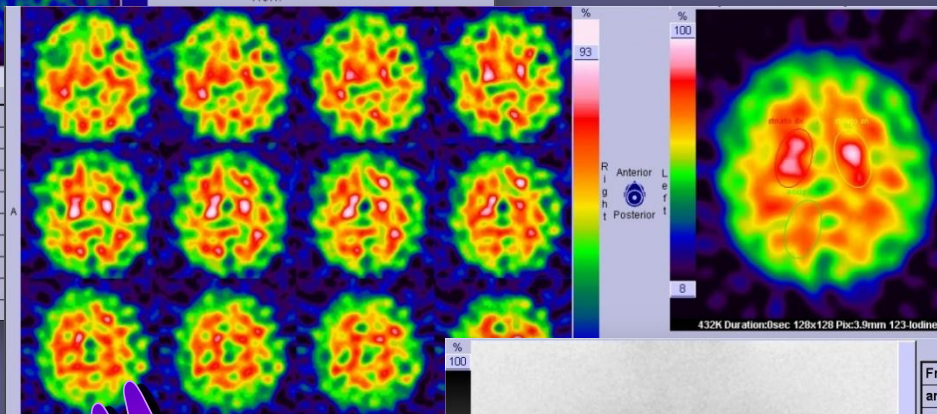
- Uomo di 65 anni.
- In osservazione per sindrome extrapiramidale ipertonico-bradicinetica asimmetrica per sn>dx esordita da circa 6 anni, con scarsa risposta alla levodopa associata a sfumato deterioramento cognitivo.
- Nella norma i precedenti accertamenti (RM cerebrale, valutazione neuro-psicologica, valutazione SNV, test in acuto alla L-Dopa e Apomorfina, studio dei movimenti oculari).
- Viene alla nostra attenzione per inquadramento strumentale...

123I-ioflupano



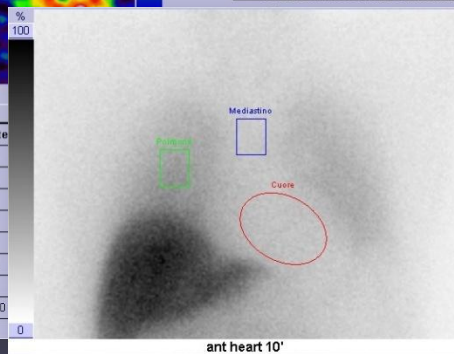
SPECT [Series ROI And Curve] 27/01/2011 - Image1

Frame Name	Statistic	Frame	striato dx	striato sn	occipite
Frame1	Avg	32.58	236.82	257.62	146.90
	Max	465.00	396.00	465.00	210.00
	Med	13.00	225.00	248.00	144.00
	Min	0.00	127.00	127.00	82.00
	Pix	16384	111	112	125
	Size(mm ²)	177953.86	1205.62	1216.48	1367.68
	Std	52.32	57.72	73.20	30.89
	Tot	533803.00	26287.00	28853.00	18363.00
	Var	2737.70	3331.55	5368.15	954.30



SPECT [Series ROI And Curve] Mar-08 - Image1

Frame Name	Statistic	Frame	striato dx	striato sn	occipite
Frame1	Avg	20.37	175.89	169.76	151.16
	Max	220.00	204.00	220.00	169.00
	Med	14.00	179.00	167.00	152.00
	Min	0.00	126.00	127.00	126.00
	Pix	16384	92	92	79
	Size(mm ²)	248609.27	1396.00	1396.00	1198.74
	Std	39.37	19.38	22.20	10.83
	Tot	432052.00	16182.00	15618.00	11942.00
	Var	1550.23	375.77	492.98	117.32



Frame Name	Statistic	Frame	Cuore	Polmone	Mediastino
ant heart 10'	Avg	98.69	159.49	250.60	142.78
	Max	642.00	209.00	317.00	185.00

Valore normale Cuore / Mediastino >1.6

Cuore 174798 cts.
Mediastino 38551 cts.
Cuore 81.93 %
Mediastino 18.07 %
Ratio(N): 1.1170

Polmone 72174 cts.
Mediastino 38551 cts.
Polmone 65.18 %
Mediastino 34.82 %
Ratio(N): 1.7552

Cuore 174798 cts.
Polmone 72174 cts.
Cuore 70.78 %
Polmone 29.22 %
Ratio(N): 0.6364

123I-IBZM

123I-MIBG



Principali settori applicativi

- *Malattie cerebro-vascolari*
- *Demenze*
- *Epilessie*
- *Malattie degenerative*
- *Neoplasie e infezioni*

*Indicatori di lesione
in SPECT cerebrale*

Indicatori di lesione

Neoplasie

- ^{99m}Tc -sestamibi

- ^{201}Tl -cloruro

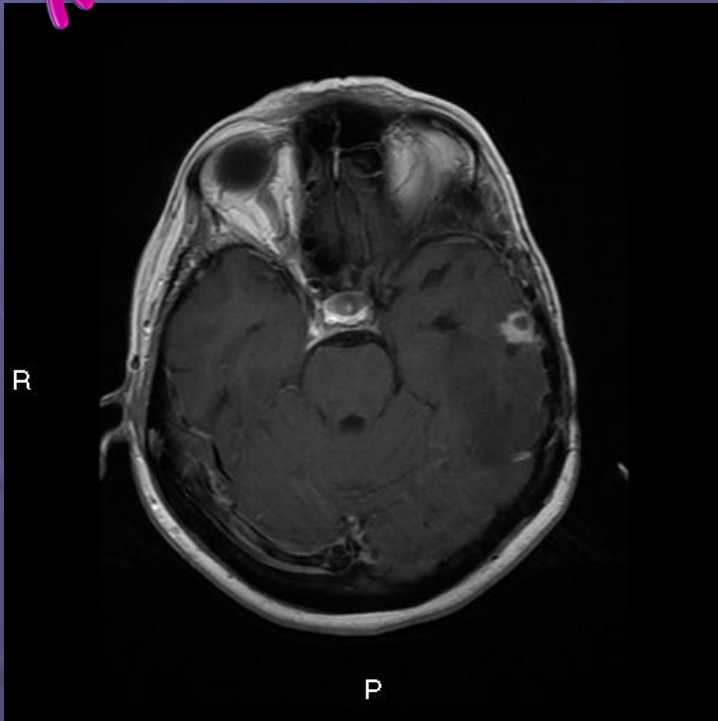
Infezioni

- ^{99m}Tc -HMPAO leucociti

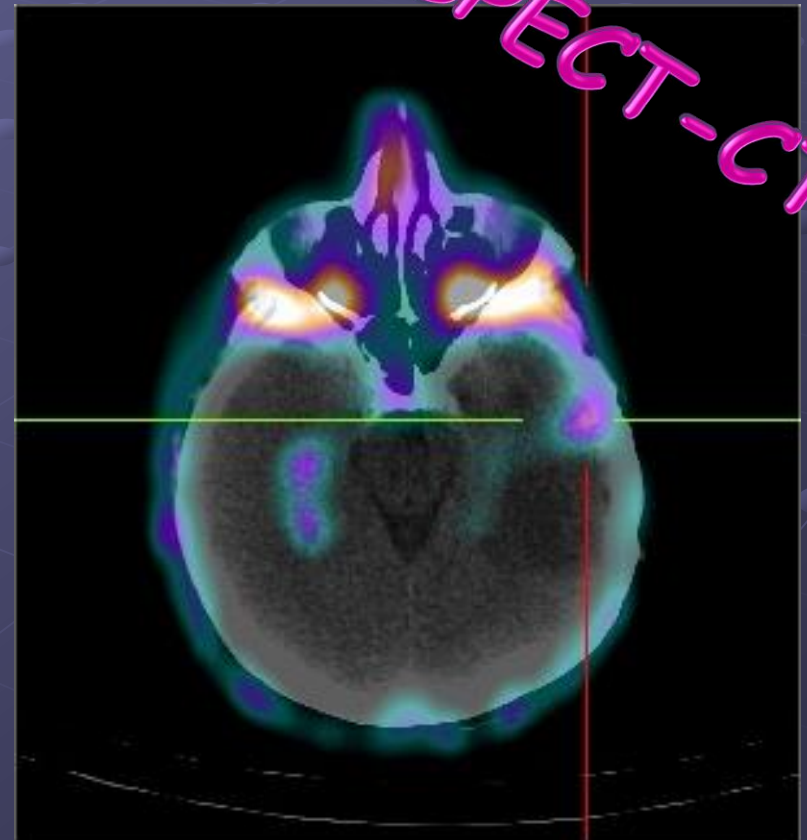
- ^{67}Ga -citrato

Scintigrafia con ^{99m}Tc -sestamibi in sospetta recidiva di glioma

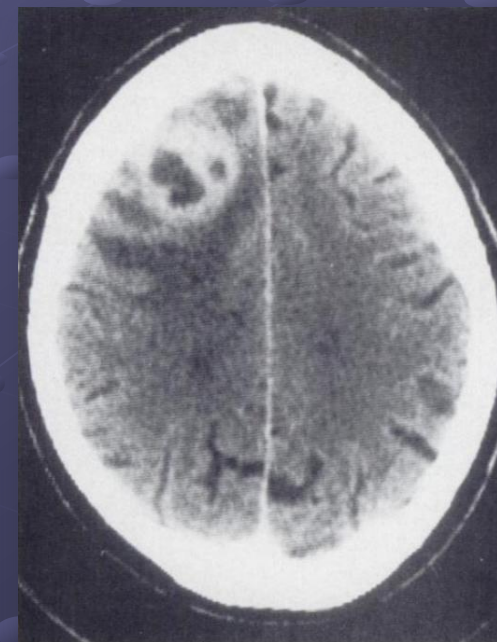
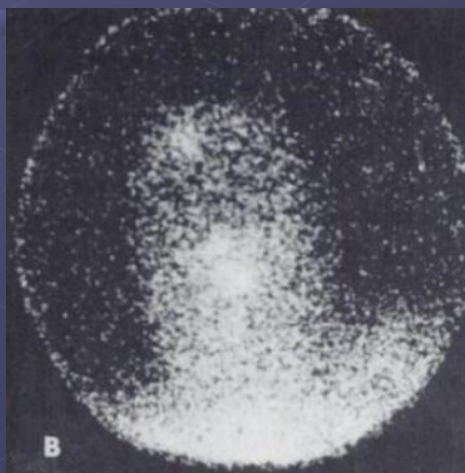
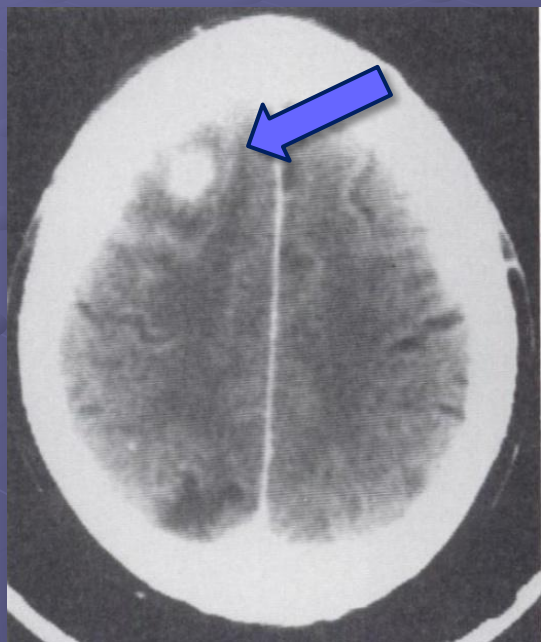
MRI



