

# IMAGING: What procedures and how they can help?

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# Disclaimer

I am an HIV physician

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# Overview:

**1** MR imaging of brain

**2** MR spectroscopy

**3** Functional MRI / other  
modalities / PET

# MR Imaging of the brain

## Contraindications



# MR Imaging of the brain

## Contraindications

- Implanted devices
- Metallic foreign bodies
- Unstable patients
- Claustrophobia
- Pregnancy?



# MR Imaging of the brain



Open MRI scanner

# Basic physics

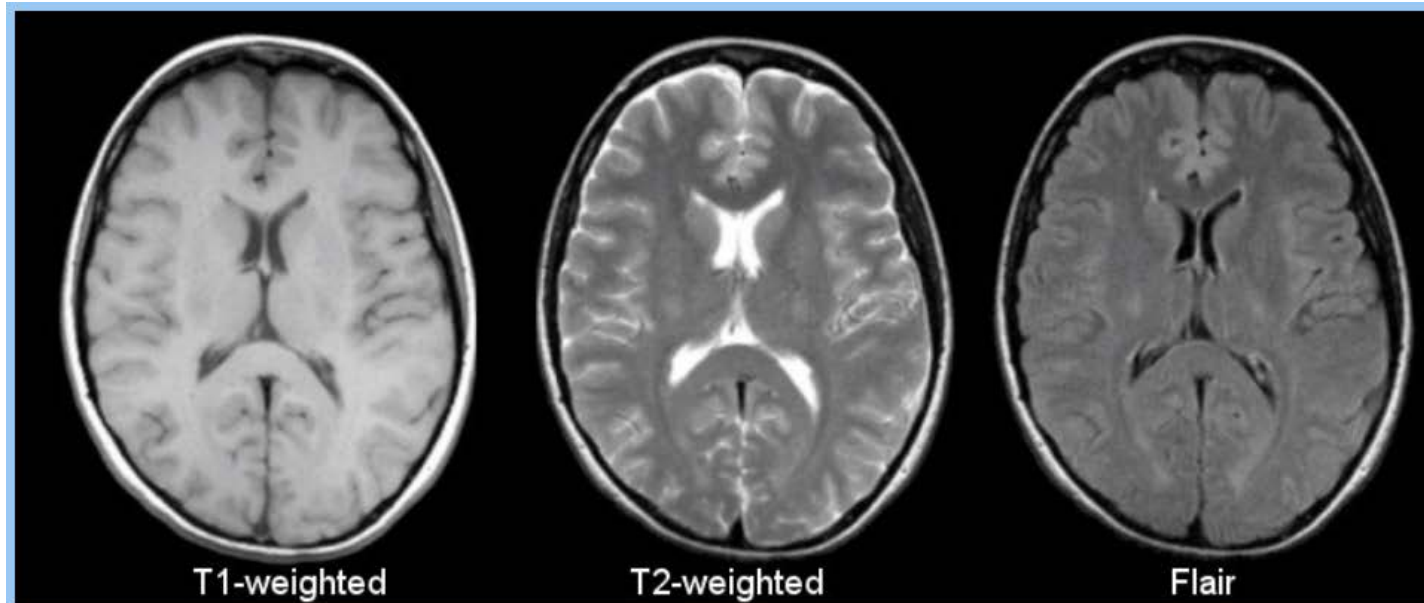
- A powerful, external magnetic field is employed to align the protons that are normally randomly oriented within the water nuclei of the tissue being examined.
- This alignment (or magnetisation) is then disrupted by introduction of an external Radio Frequency (RF) energy.
- The nuclei return to their resting position through various relaxation processes and in so doing emit RF energy.
- After a certain period the emitted signals are measured.
- By varying the sequence of RF pulses applied & collected, different types of images are created.
  - **Repetition Time (TR)** is the amount of time between successive pulse sequences applied to the same slice.
  - **Time to Echo (TE)** is the time between the delivery of the RF pulse and the receipt of the echo signal.

# Common sequences

	<b>TR (msec)</b>	<b>TE (msec)</b>
<b>T1-Weighted</b> (short TR and TE)	<b>500</b>	<b>14</b>
<b>T2-Weighted</b> (long TR and TE)	<b>4000</b>	<b>90</b>
<b>Flair</b> (very long TR and TE)	<b>9000</b>	<b>114</b>



# Common sequences



Tissue	T1-Weighted	T2-Weighted	Flair
CSF	Dark	Bright	Dark
White Matter	Light	Dark Gray	Dark Gray
Cortex	Gray	Light Gray	Light Gray
Fat (within bone marrow)	Bright	Light	Light
Inflammation (infection, demyelination)	Dark	Bright	Bright

# What is it good for?

## Differential diagnoses

Very common differential diagnoses in PWH with cognitive disorders:

- Vascular
- Neurodegenerative

Less common differential diagnoses in PWH with cognitive disorders:

- Inflammatory and demyelinating lesions
- AIDS defining OI and tumours
- Other CNS infections and tumours
- Trauma

# Some cases

## 82 year old British man

- HIV positive for 30 years
- On ART with suppressed viral load
- Concentration difficulties over 3 years, progressively worsening
- Cognitive testing confirms impairment predominantly in short term memory
- Several AIDS defining illnesses including PCP in 1990s
- Hypertension and type II DM

# Some cases

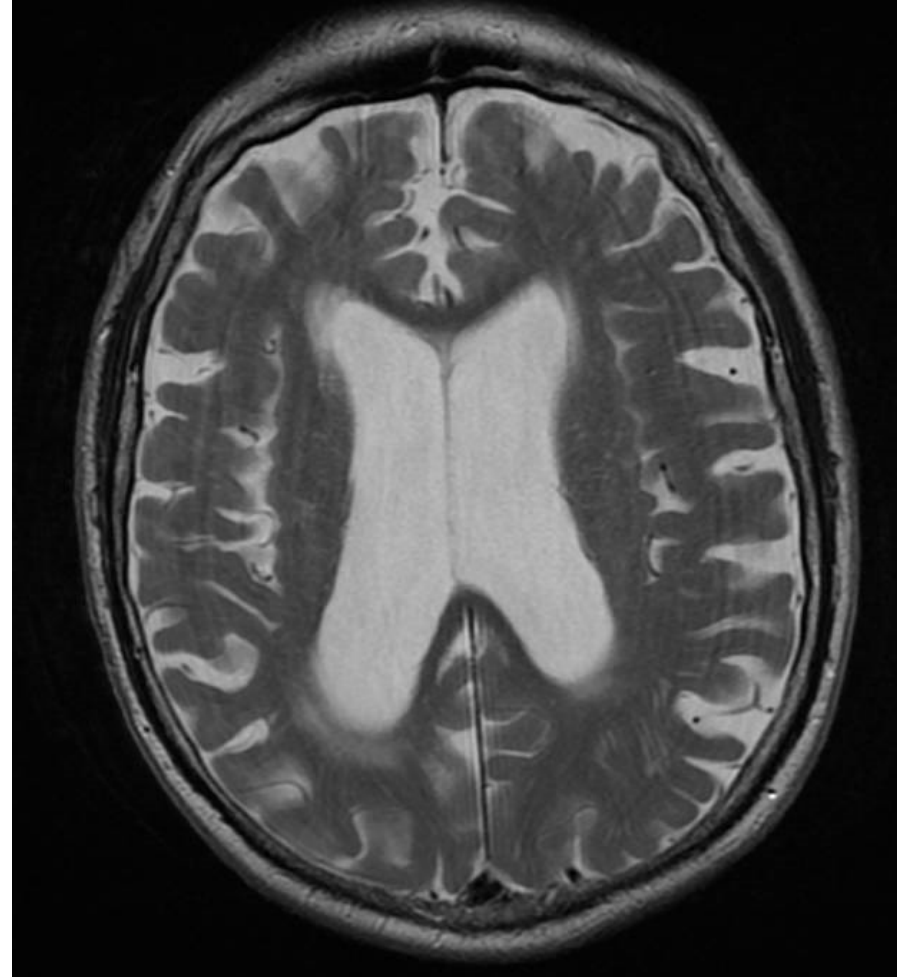
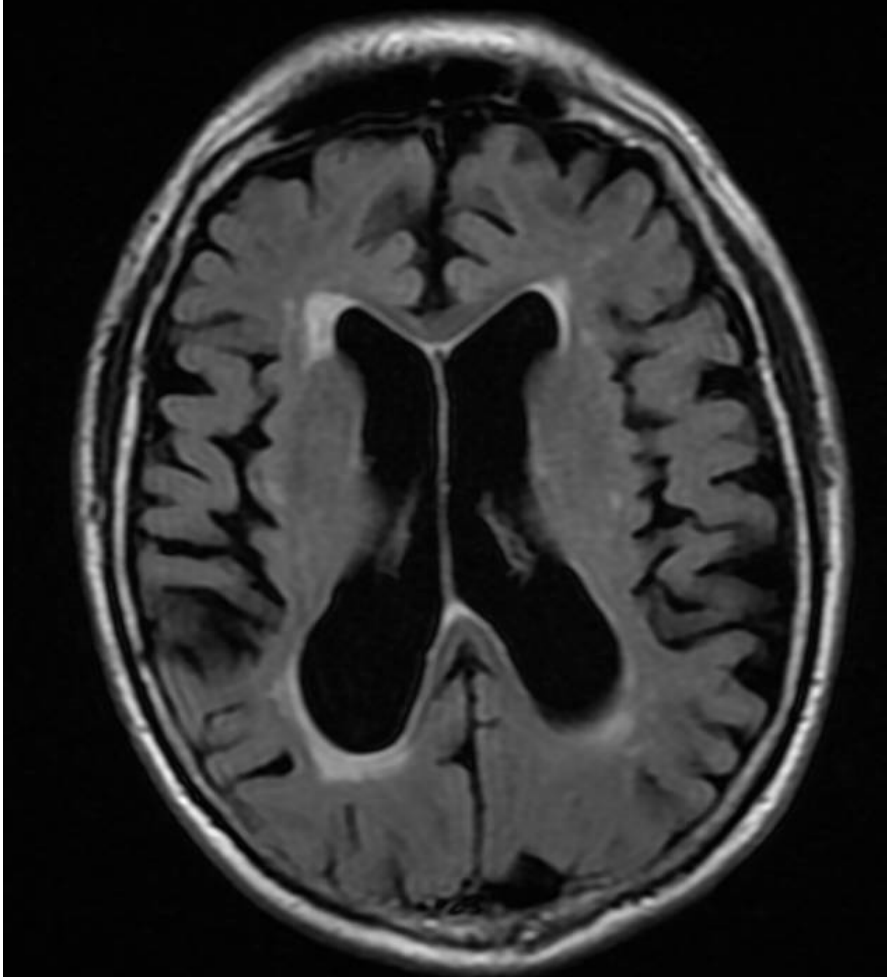
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## Differential diagnoses



