



# Functional Brain Imaging with Single Photon Emission Computed Tomography (SPECT)

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# Structure of Presentation

- I. Overview of brain mapping modalities
- II. Description of SPECT
- III. Patient presentation



# What is functional brain imaging?

- Techniques used to derive images reflecting biochemical, physiologic, or electrical properties of the CNS.
- Main principle: Increased *brain activity* results in increased *blood flow* to the active site, or regional cerebral blood flow (Ingvar and Lassen, 1961).



# What are the uses of functional imaging?

- ***Investigative tool*** for understanding neurological processes in normal and abnormal states.
- ***Clinical uses*** for assisting in diagnosis and prognosis.
- Assist in psychiatric ***drug development*** and management.



# Modalities Compared

Technique	Res.	Advantages	Disadvantages
SPECT (1976)	7-10 mm	<ul style="list-style-type: none"><li>- Low cost</li><li>- Availability</li></ul>	<ul style="list-style-type: none"><li>- Radioactivity</li><li>- Limited resolution</li></ul>
PET (1984)	5 mm	<ul style="list-style-type: none"><li>- Good resolution</li><li>- Metabolic studies (uses <math>^{15}\text{O}</math>, <math>^{18}\text{F}</math>, <math>^{11}\text{C}</math>)</li></ul>	<ul style="list-style-type: none"><li>- Radioactivity</li><li>- Expensive</li></ul>
fMRI (1991)	3 mm	<ul style="list-style-type: none"><li>- Good resolution</li><li>- non-invasive</li></ul>	<ul style="list-style-type: none"><li>- Expensive</li><li>- Limited to activation studies</li></ul>



# SPECT: The basic tools (I)

## 1) IV bolus of radio-labeled tracer

### Perfusion studies:

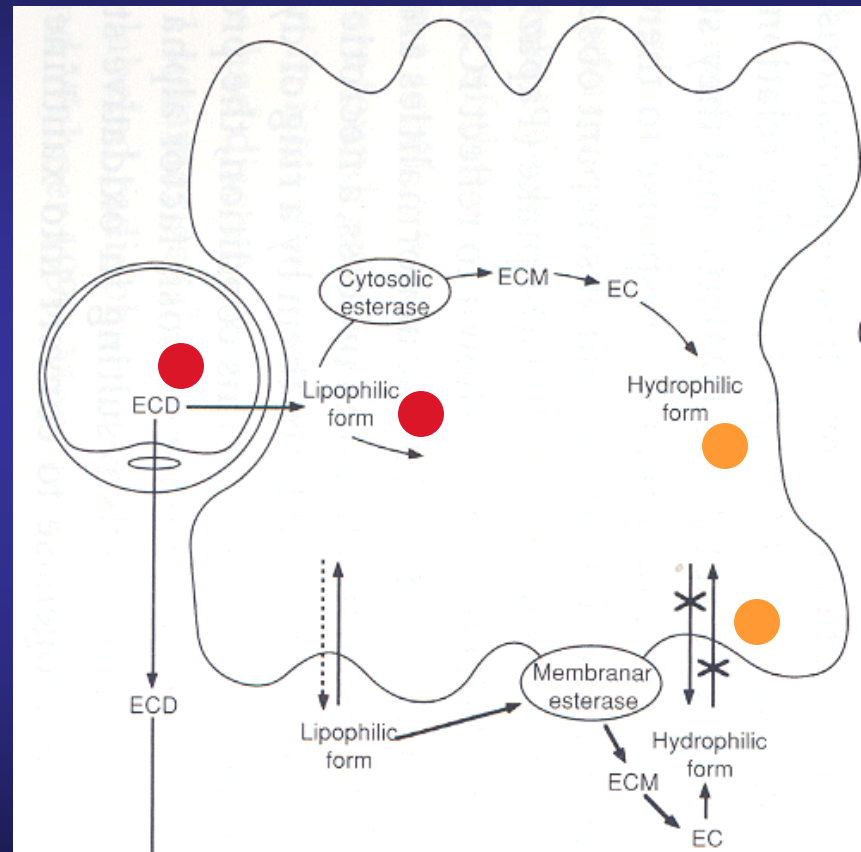
- $^{99m}\text{Tc}$  hexamethylpropyleneamine oxime (HMPAO)
- $^{99m}\text{Tc}$  ethylene cysteinate dimer (ECD)





# Radiopharmaceutical (I)

- **HMPAO and ECD are lipophilic:**
  - cross blood-brain barrier (within 1-2 minutes)
  - trapped intracellular (diffusion rate = 6%/hr)



Adapted from Otte, A. *Nuclear Medicine in Psychiatry*. Berlin: Springer, 2004. 7



# Radiopharmaceutical (II)

- **Significance for imaging:**
  - Rapid uptake: “*Scintigraphic snapshot*” of regional perfusion at moment of IV bolus
  - Long half life (6 hr) and slow diffusion rate: “*Stable map*”, image can be taken several hours after injection.