SPECT-CT

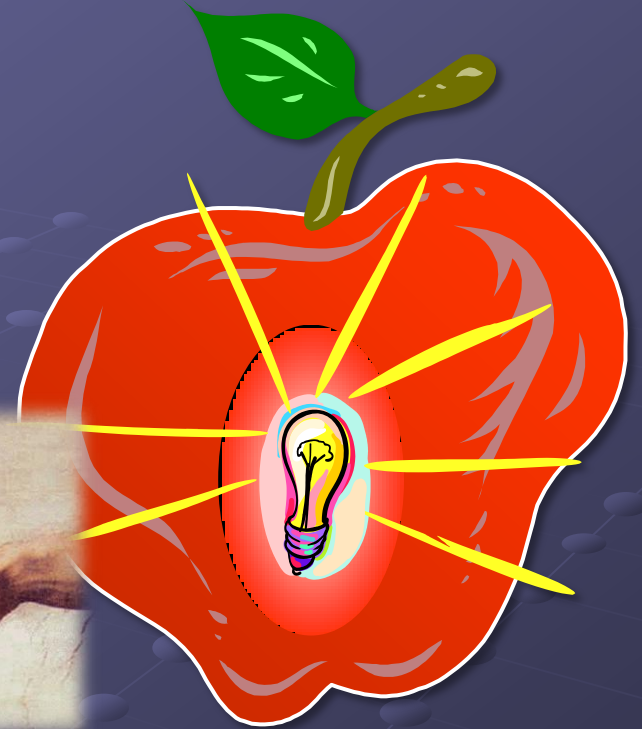
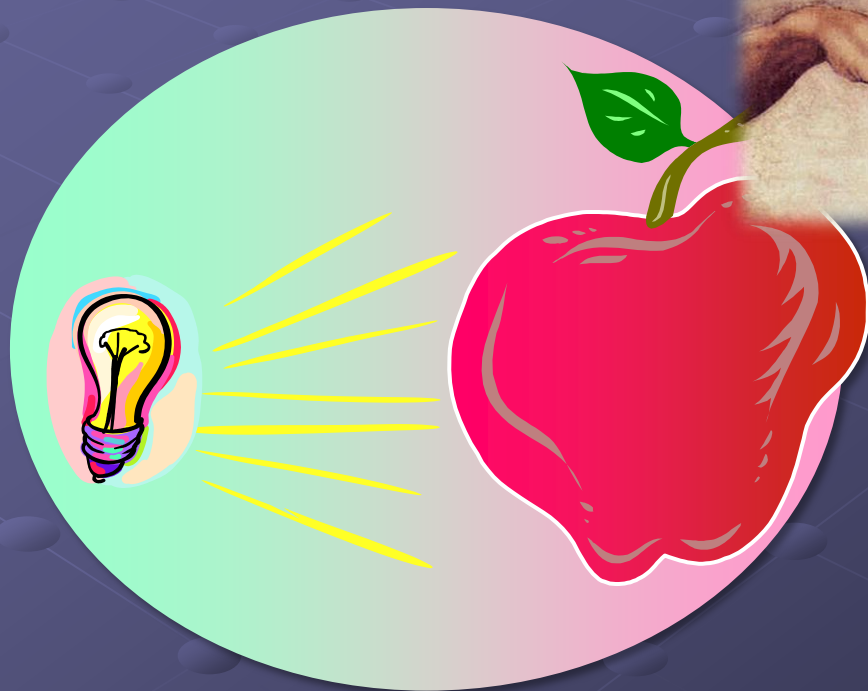


Scintigrafia con ^{99m}Tc -HMPAO leucociti: ascesso cerebrale

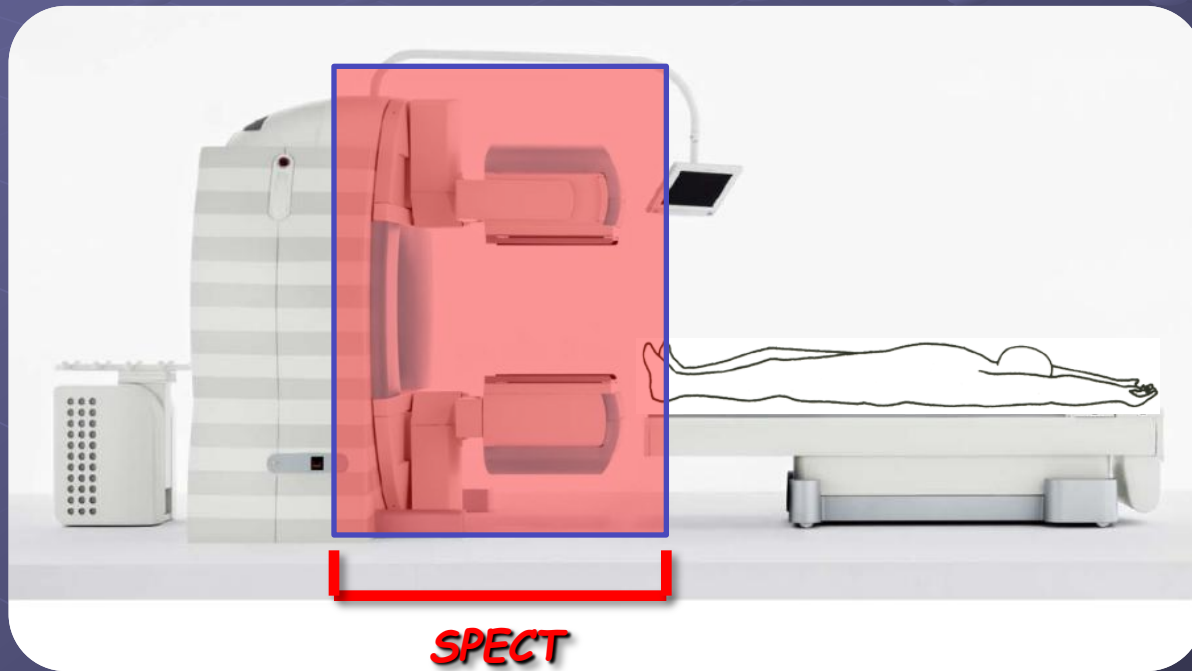


PET o SPECT

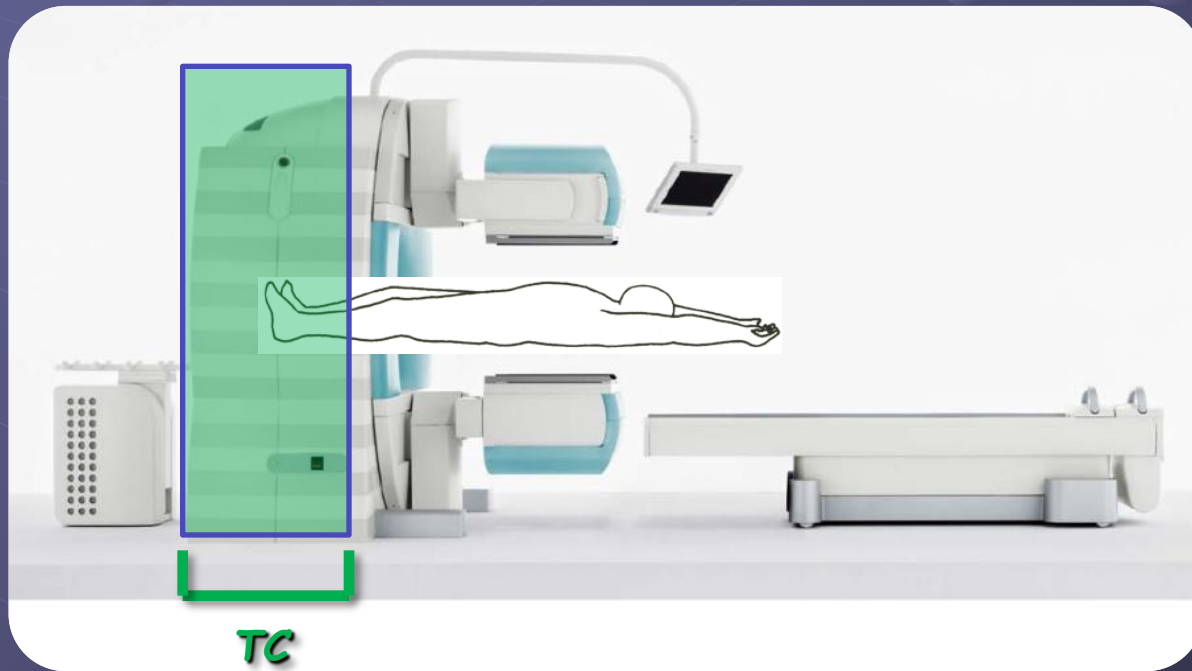
CT

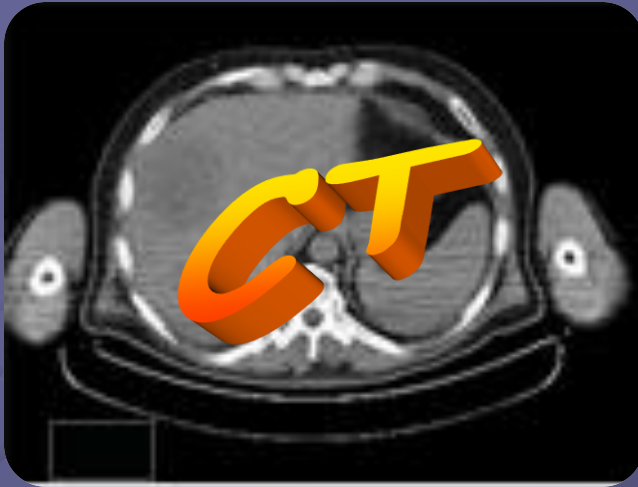


Acquisizione delle indagini SPECT-CT: la SPECT



Acquisizione delle indagini SPECT-CT: la CT





Applicazioni Diagnostiche (I)

The Role of
Emission
Tomography

Marius Horger,

Single-Photon Emission
Computed Tomography/Computed
Tomography in Abdominal

Orazio Schillaci, MD, PhD, Luca F...
and Giovanni Simonetti, MD

The Additional Value of SPECT/CT in Lymphatic
Mapping in Breast Cancer and Melanoma

Iris M.C. van der Ploeg¹, Renato A. Valdés Olmos², Omgo E. Niewes¹, Emiel J.Th. Rutgers¹, Bin B.R. Kroon¹, and
Cornelis A. Hoefnagel²
¹Department of Surgery, The Netherlands Cancer Institute—Antoni van Leeuwenhoek Hospital, Amsterdam, The Netherlands; and
²Department of Nuclear Medicine, The Netherlands Cancer Institute—Antoni van Leeuwenhoek Hospital, Amsterdam, The Netherlands

Comparison
Imaging

Tomography/Computed
Tomography Malignant Bone Disease

Computed
Tomography
Malignant Lymphoma

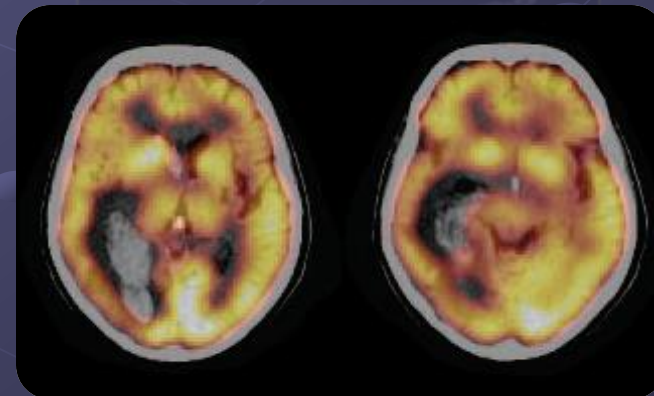
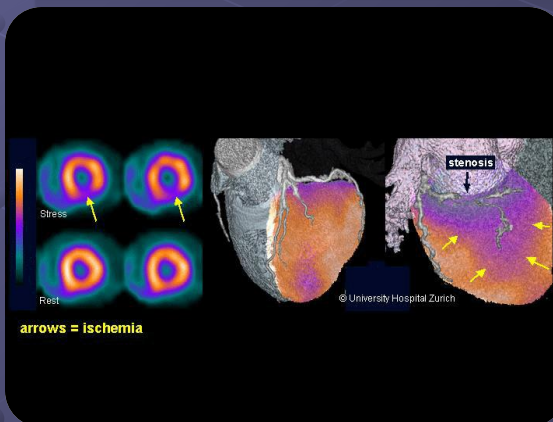
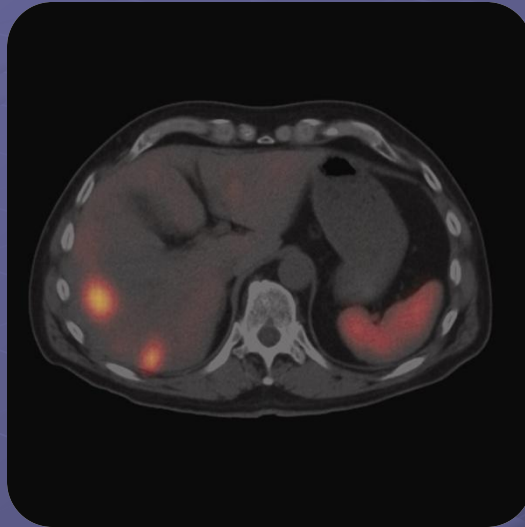
Immunoscintigraphic Evaluation
of Inflammation and Inflammation: Role
of Emission Computed Tomography,
Tomography Fusion Imaging