# 80 year old man



## Case 2

### 52 year old woman

- HIV positive for 15 years
- Born in India
- On ART with suppressed viral load
- Concentration difficulties over 2 years
- Not had cognitive testing yet
- No ADI
- Hypertension (poorly controlled), type II DM, hyperlipidaemia, raised BMI (over 30)

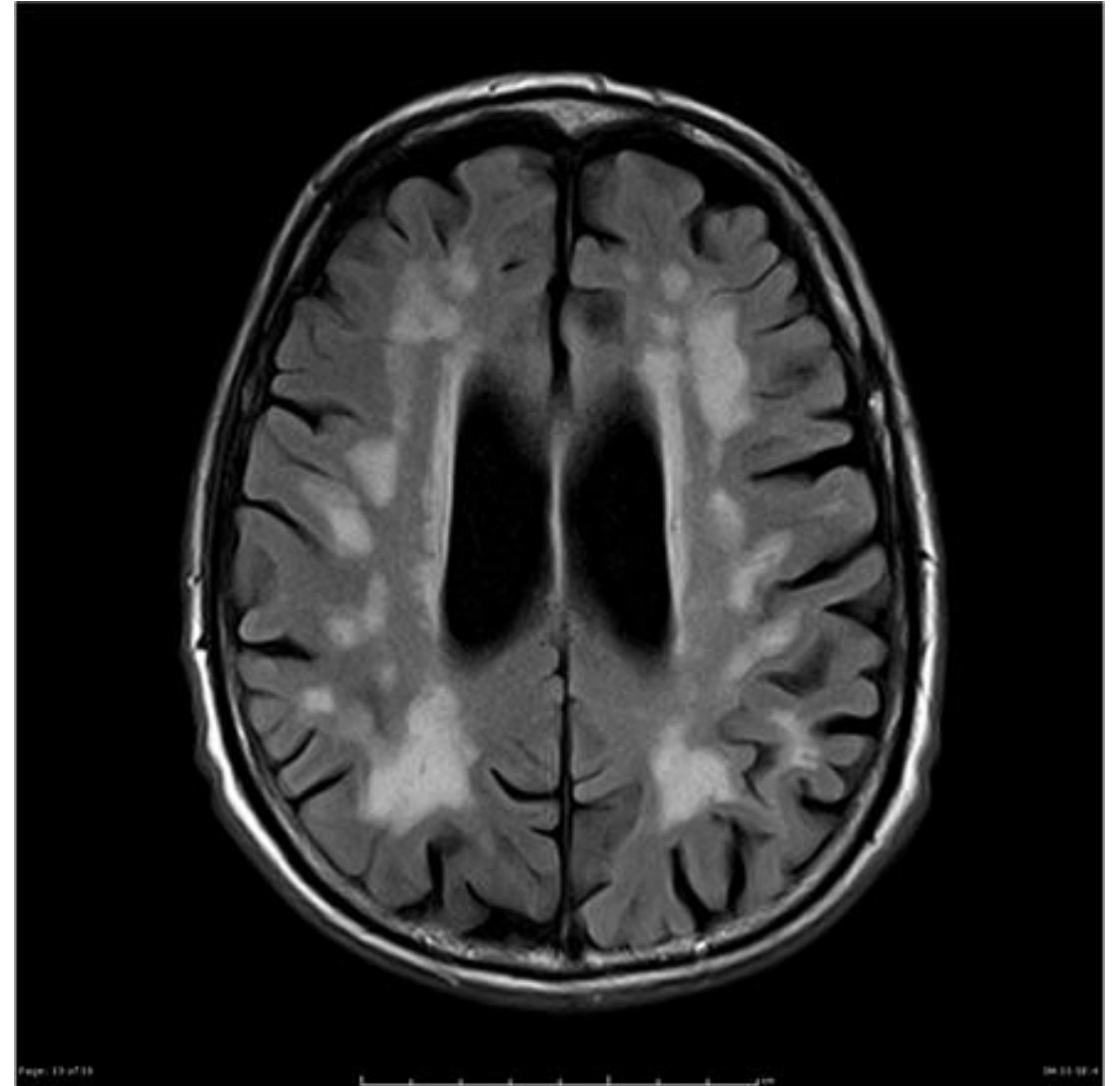
Differential diagnoses?

## Case 2

### 52 year old woman

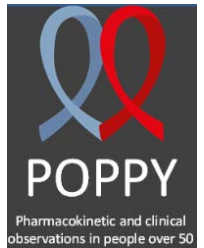
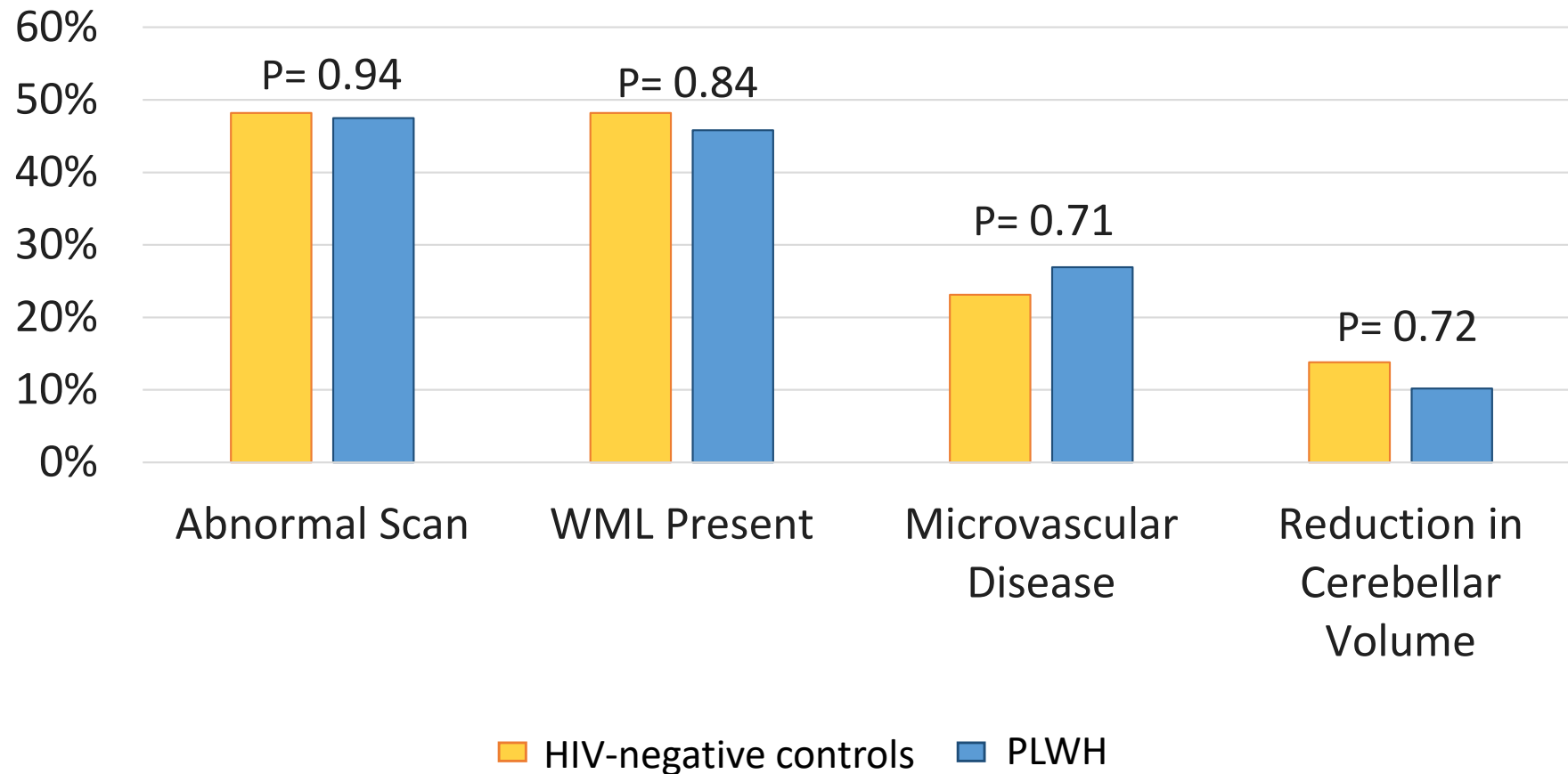
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Differential diagnoses?