Tira Bunyaviroch, MD, Atul Aggarwal, MD, and M. Elizabeth

Thyroid Scintigraphy
Dual-Phase
SPECT, and Planar

Medman¹, Jeffrey P. Leal¹, Zhe Zhang², Elizabeth Garet-Mayer²,
A. Zeiger³, and Harvey A. Ziessman¹
¹Department of Radiological Sciences, Division of Nuclear Medicine, Johns Hopkins University, Baltimore, Maryland; and
²Department of Oncology and Biostatistics, Johns Hopkins University, Baltimore, Maryland; and
³Department of Radiology, Johns Hopkins University, Baltimore, Maryland

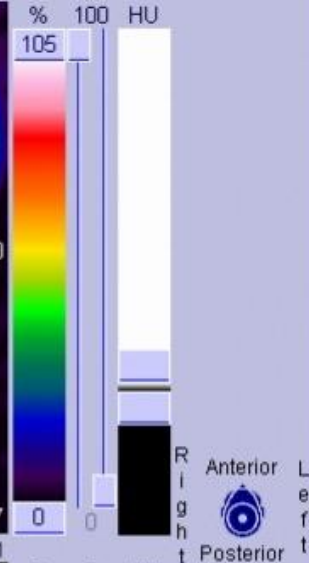
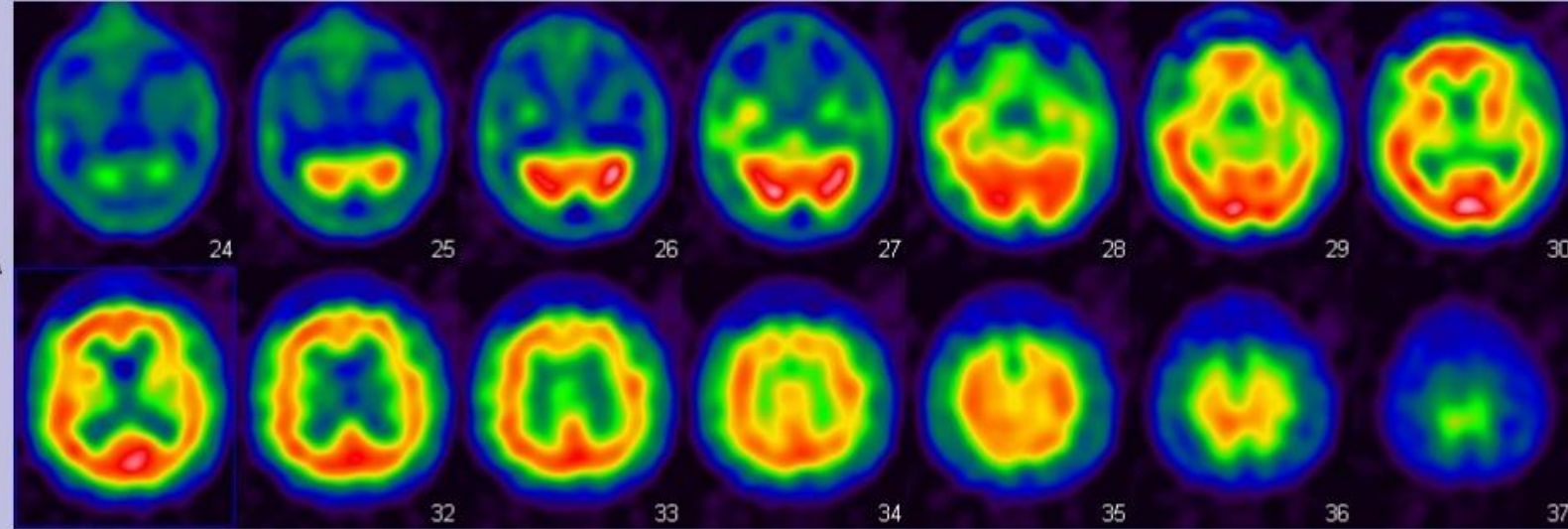
Applicazioni cliniche (II)



BRAIN SCAN [Iter - AC e scatter], 22/08/2011

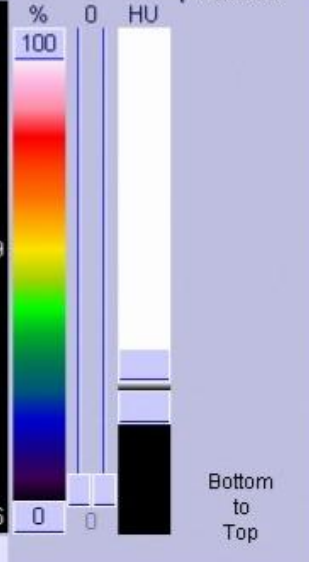
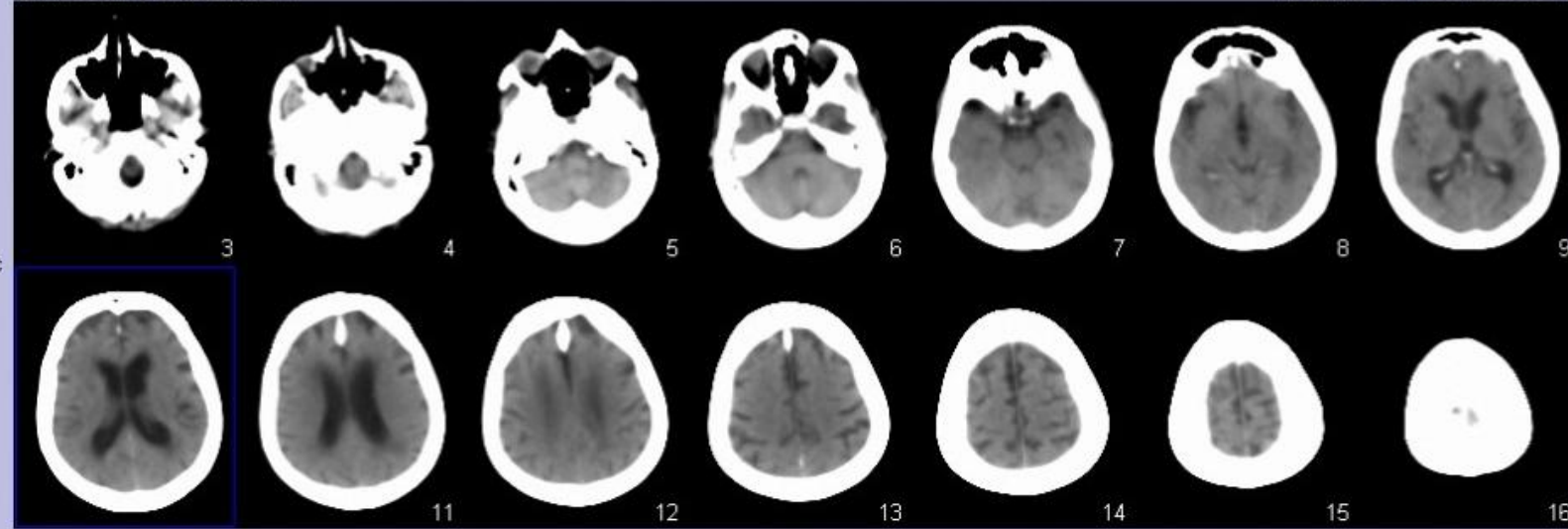
Transverse

AC Brain 3.0 H08s, 22/08/2011



BRAIN SCAN [FBP], 22/08/2011

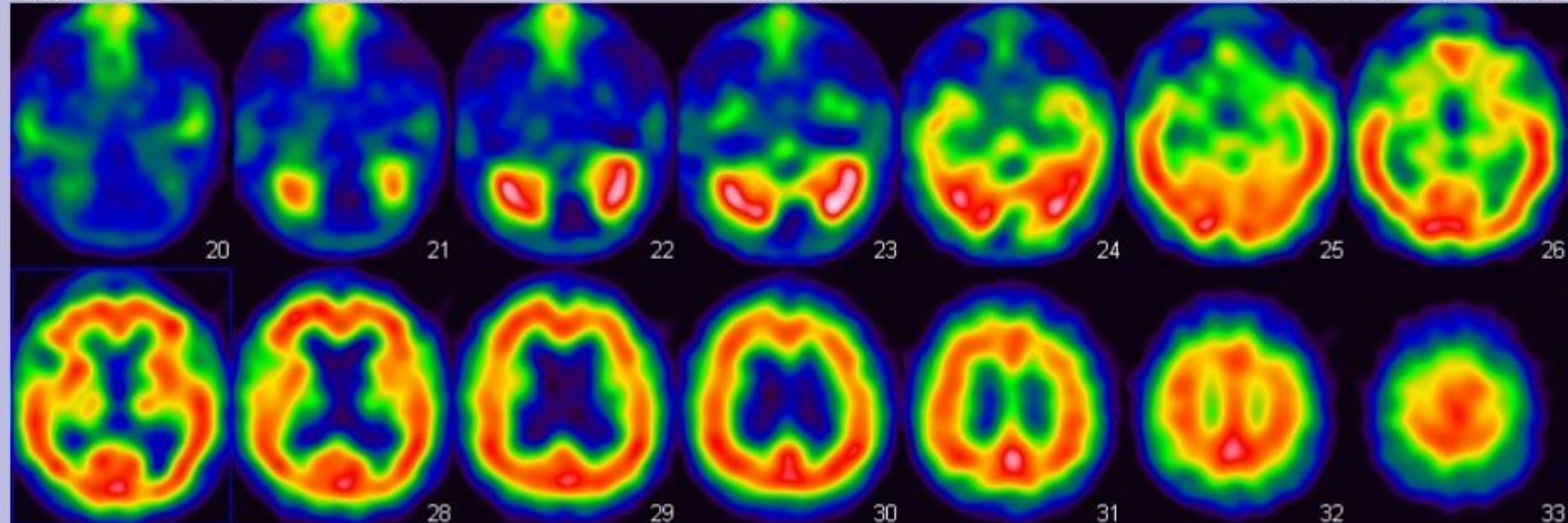
AC Brain 3.0 H08s, 22/08/2011



BRAIN HMPAO [iter - AC e scatter], 10/05/2012

Transverse

AC Brain 3.0 H08s, 10/05/2012



% 100 HU

98

5

0

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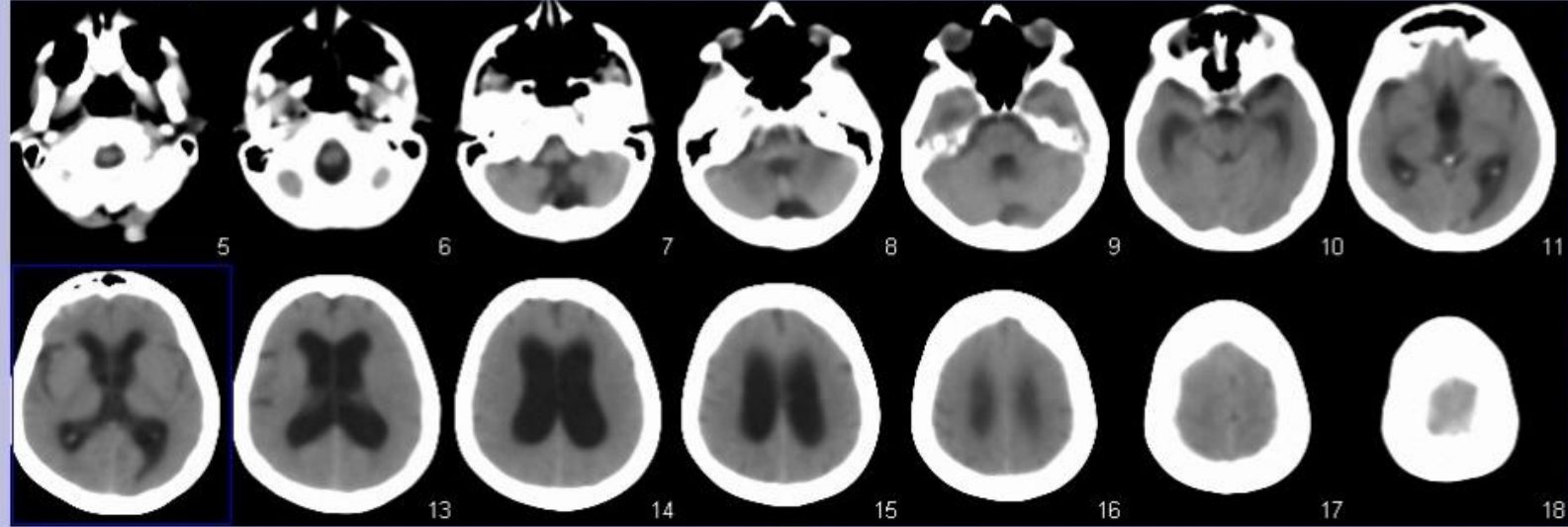
R
i
g
h
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Anterior
Posterior

L
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f
t

BRAIN HMPAO [FBP], 10/05/2012

AC Brain 3.0 H08s, 10/05/2012



% 0 HU

100

0

0

0

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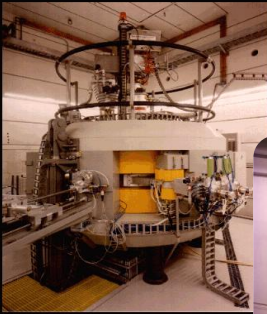
0

0

0

Bottom
to
Top

*Traccianti cerebrali
in campo PET*



PET

- E' una tecnica **emissiva** basata sull'uso di molecole biologiche (**aminoacidi, zuccheri, peptidi, ormoni, ecc.**) marcate con **ISOTOPI β^+ EMITTENTI** (^{11}C , ^{13}N , ^{15}O , ^{18}F) prodotti da acceleratori di particelle detti **ciclotroni**.

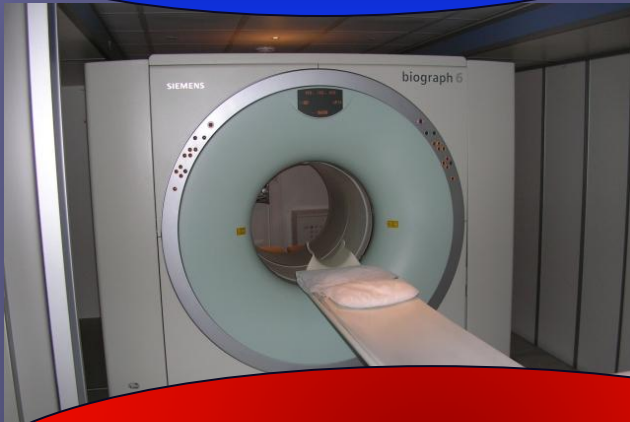
Stazione mobile: tomografi utilizzati



**SIEMENS ACCEL (LSO)
PET**



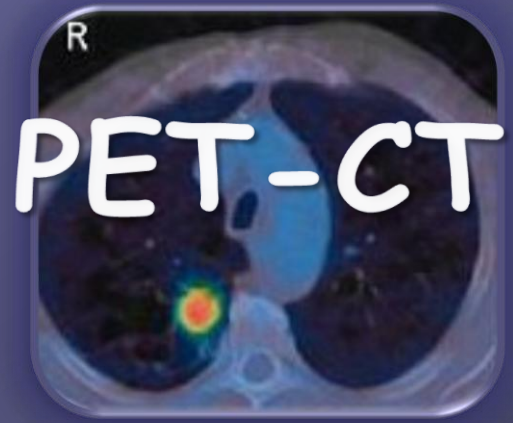
**GE DISCOVERY ST (BGO)
PET-CT**



**SIEMENS BIOGRAPH (LSO)
PET-CT**



**PHILIPS GEMINI TOF (BGO)
PET-CT**



Principali categorie di radiofarmaci

- Traccianti di perfusione
- Traccianti di metabolismo
- Traccianti recettoriali
- Traccianti per la β -amiloide

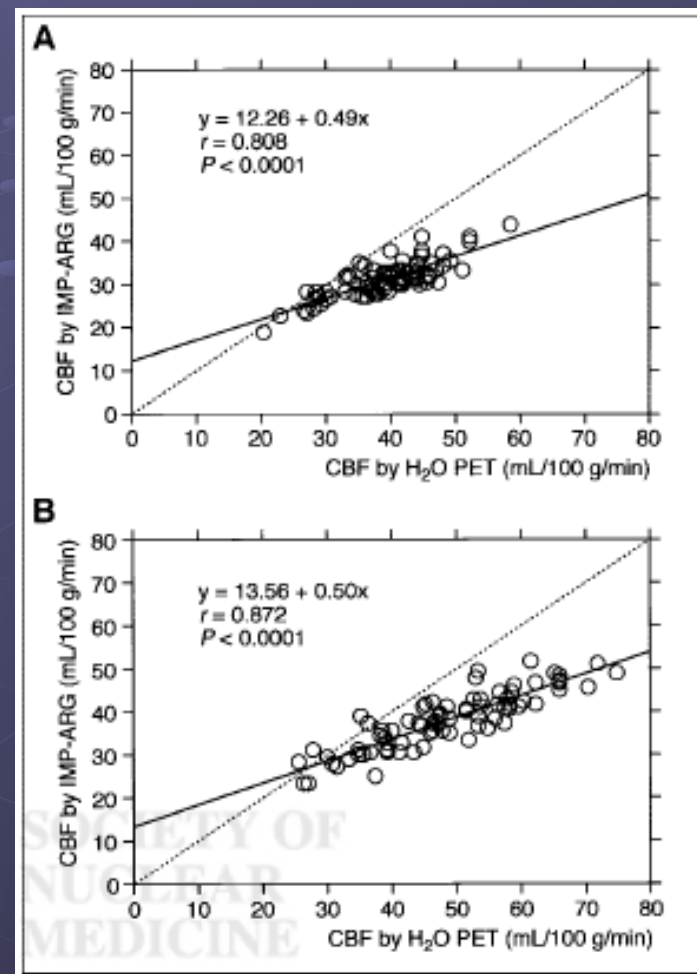
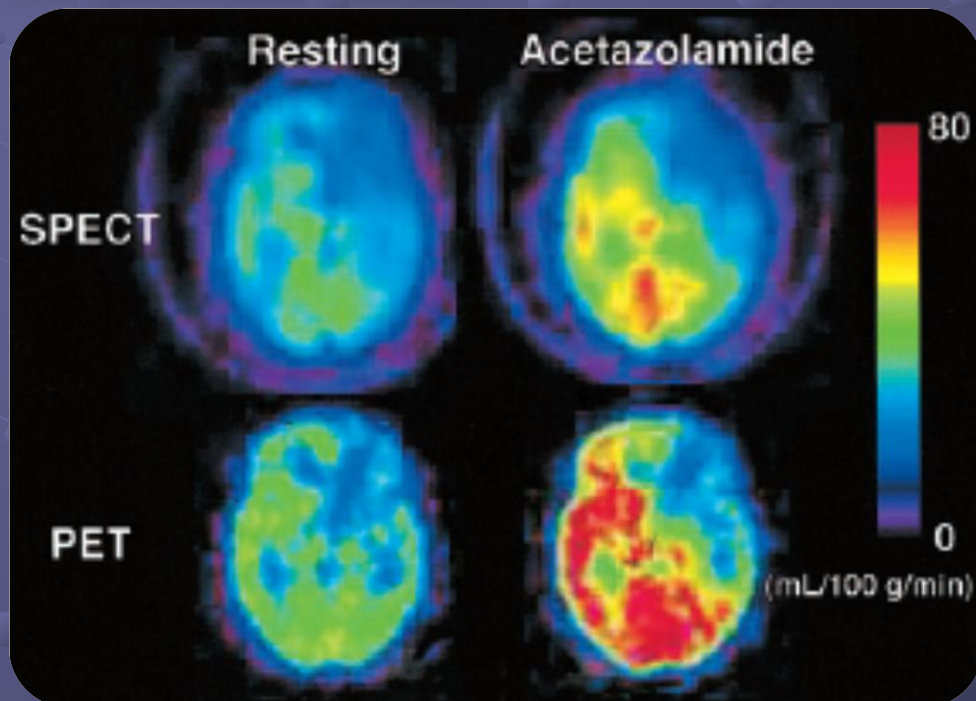
Traccianti PET di perfusione



Quantitative Measurement of Regional Cerebrovascular Reactivity to Acetazolamide Using ^{123}I -*N*-Isopropyl-*p*-Iodoamphetamine Autoradiography with SPECT: Validation Study Using H_2^{15}O with PET

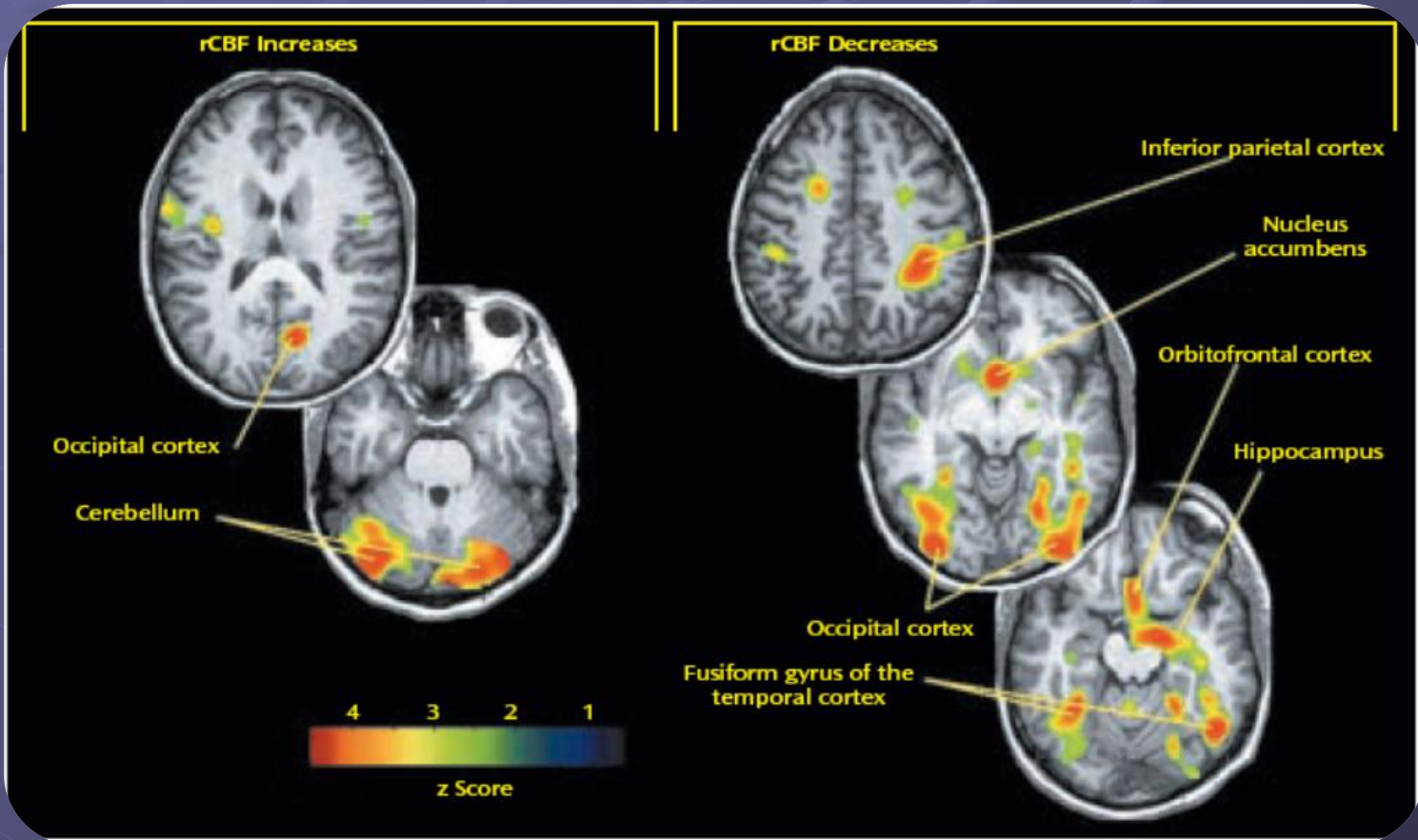
Kuniaki Ogasawara, MD^{1,2}; Hiroshi Ito, MD³; Masayuki Sasoh, MD^{1,2}; Taku Okuguchi, MD^{1,2}; Masakazu Kobayashi, MD^{1,2}; Hirotsugu Yukawa, MD^{1,2}; Kazunori Terasaki, PhD²; and Akira Ogawa, MD^{1,2}

J Nucl Med 2003; 44:520–525



Regional Cerebral Blood Flow Responses to Smoking in Tobacco Smokers After Overnight Abstinence

(*Am J Psychiatry* 2005; 162:567–577)

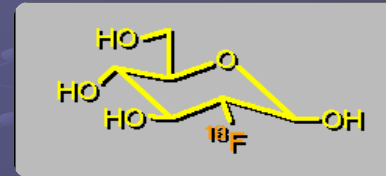
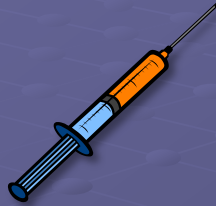