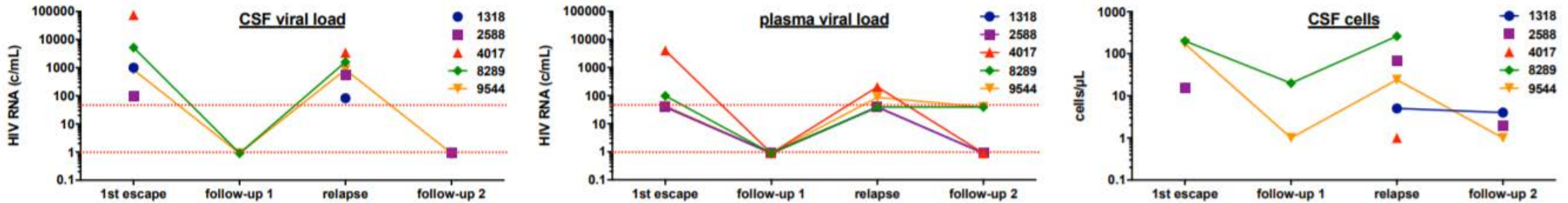
# Case 2

## MRI Findings by HIV Status





# CSF escape



Escape 1<sup>st</sup> episode

Follow-up 1

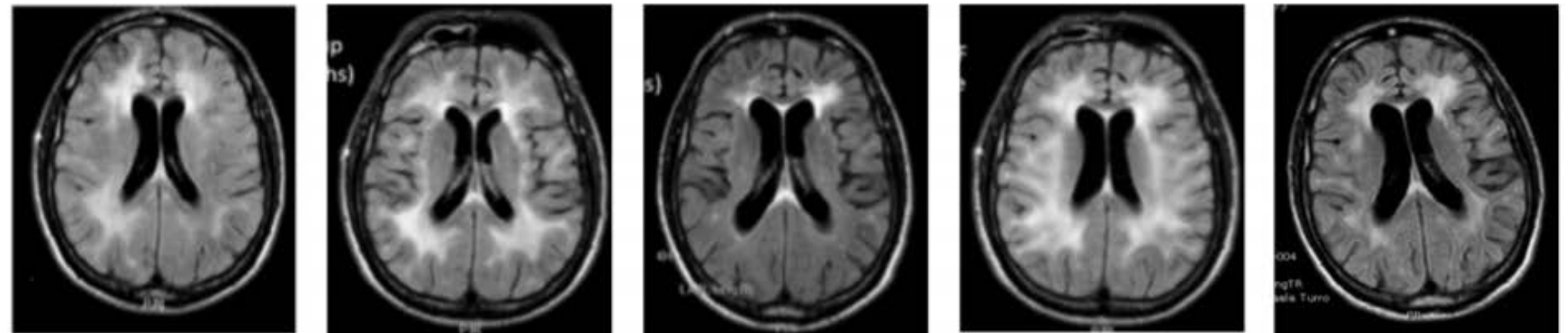
Relapse

Follow-up 2

2 months

12 months

**Figure. Upper panels:** CSF and plasma viral load and CSF cell count of the five patients with CSF relapse. Red dotted lines represent the LLQ and LLD of the assay (40 and 1 c/mL). **Lower panels:** Sequential MRI axial FLAIR sequence images of patient 9544 (see Table for description).



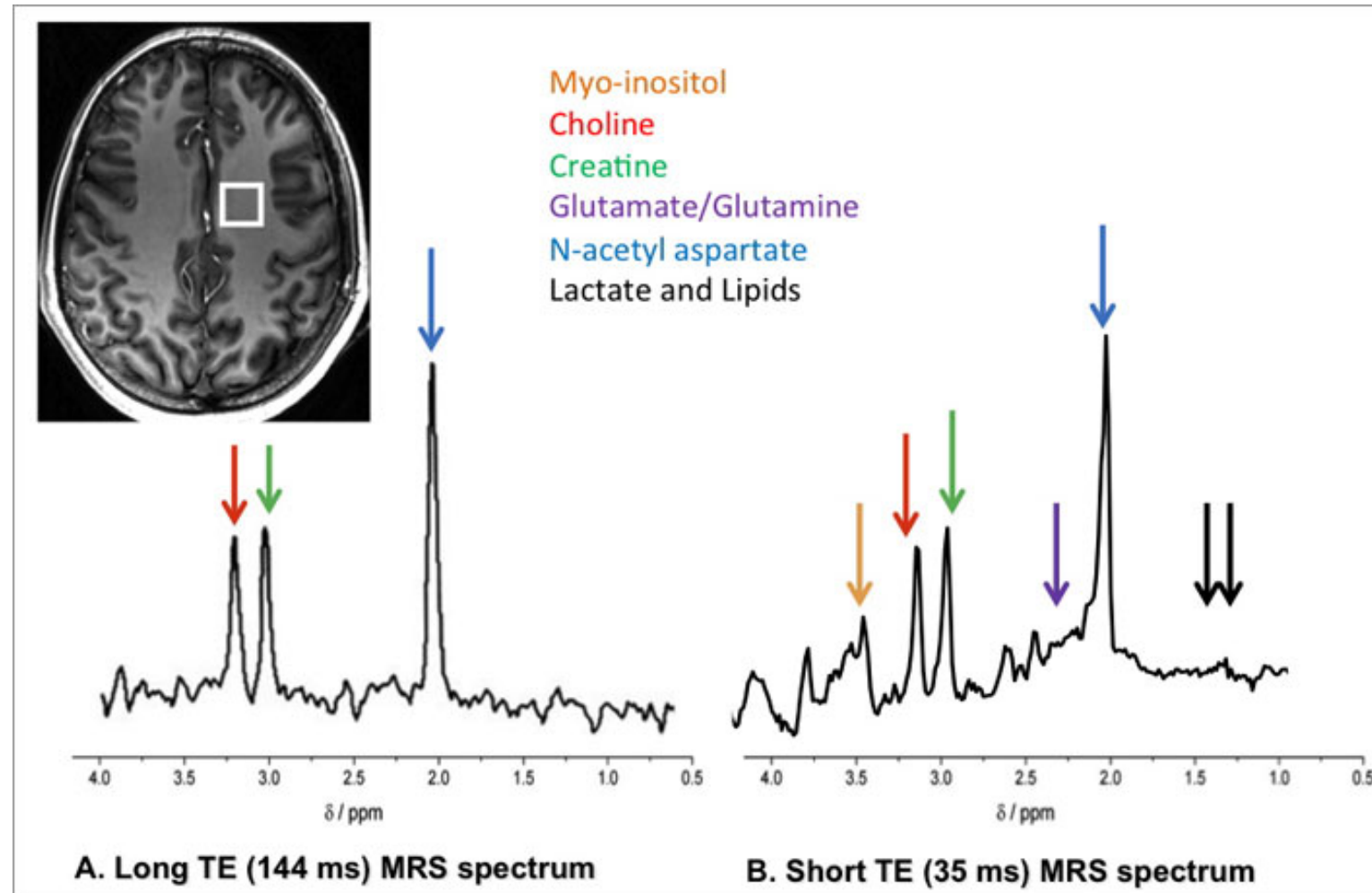
# Overview:

1 MR imaging of brain

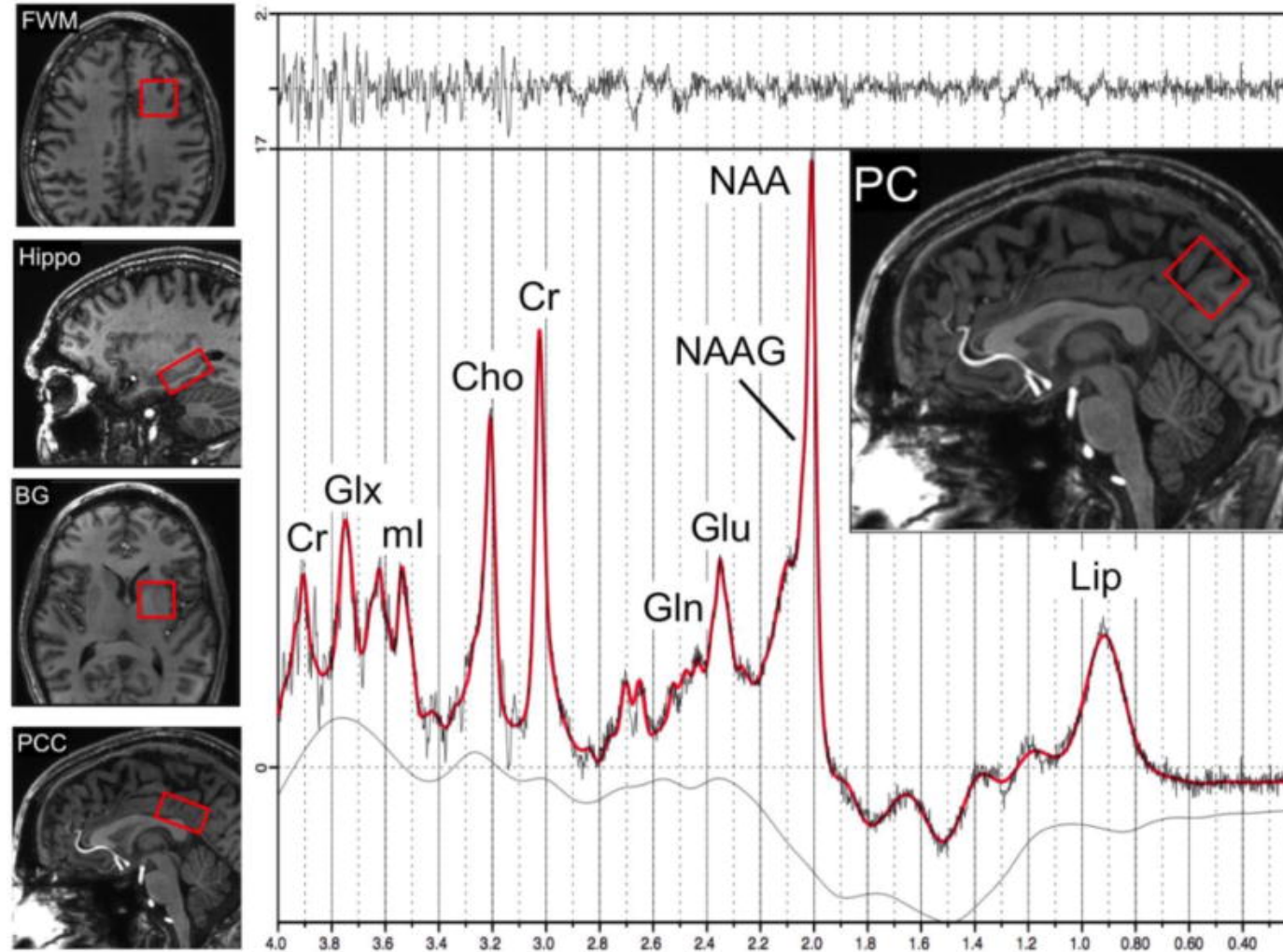
2 MR spectroscopy

3 Functional MRI / other  
modalities / PET

# MRS the basics – $^1\text{H}$

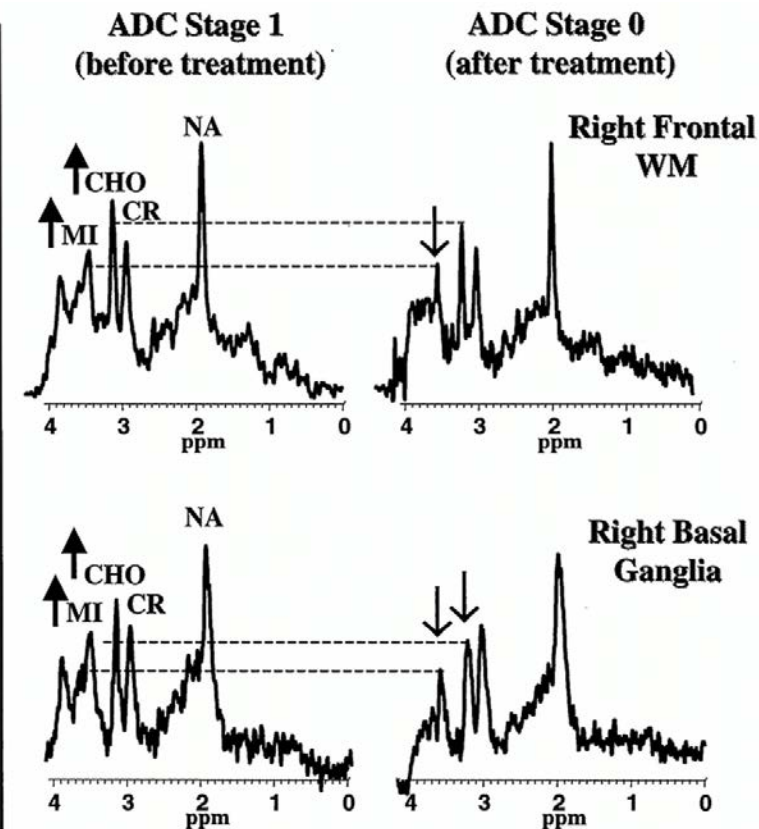
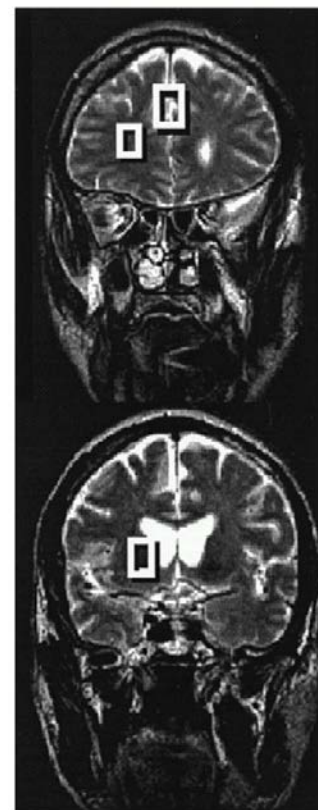
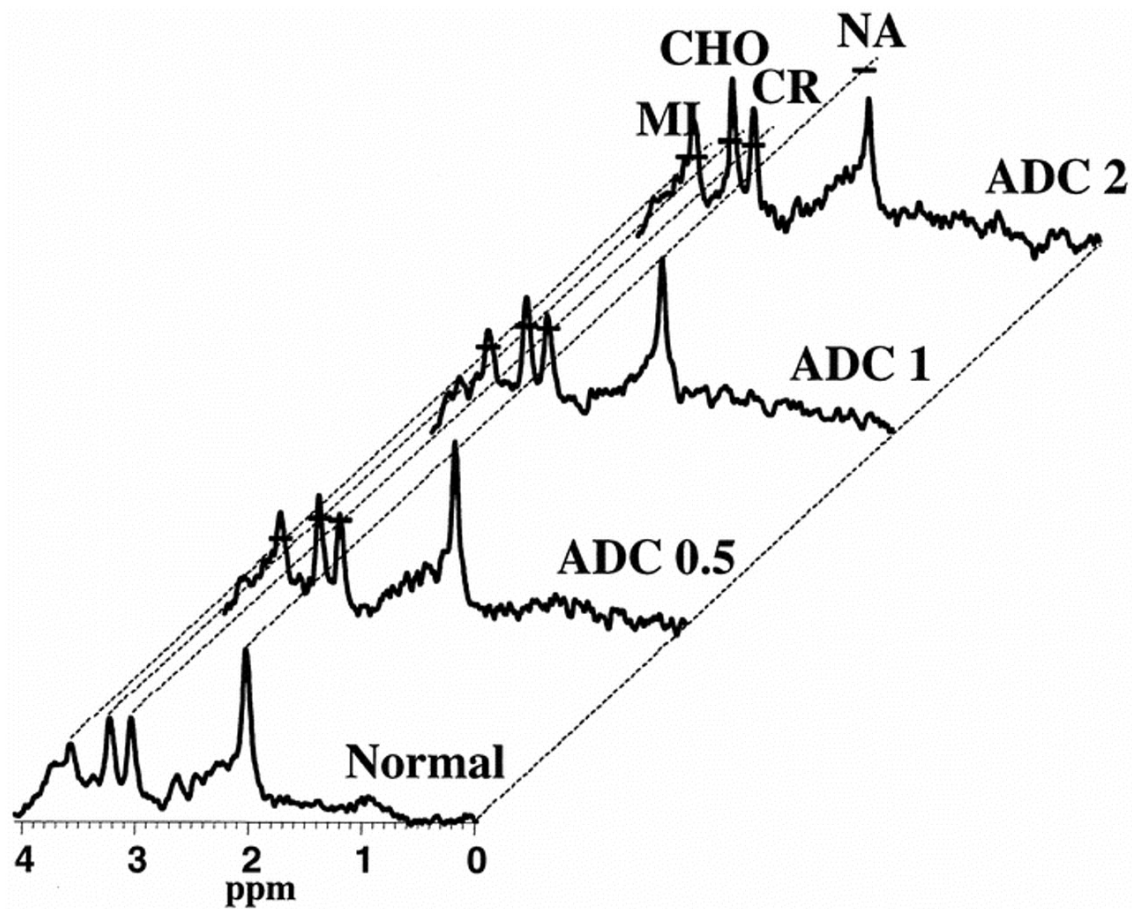


# MRS the basics – 7-Tesla





# Clinical utilities?



# Case 3

42 year old man

2007

- Originally from Eritrea
- Diagnosed with HIV 2007
- Presented with symptomatic HIV
  - Concentration difficulties, weight loss
- MRI scan brain normal
- Cognitive testing severe impairment
- CSF exam unremarkable (CSF RNA 1log lower plasma)
- Commenced TDF/FTC/efavirenz