Traccianti PET di metabolismo

● ^{18}F -FDG

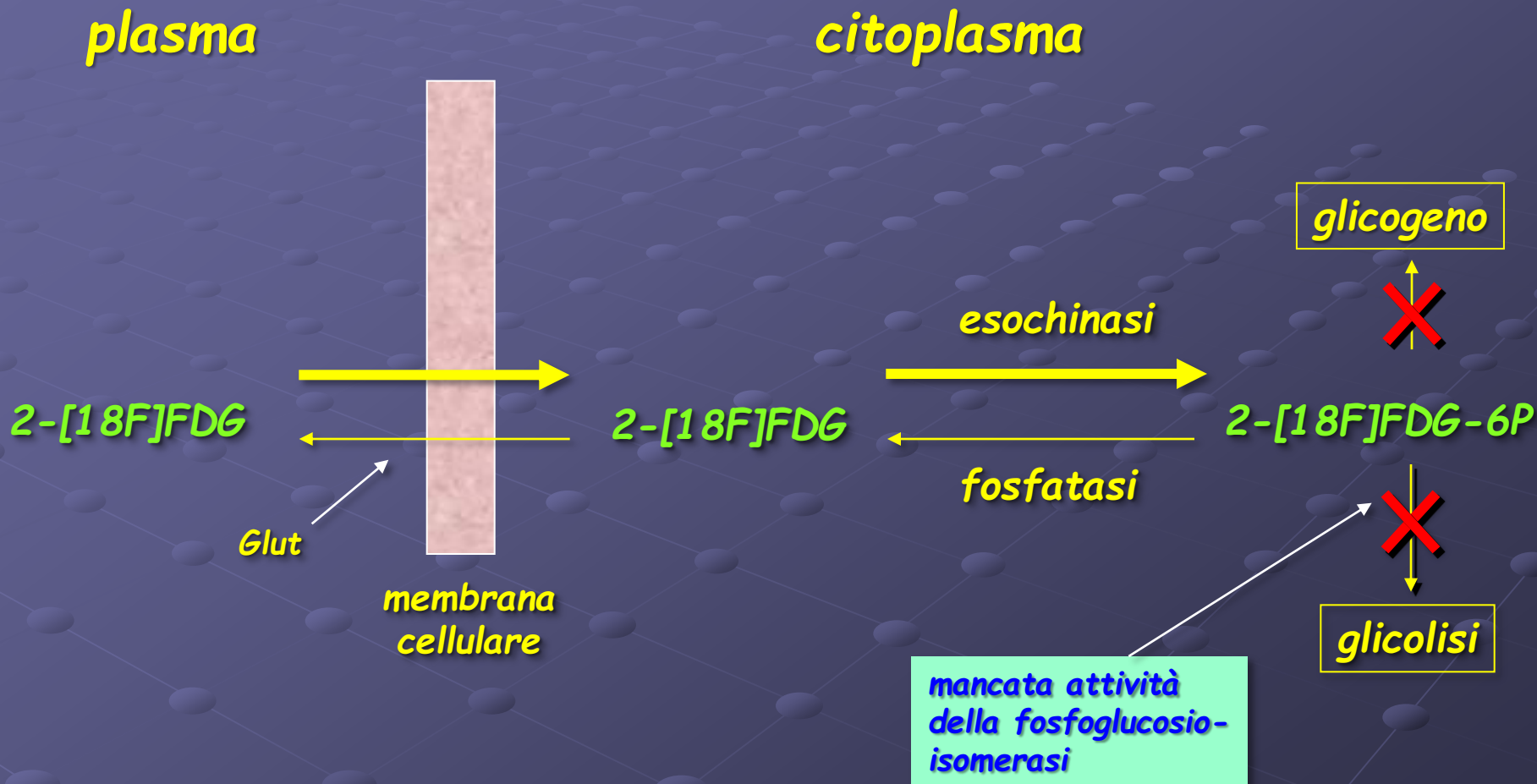
● ^{11}C -Metionina

Il radiofarmaco di "metabolismo" per eccellenza: il ^{18}F -FDG

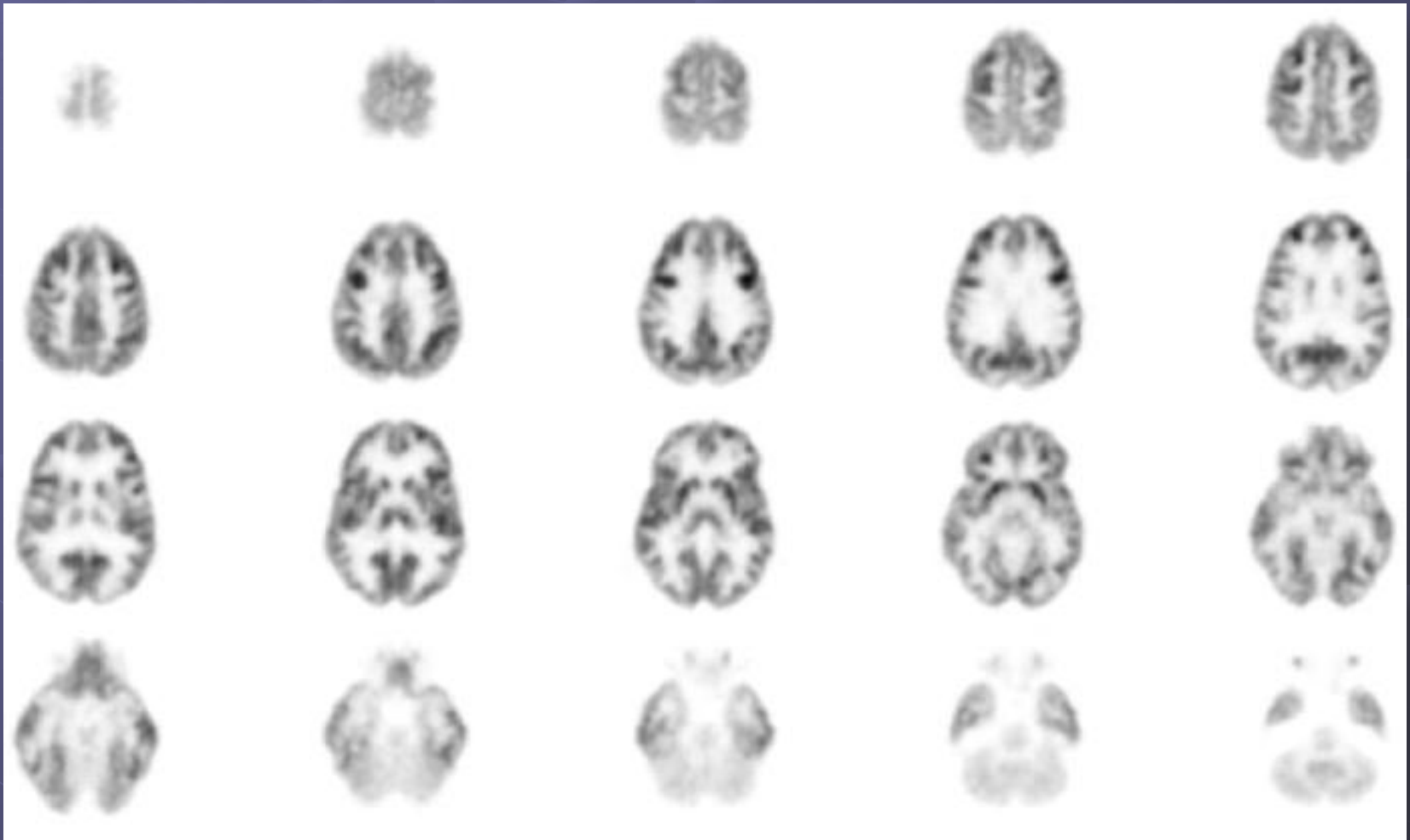


- E' un **analogo** "strutturale" del **glucosio**.
- Entra nella cellula e viene fosforilato dall'enzima "**esochinasi**" a FDG6-P, con consumo di **ATP**.
- Non può però proseguire nella via glicolitica e resta, pertanto, **intrappolato** all'interno del miocita, dove si accumula.

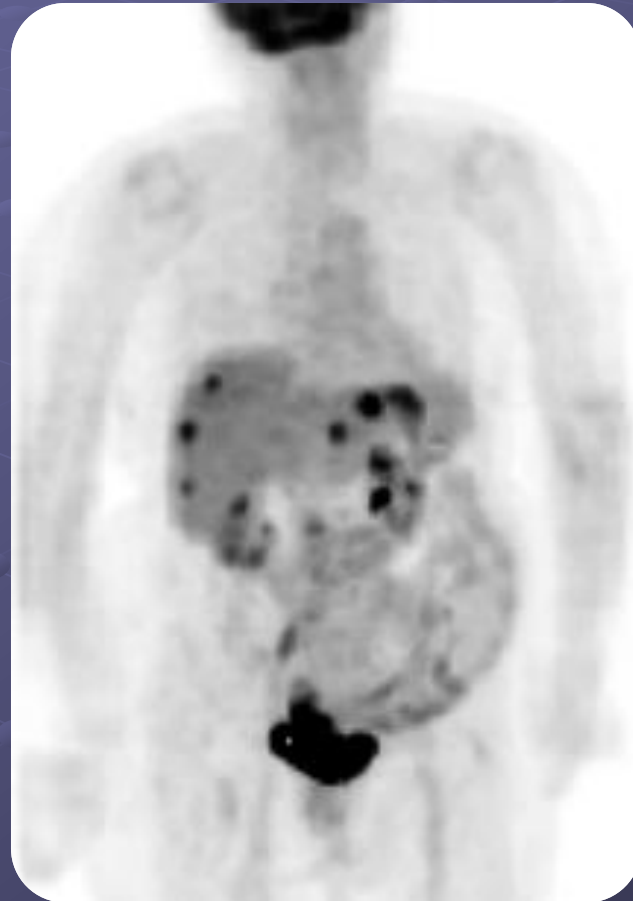
Metabolismo del ^{18}F -FDG



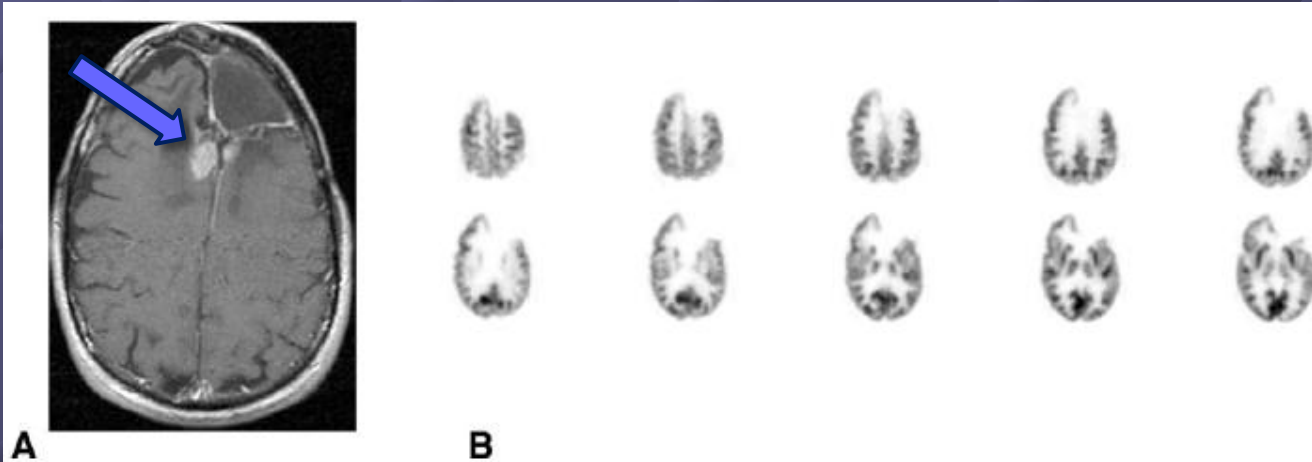
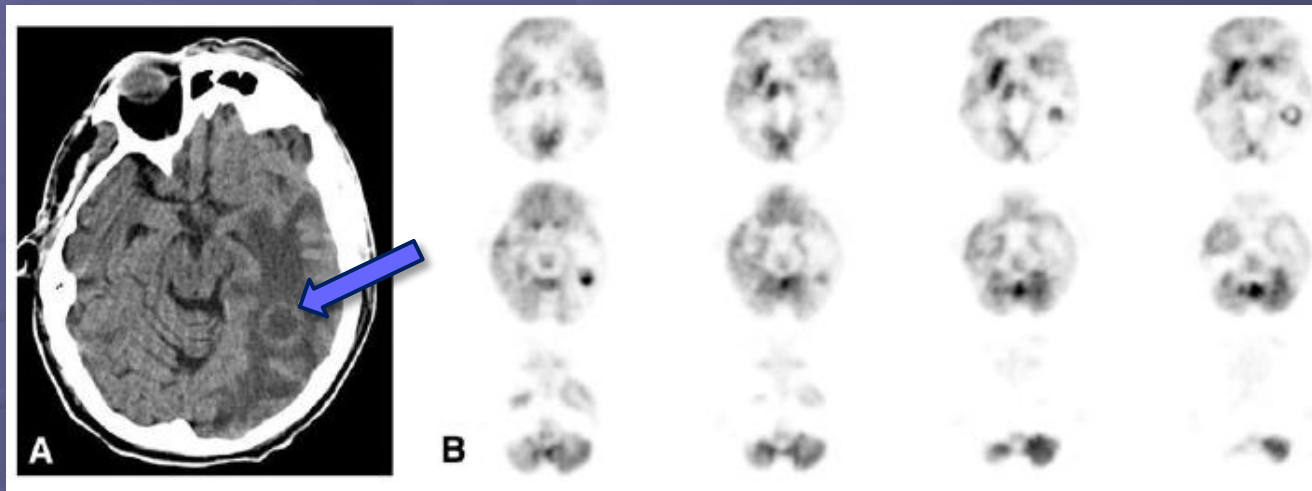
Metabolismo glucidico con ^{18}F -FDG nel cervello: caso normale