# Case 3

42 year old man

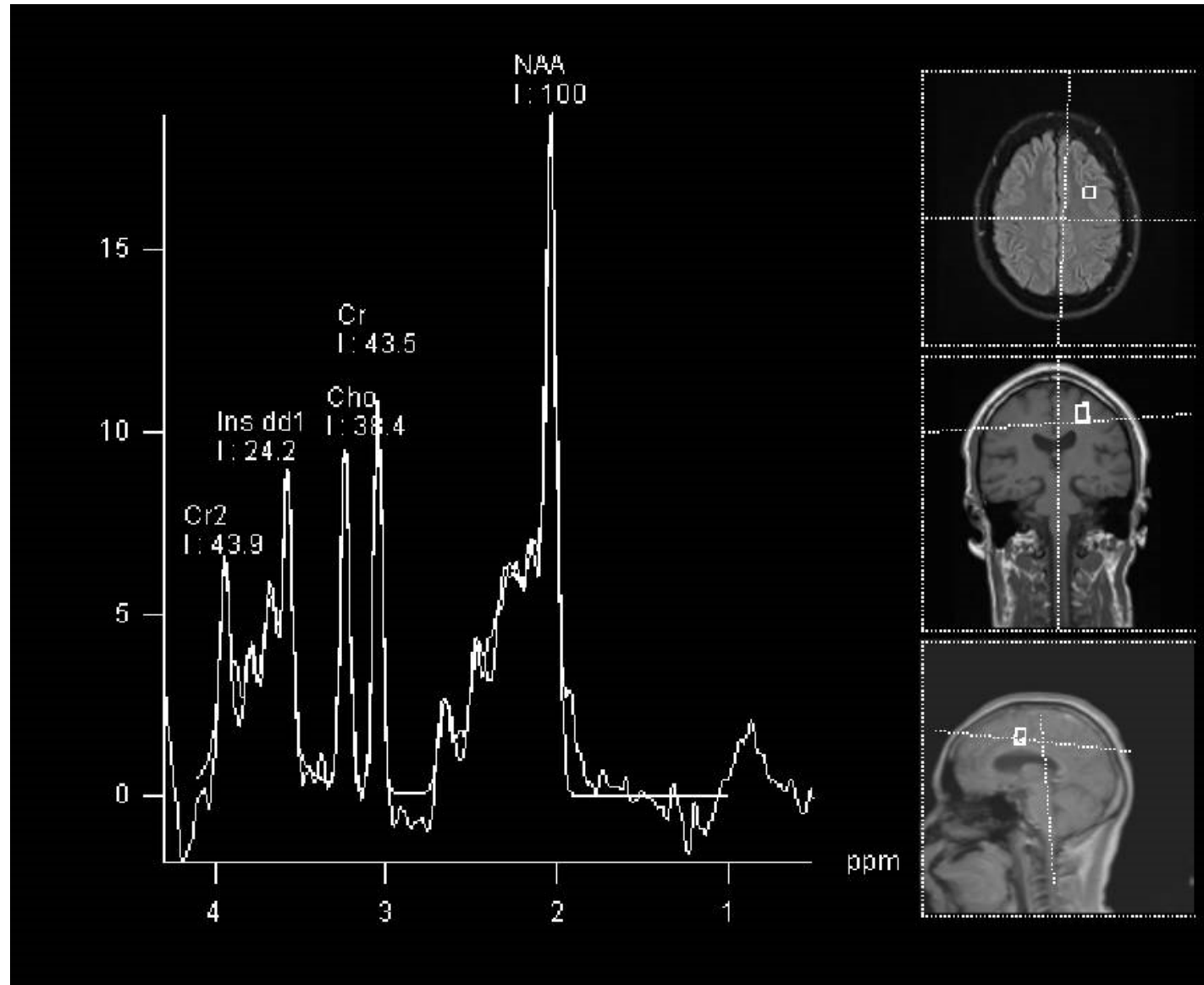
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2007 to 2019

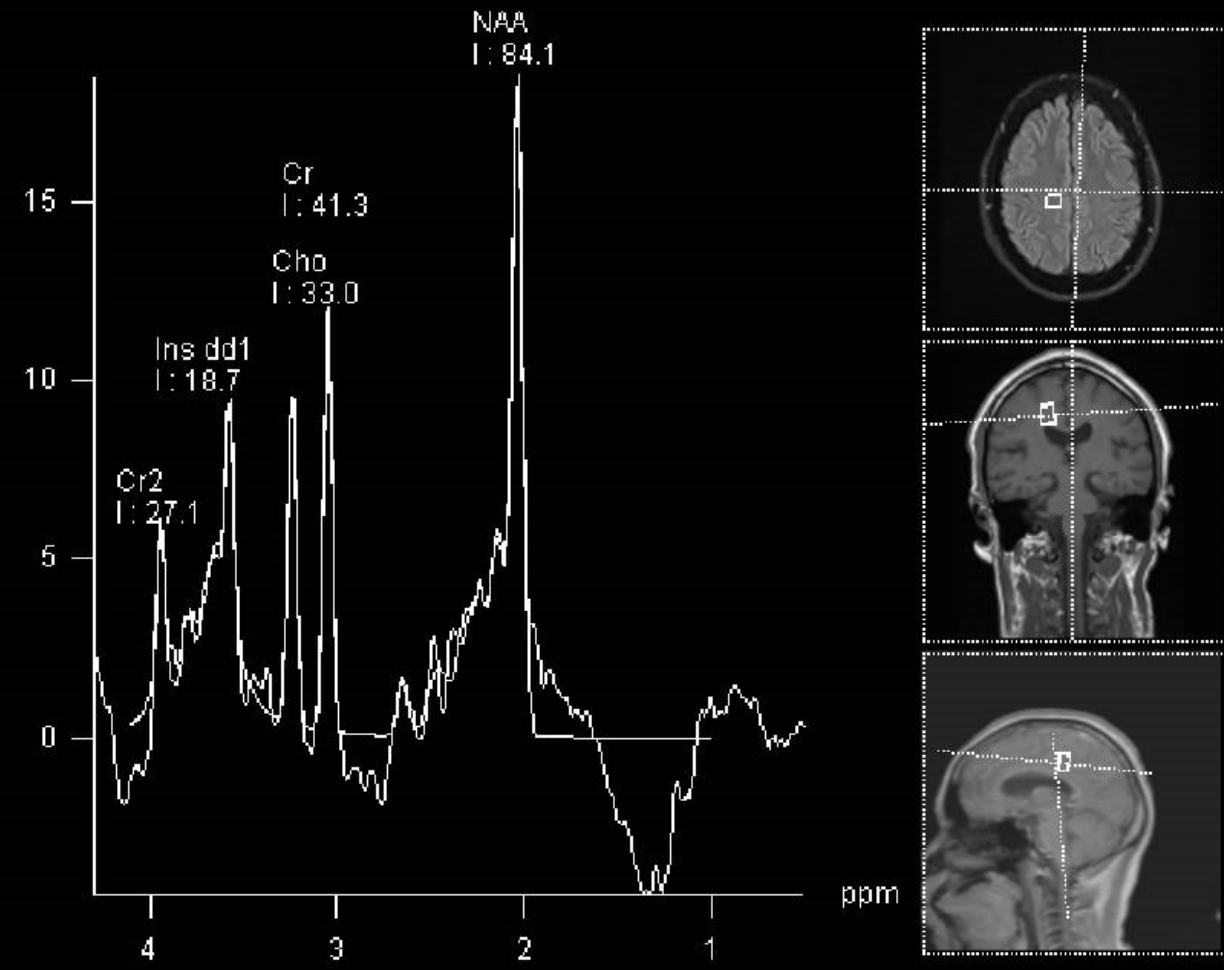
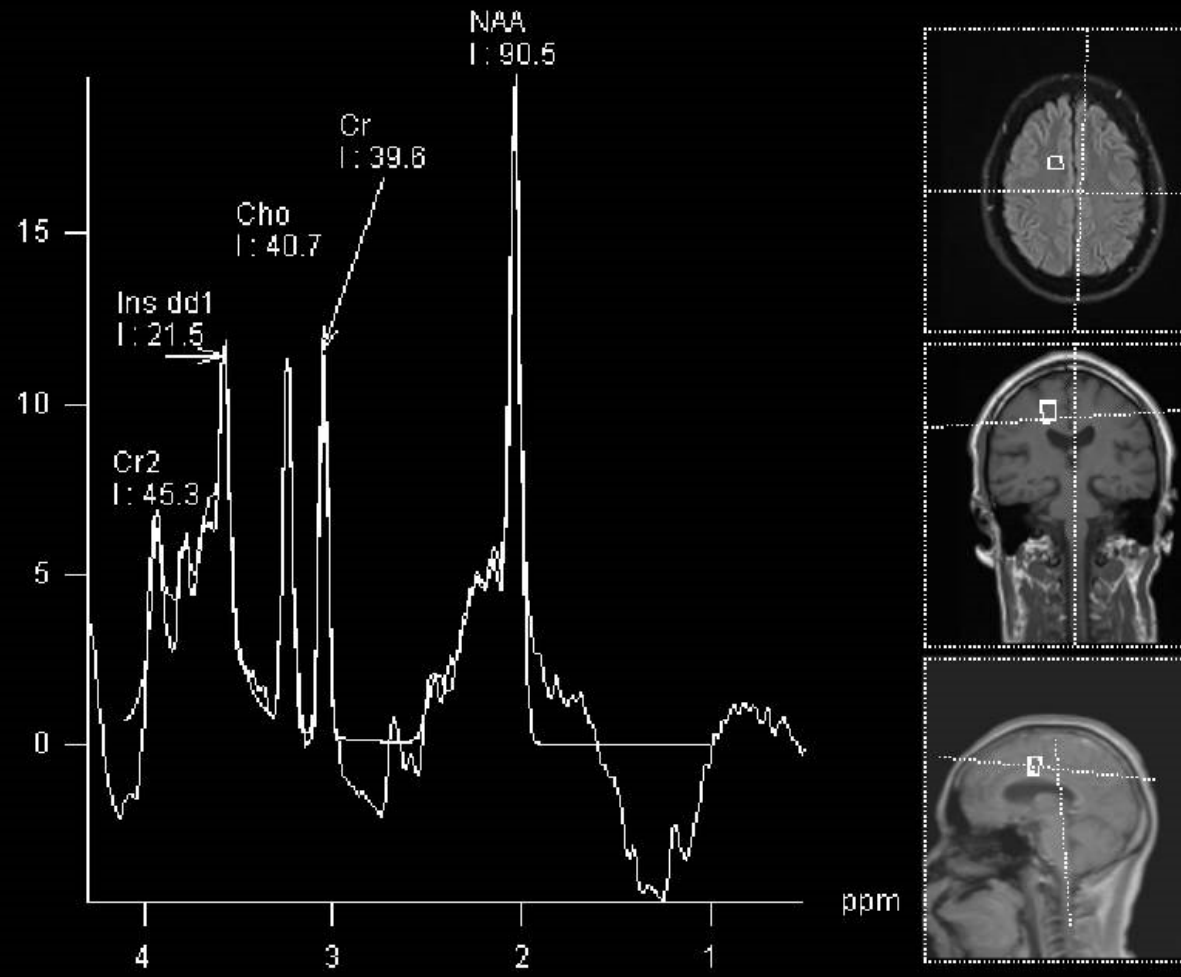
- Ongoing concentration complaints
- Attended neurology, psychiatry, psychology
  - Premorbid personality disorder, PTSD, depression
- ALWAYS suppressed in plasma
- Repeat CSF exams undetectable HIV RNA
- Repeat MRI brain normal
- Switched off efavirenz – no change
- Cognitive testing deteriorating