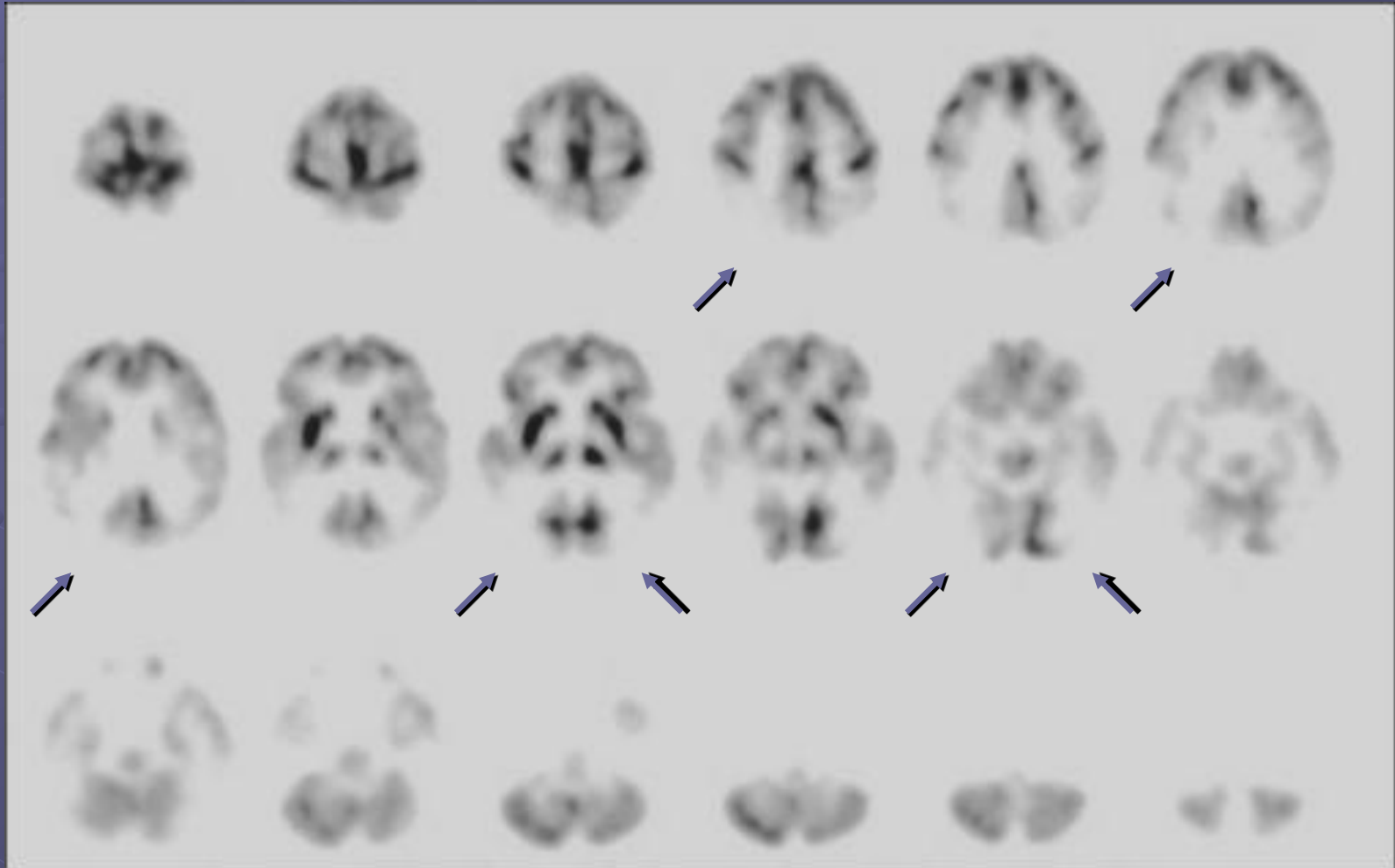
Limiti del ^{18}F -FDG nell'imaging oncologico cerebrale...

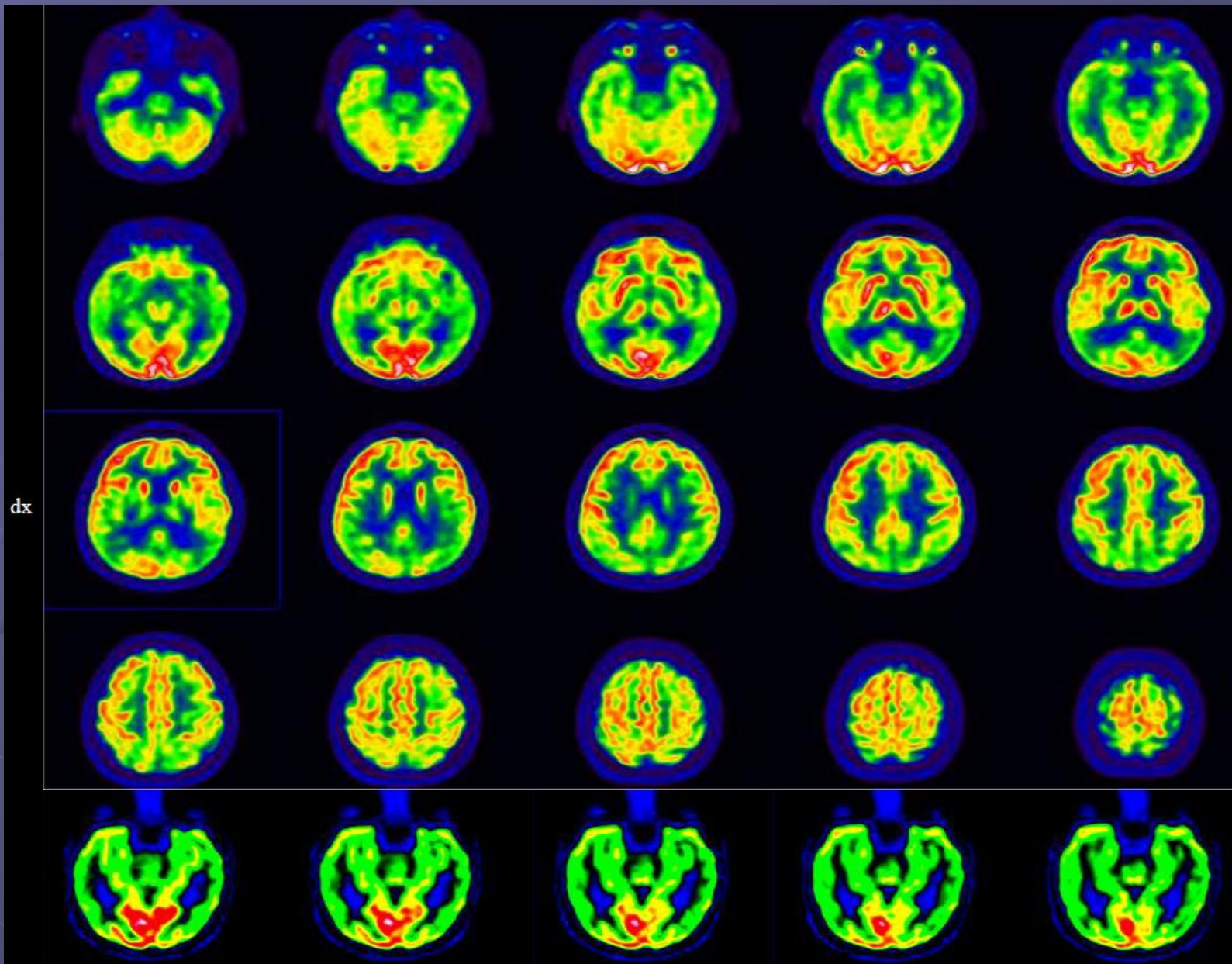


Valutazione del metabolismo glucidico con ^{18}F -FDG in campo oncologico

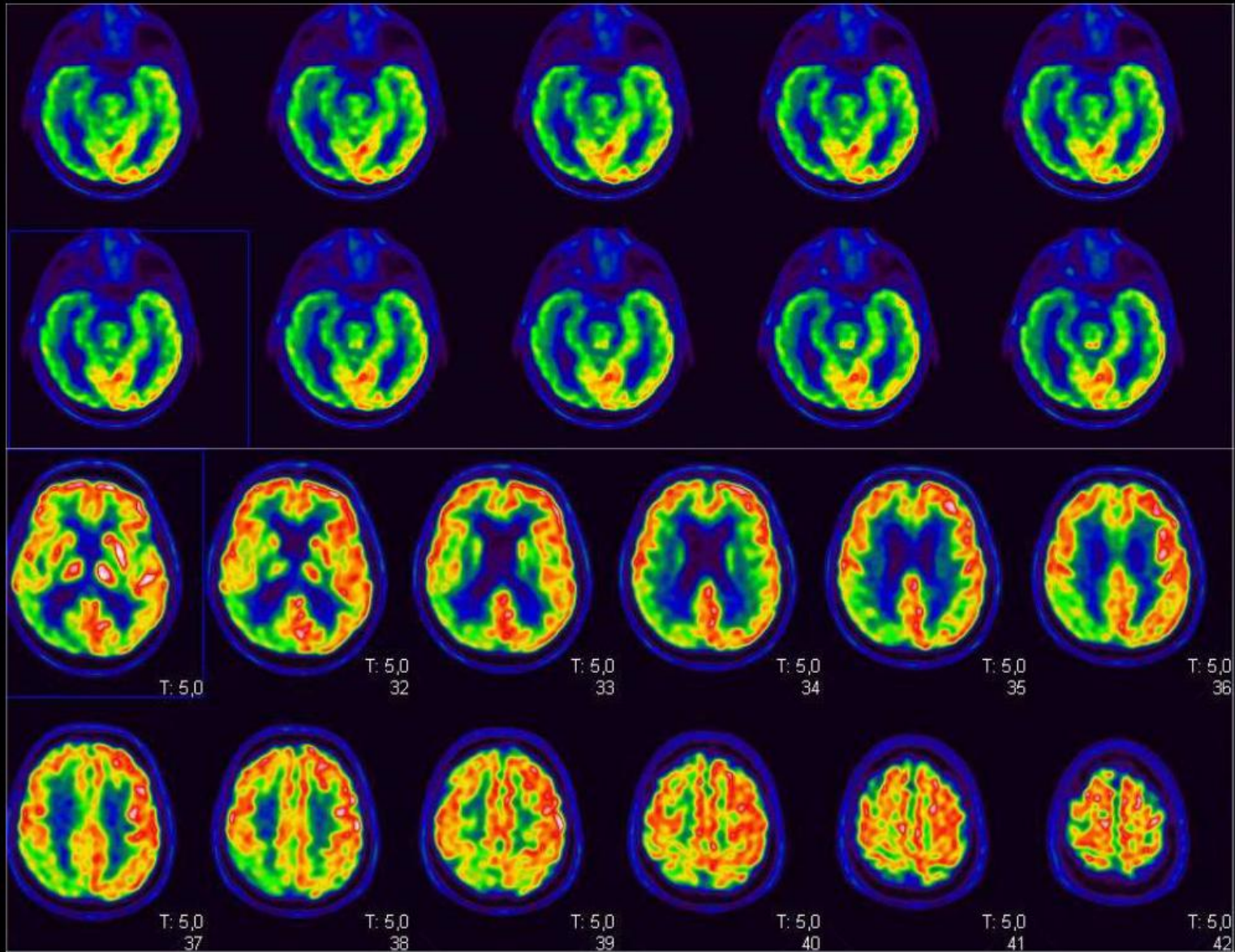


Metabolismo glucidico con ^{18}F -FDG nel Morbo di Alzheimer





dx



Review and Meta-Analysis of Biomarkers and Diagnostic Imaging in Alzheimer's Disease

Lisa M. Bloudek^a, D. Eldon Spackman^b, Michael Blankenburg^c and Sean D. Sullivan^{d,*}

Journal of Alzheimer's Disease 26 (2011) 627–645

A systematic review was undertaken to locate and abstract all studies of biomarkers or diagnostic imaging for AD published in English from January 1990 to March 2010 that provided estimates of SN and SP.