# Case 3





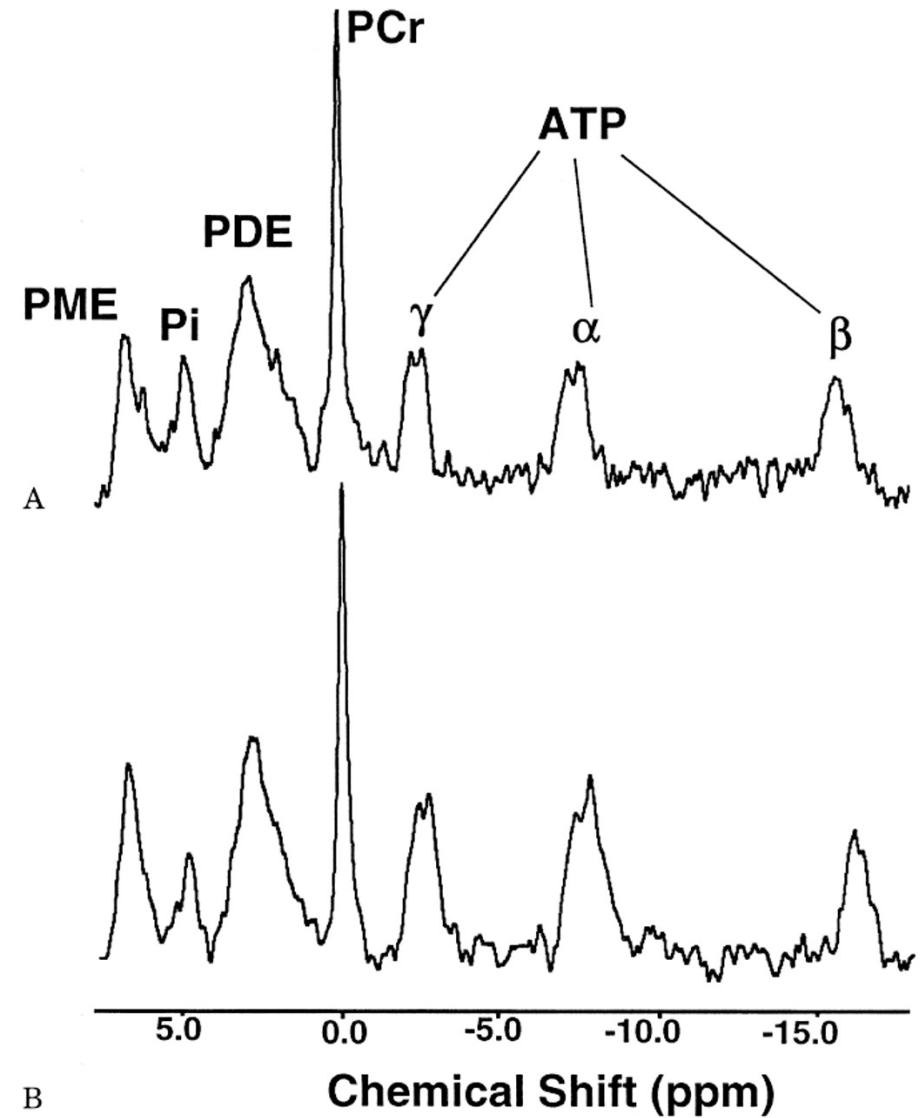
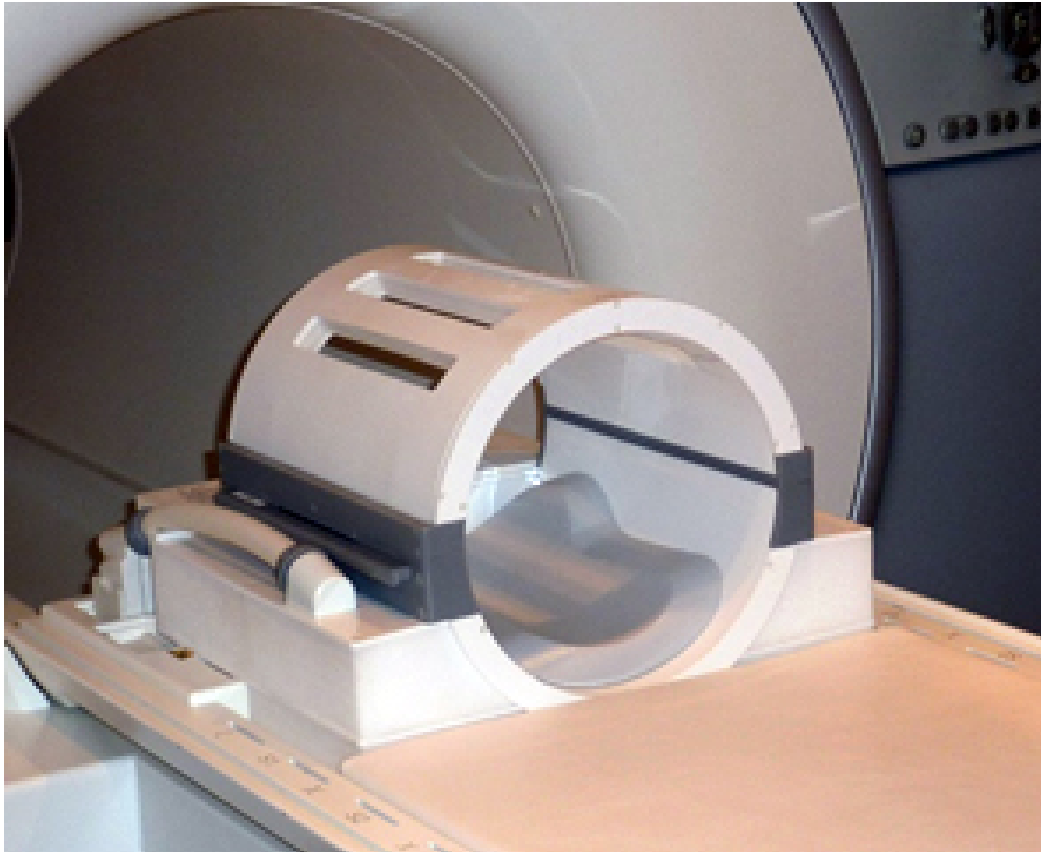
# Case 3



# Clinical use of brain $^1\text{H}$ -MRS

- Is available at ICHNT
- In cases where we suspect HIV may still be contributing to cognitive disorders and other biomarkers have not proven useful
- We infrequently use 'intensification' ART strategies such as maraviroc – if we do take this approach longitudinal MRS can be helpful in monitoring progress

# Other types of MRS – $^{31}\text{P}$



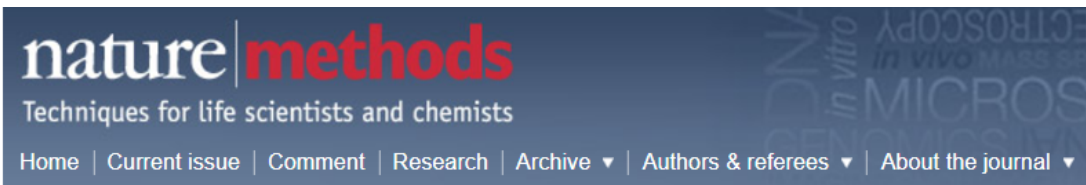
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# Quantification of HIV – Gp120 Ab



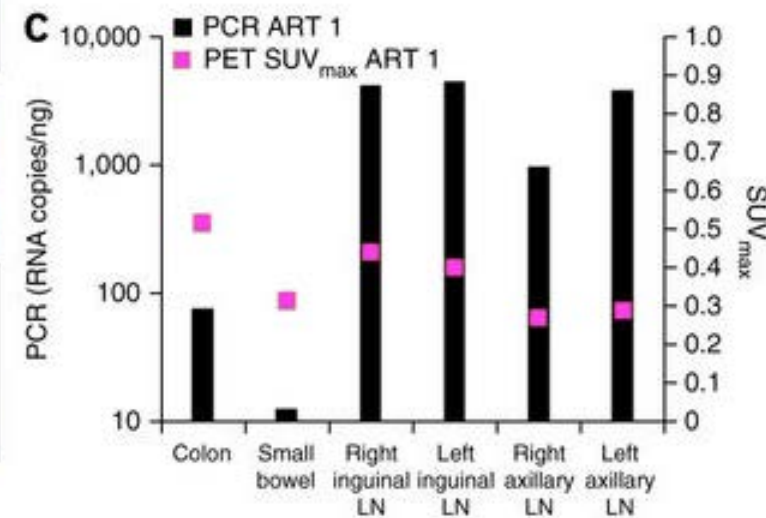
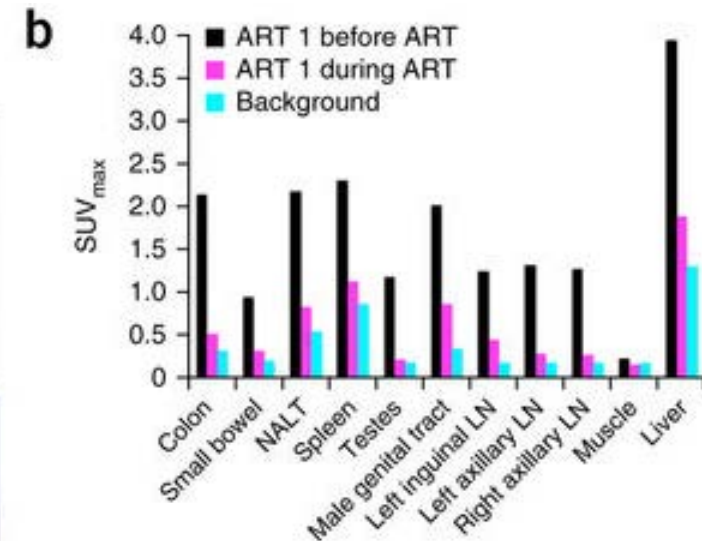
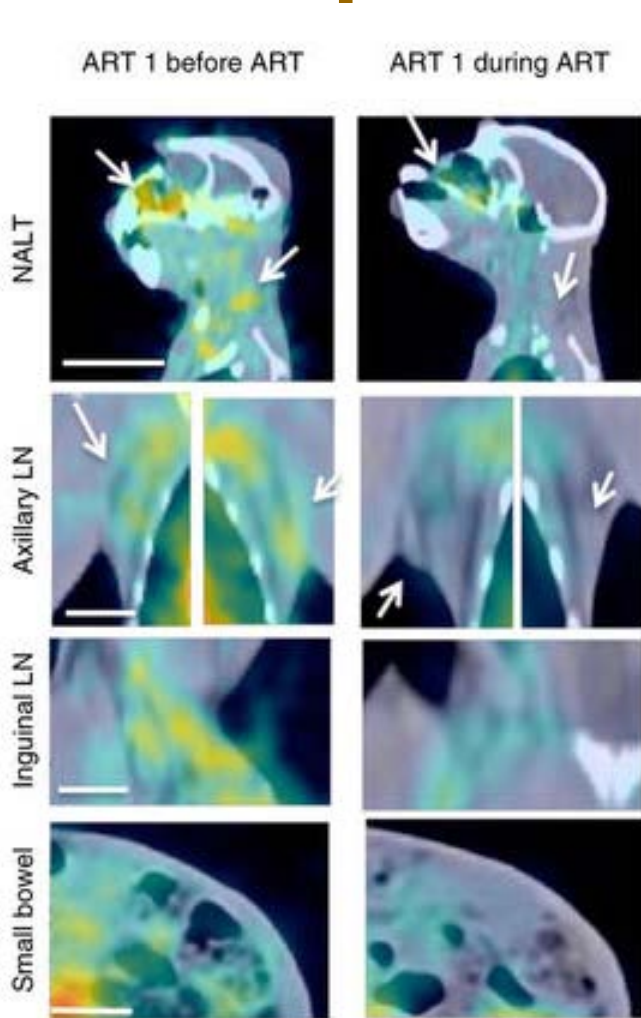
home > archive > issue > article > abstract

NATURE METHODS | ARTICLE



## Whole-body immunoPET reveals active SIV dynamics in viremic and antiretroviral therapy-treated macaques

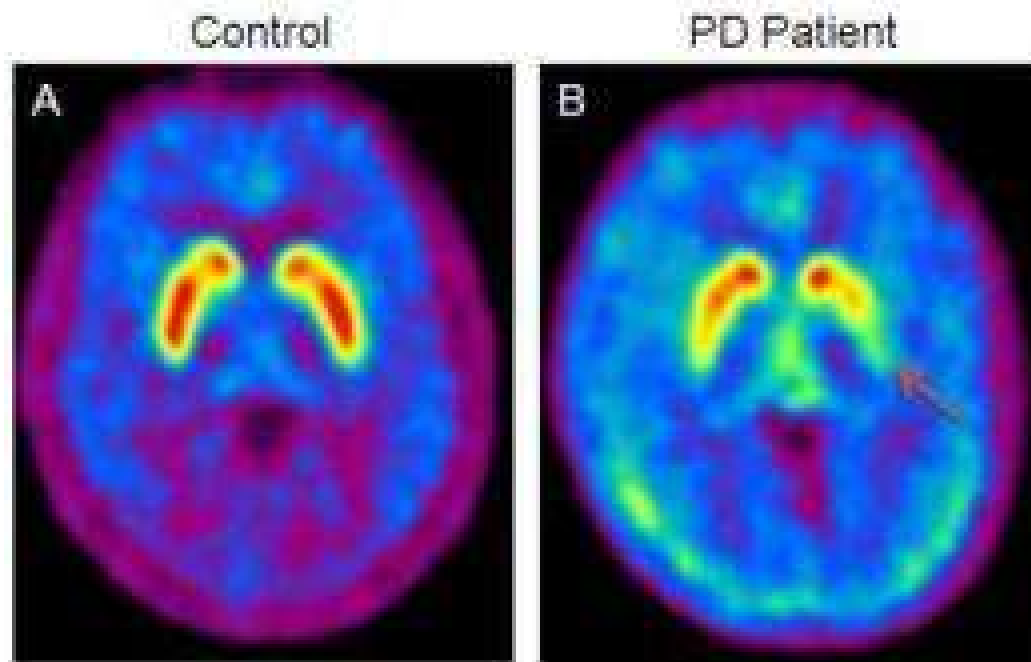
Philip J Santangelo, Kenneth A Rogers, Chiara Zurla, Emmeline L Blanchard, Sanjeev Gumber, Karen Strait, Fawn Connor-Stroud, David M Schuster, Praveen K Amancha, Jung Joo Hong, Siddappa N Byrareddy, James A Hoxie, Brani Vidakovic, Aftab A Ansari, Eric Hunter & Francois Villinger