... Of 1,840 unique studies identified, 119 presented primary data sufficient for analysis. SN and SP were calculated against non-demented controls, non-AD dementias with and without MCI, if available.

RESULTS

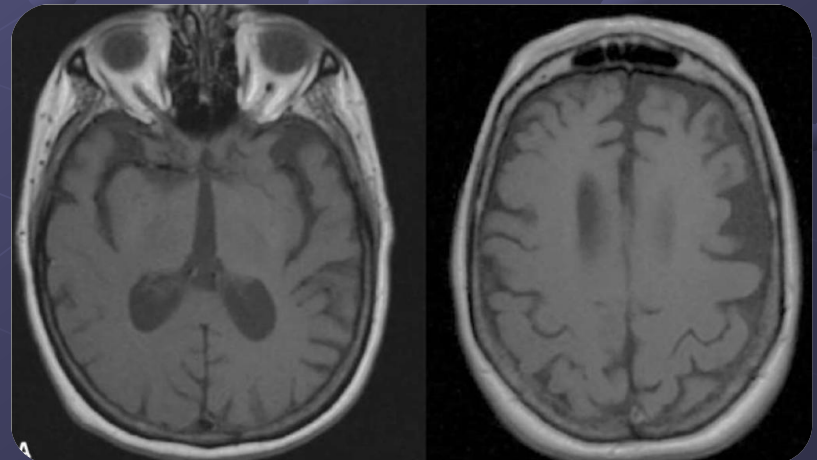
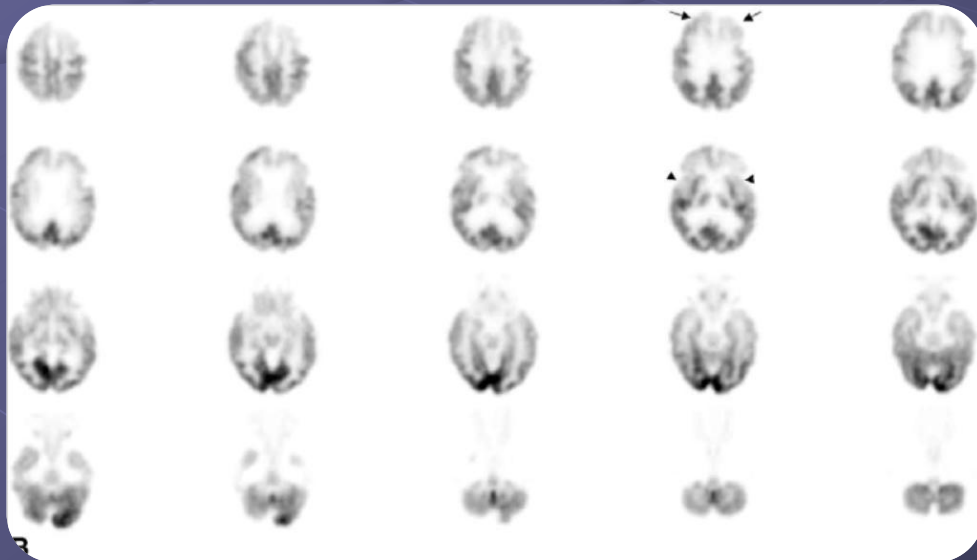
Compared to non-demented controls, FDG-PET demonstrated the highest AUROC (0.96), with 90% SN (95%CI 84% to 94%), and 89% SP (95%CI 81% to 94%). FDG-PET also was most accurate in discriminating AD from demented controls (including MCI) with AUROC 0.91, and 92% SN (95%CI 84% to 96%) and 78% SP (95%CI 69% to 85%). For discrimination of AD from non-AD dementias (excluding MCI), CSF Ptau and SPECT produced identical AUROC (0.86).

Metabolismo glucidico con ^{18}F -FDG nella demenza fronto-temporale

2-Deoxy-Fluorglucose-Positron Emission Tomography Imaging of the Brain: Current Clinical Applications with Emphasis on the Dementias

Ronald L. Van Heertum, Elizabeth A. Greenstein, and Ronald S. Tikofsky

Semin Nucl Med 34:300-312 © 2004



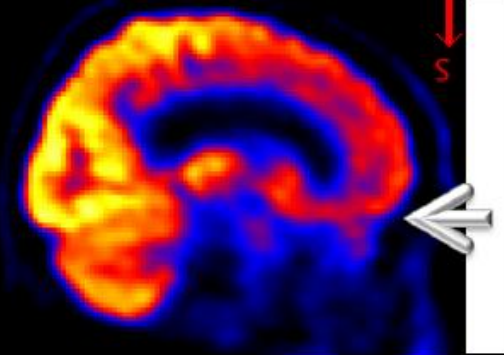
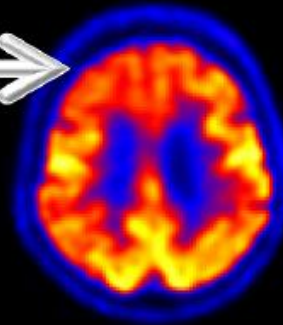
^{18}F -FDG PET - bvFTD



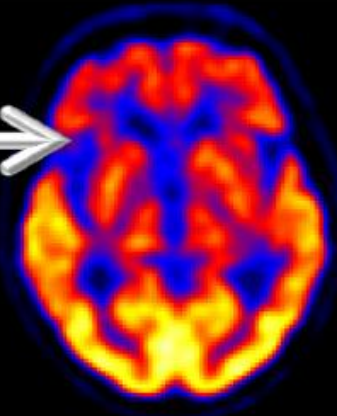
Pattern di ipometabolismo

Lobo frontale

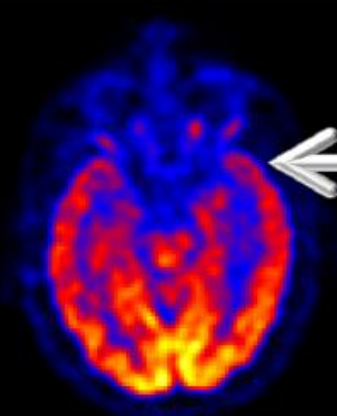
Orbito-frontale
Cingolo anteriore
Frontale dorso-laterale



Insula
anteriore



Poli temporali
Amigdala



^{18}F -FDG PET - SD

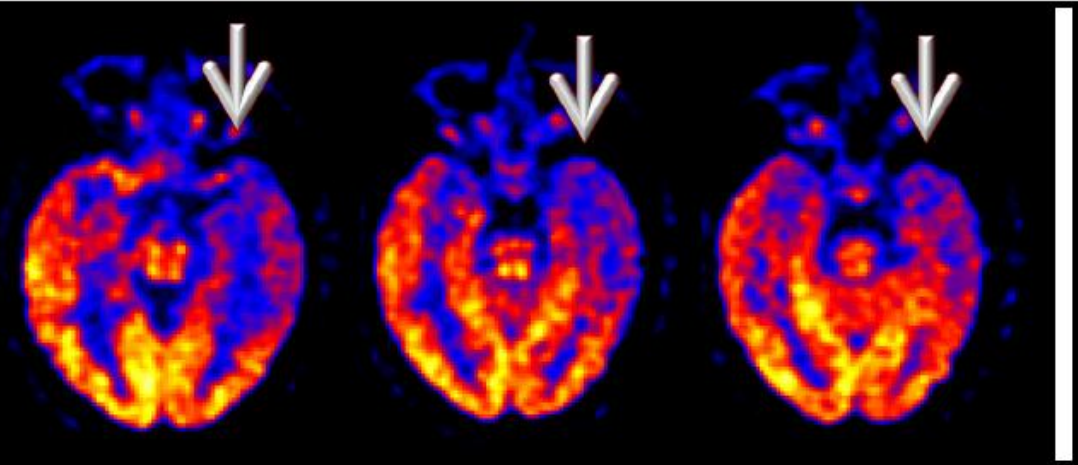


Pattern di ipometabolismo

Lobo temporale

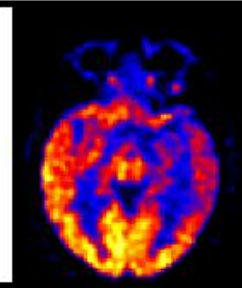
Parte anteriore dei giri
temporale medio e
inferiore

Asimmetria: sinistra < destra



Regione ippocampale

ippocampo, giro paraippocampale ed amigdala



^{18}F -FDG PET - PNFA

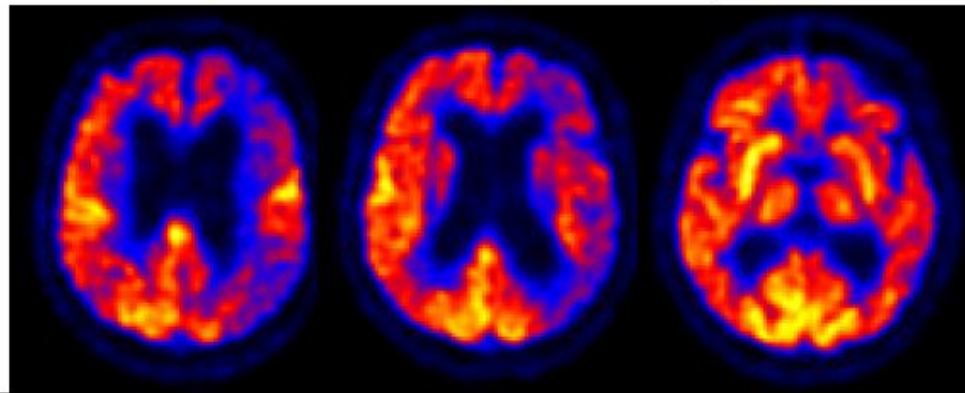
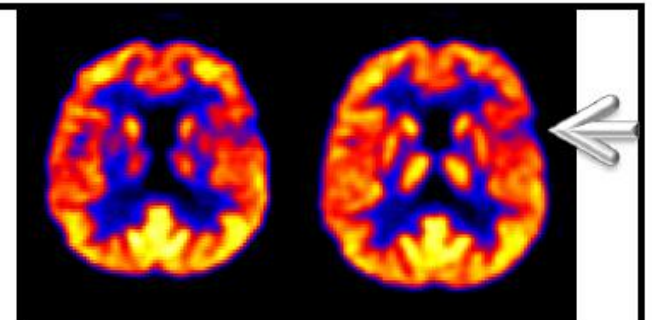


Pattern di ipometabolismo

Regione frontale laterale sinistra

Giro frontale inferiore, sede opercolare

Insula anteriore



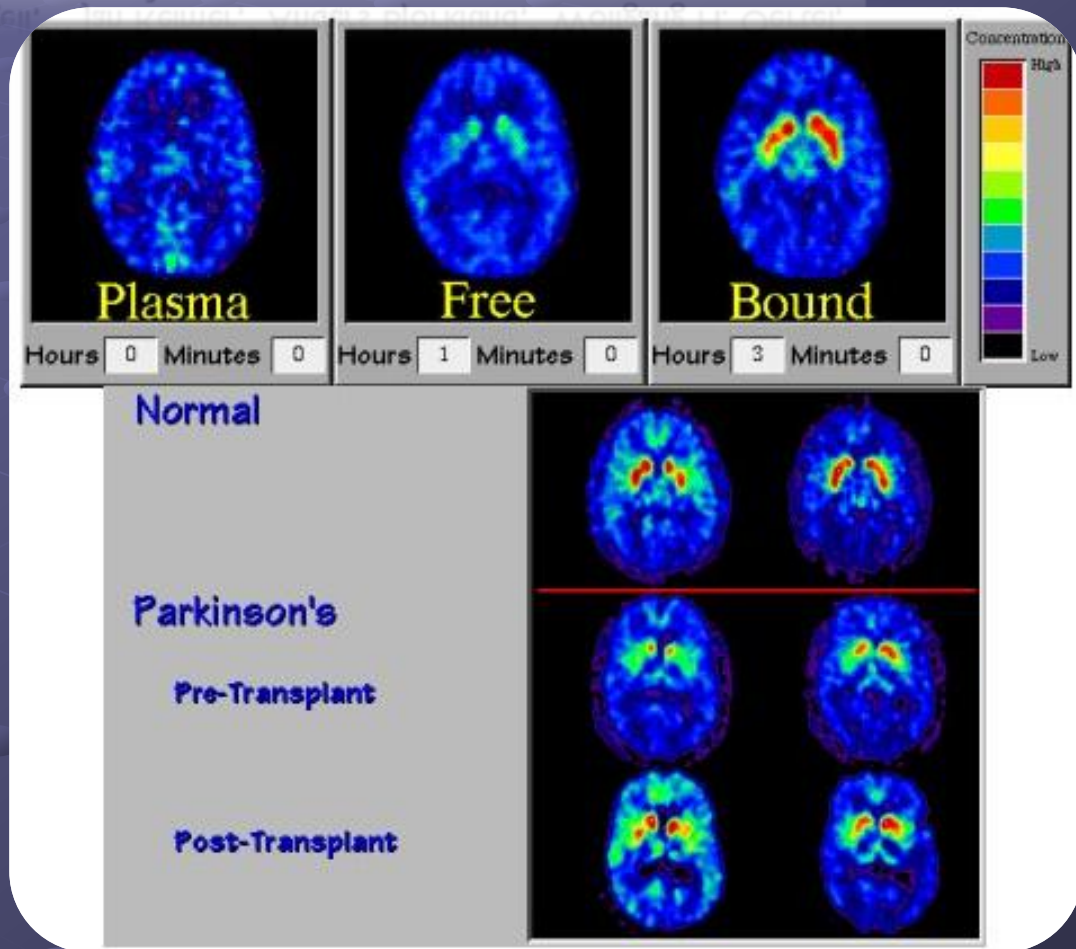
Traccianti PET recettoriali

- ^{18}F -L-Dopa (presinaptico)
- ^{11}C -Nomifensina e ^{18}F -FP-CIT (siti di re-uptake della dopamina)
- ^{18}F -Metilspiperone e ^{11}C -Raclopride (recettori D2)

Factors affecting the clinical outcome after neural transplantation in Parkinson's disease

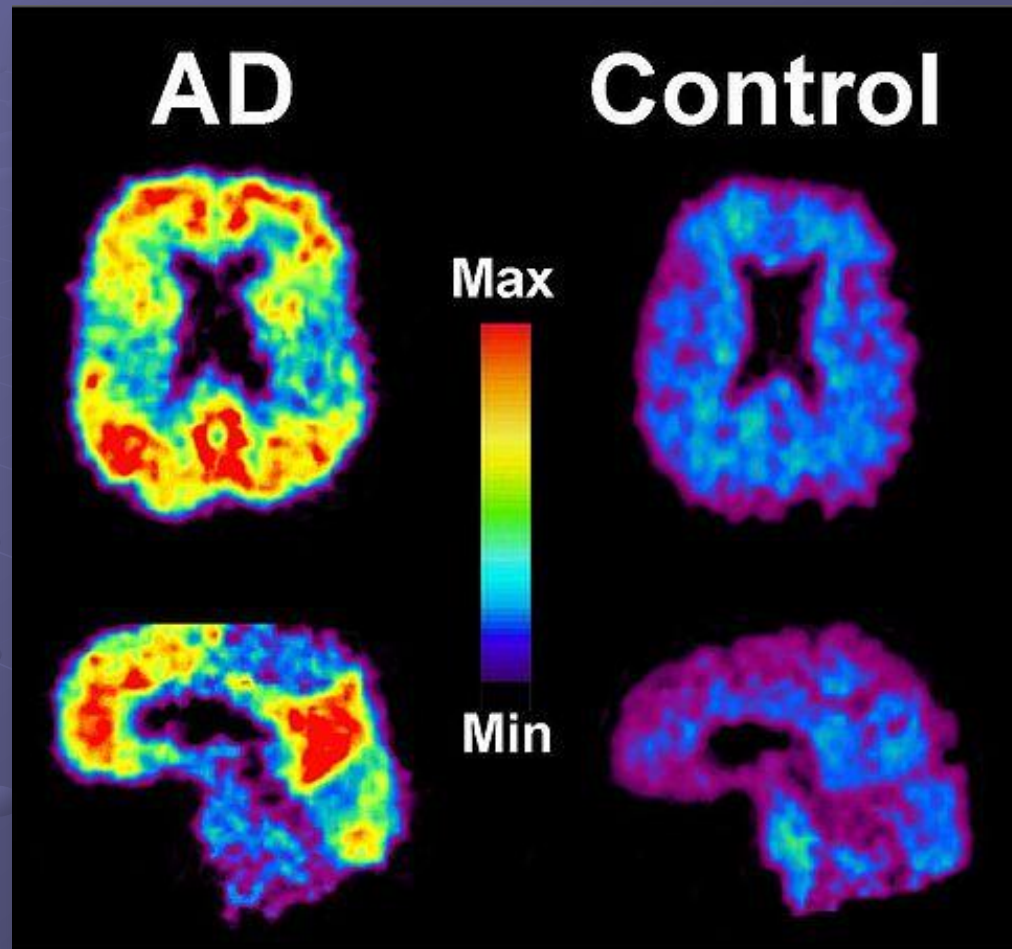
Paola Piccini,¹ Nicola Pavese,¹ Peter Hagell,^{3,4} Jan Reimer,³ Anders Björklund,⁵ Wolfgang H. Oertel,⁶ Niall P. Quinn,² David J. Brooks¹ and Olle Lindvall³

Brain (2005), **128**, 2977–2986



Traccianti PET per la β -amiloide

- ^{11}C -PiB (Pittsburgh compound B)
- ^{18}F -Florbetaben
- ^{18}F -Flutemetamol
- ^{18}F -Florbetapir





Neurologia

Major Trends

SNM
Society for Neuroscience Meeting

- Beta-amyloid imaging – 48 (26) abstracts
- Brain Tumor imaging – 33 (15) abstracts
- DAT/VMAT imaging – 13 (25) abstracts
- Small animal imaging – 28 (22) abstracts
- Non-human primate imaging – 18 abstracts
- Increasing variety of radioligands – 57
- FDG PET studies still predominate – 69 abstracts



Neuroscience — areas of activity

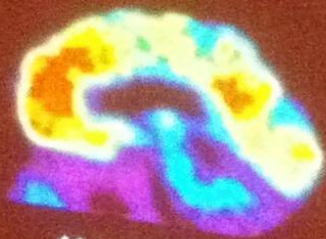
SNM
Advancing Molecular Imaging and Therapy

The Areas of Research:

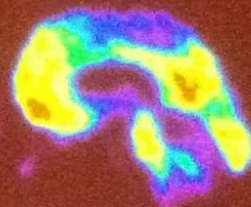
- Cognitive Decline / Dementia +++++
- Neuroreceptor Tracers +++++
- Brain Tumors +++++
- Movement disorders +++++
- Psychiatric disorders ++
- Drug/alcohol abuse ++
- Epilepsy ++
- Neuroinflammation ++
- Traumatic brain injury ++
- Stroke +
- Chemo brain +



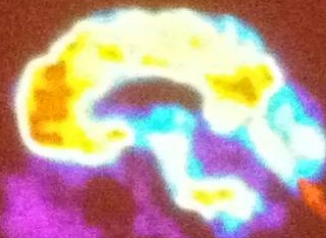
Beta-Amyloid Plaque Imaging with PET



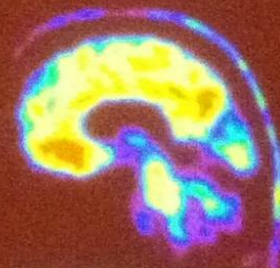
^{11}C -PiB



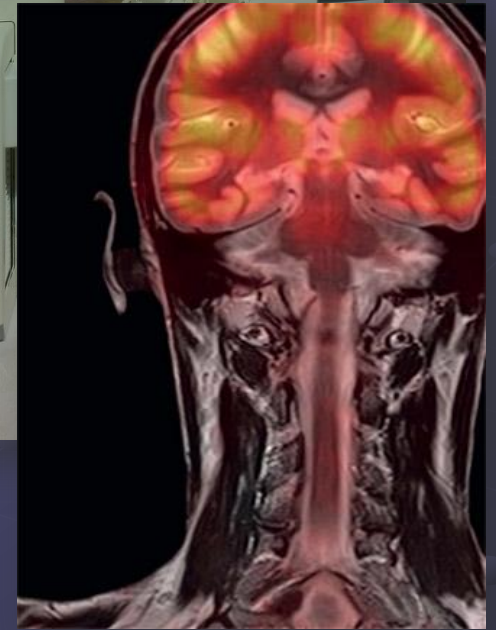
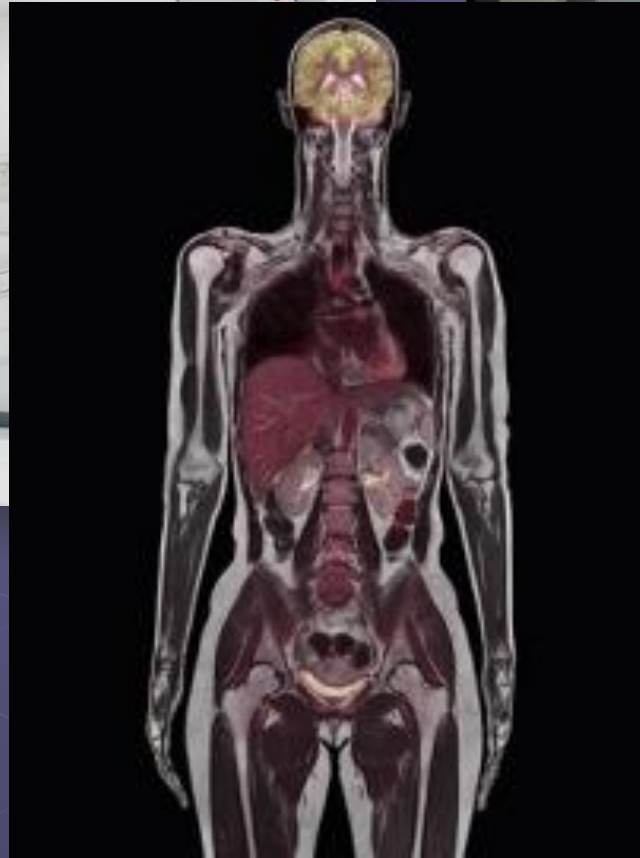
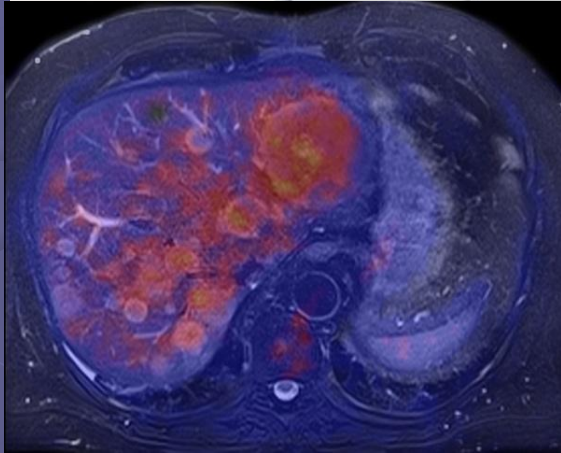
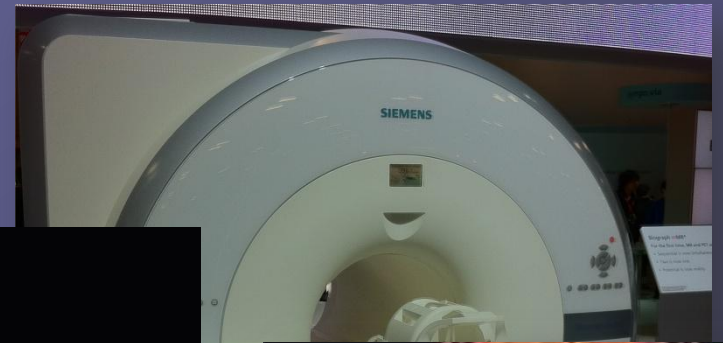
^{18}F -Florbetaben



^{18}F -Flutemetamol



^{18}F -Florbetapir



PET-MRI