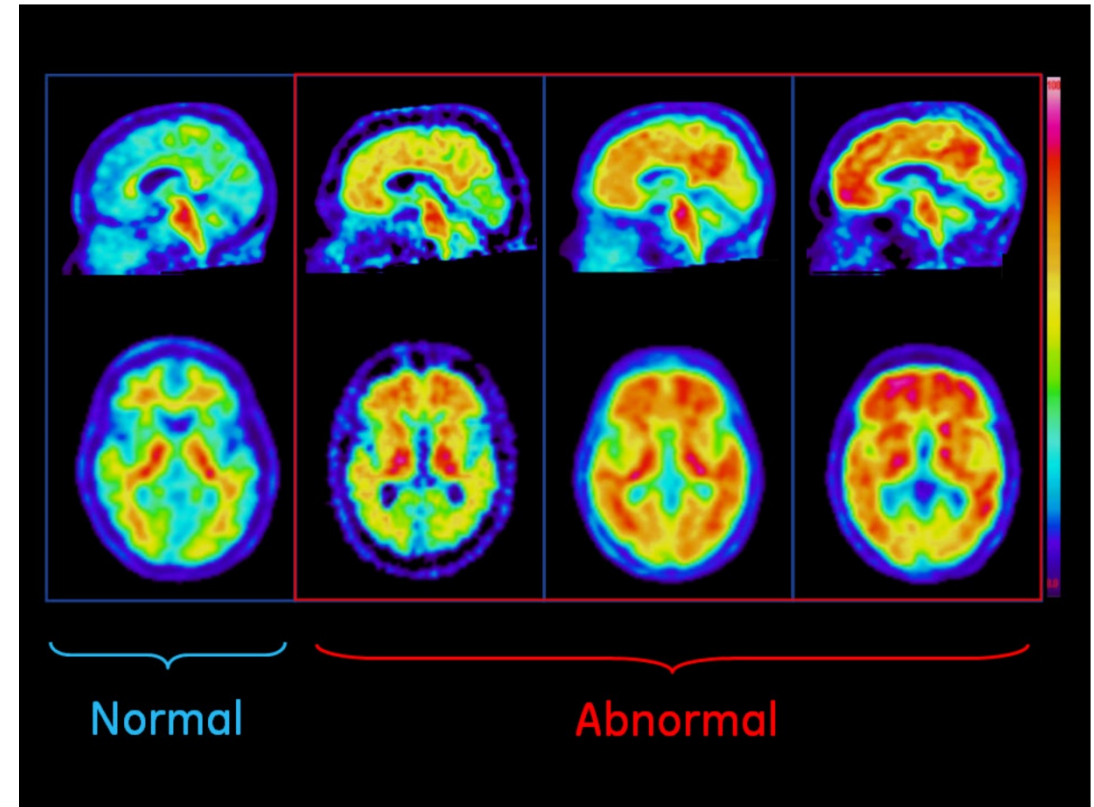
# PET in clinical use

## Presynaptic dopaminergic imaging:

- DaTscan

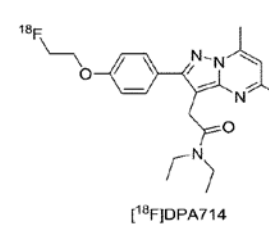
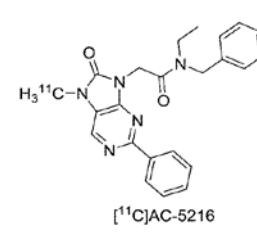
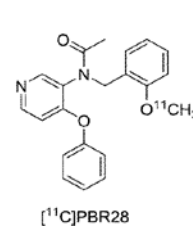
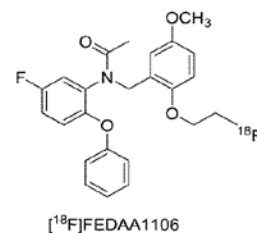
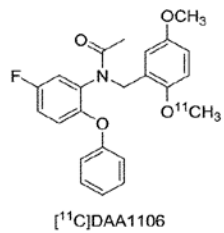
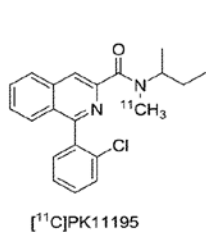


## Amyloid PET

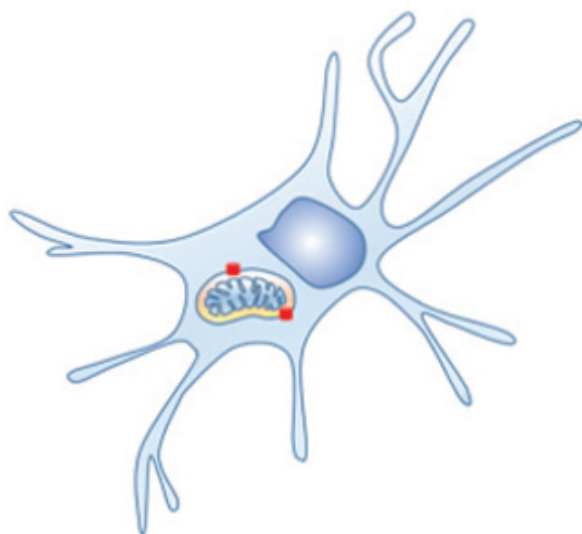




# TSPO PET



RESTING MICROGLIA



-  TSPO
-  Ligand
-  Mitochondrion

NEUROINFLAMMATION

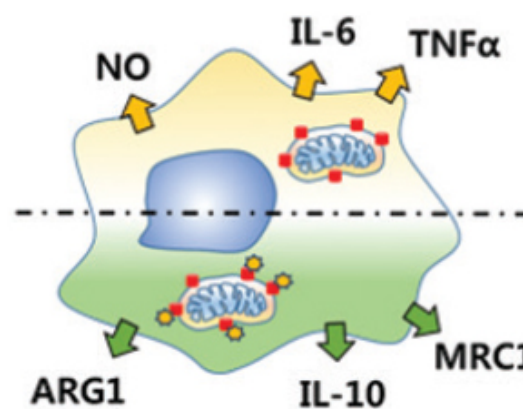
TSPO  
Up-regulation/  
Ligand binding



NEUROPROTECTION

REACTIVE  
MICROGLIA

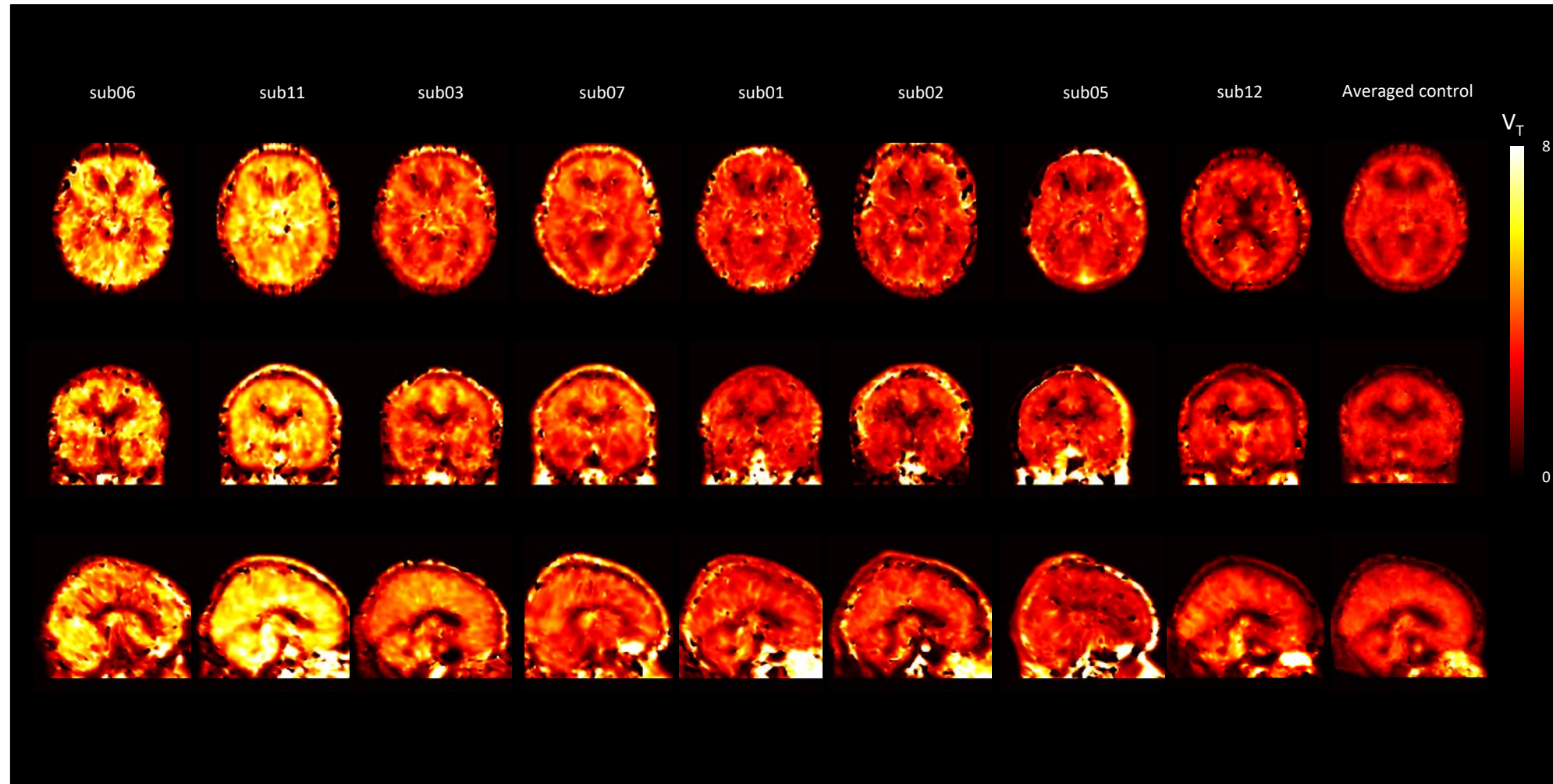
M1 Pro-inflammatory



M2 Anti-inflammatory



# TSPO PET in research use





# Summary: MRI imaging in PWH on ART

## MR imaging of brain

Important in defining differential diagnoses

Common DDx:

- Vascular changes
- Neurodegenerative diseases
- HIV related changes

Important routine investigation in PWH with cognitive disorders

**Often abnormal in PWH but not necessarily HIV related**

## MR spectroscopy of brain

May be useful modality to detect ongoing inflammation

May be a useful modality to detect treatment responses

Reserve for challenging management cases