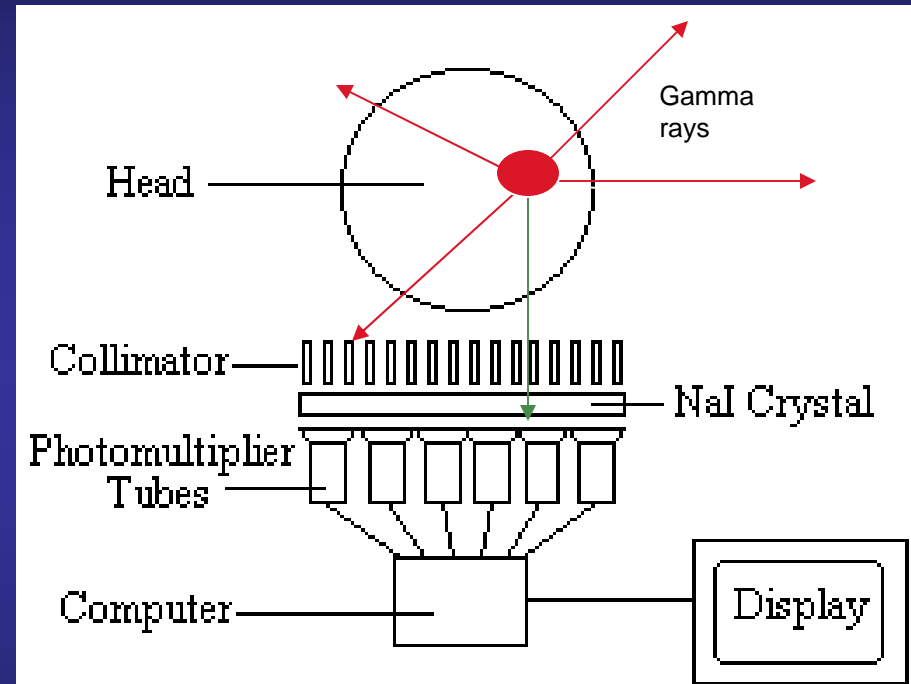




# SPECT: The basic tools (II)

## 2) Gamma camera:

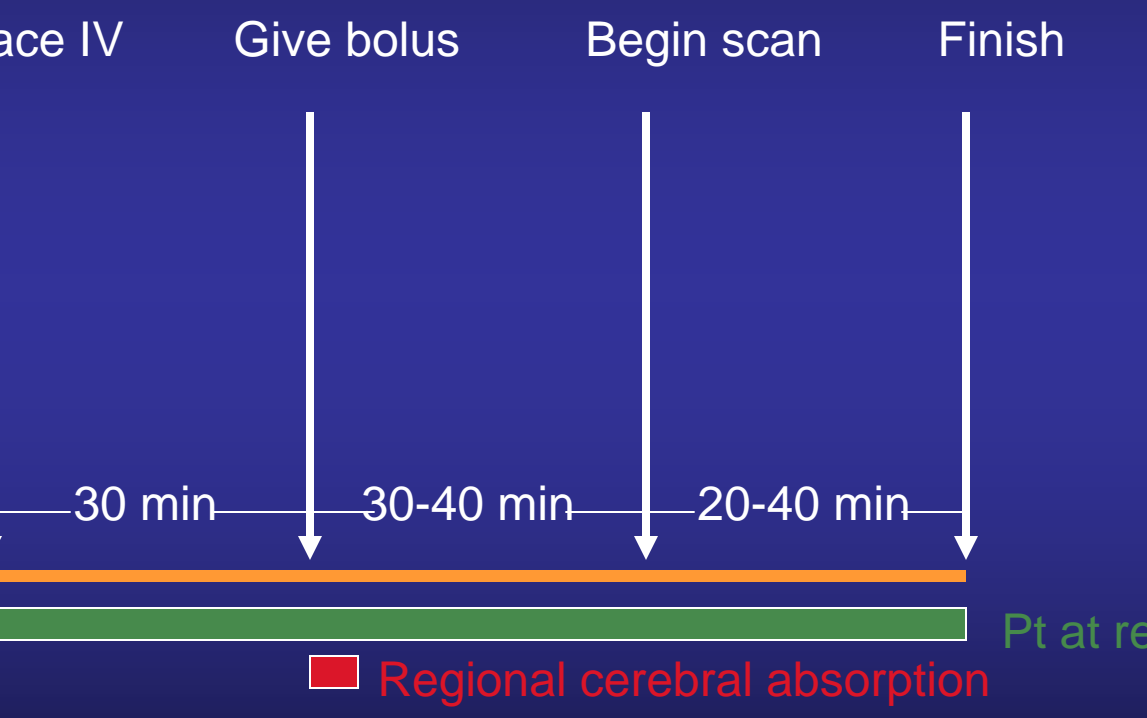
- Rotates 360° around patient's head, as close as possible.
- Consists of a collimator, NaI crystals, and photomultiplier tubes.



*Adapted from Clare, S. Functional MRI: Methods and Applications (1997).*



# Baseline scan protocol





# Patient Presentation

- Patient is a 63 y.o. male with two years of behavioral and cognitive changes, including decreased activity, loss of interest, and flat emotional state.
- No family hx of AD or dementia.
- Patient has undergone 1.5 yrs of unsuccessful diagnosis/treatment.

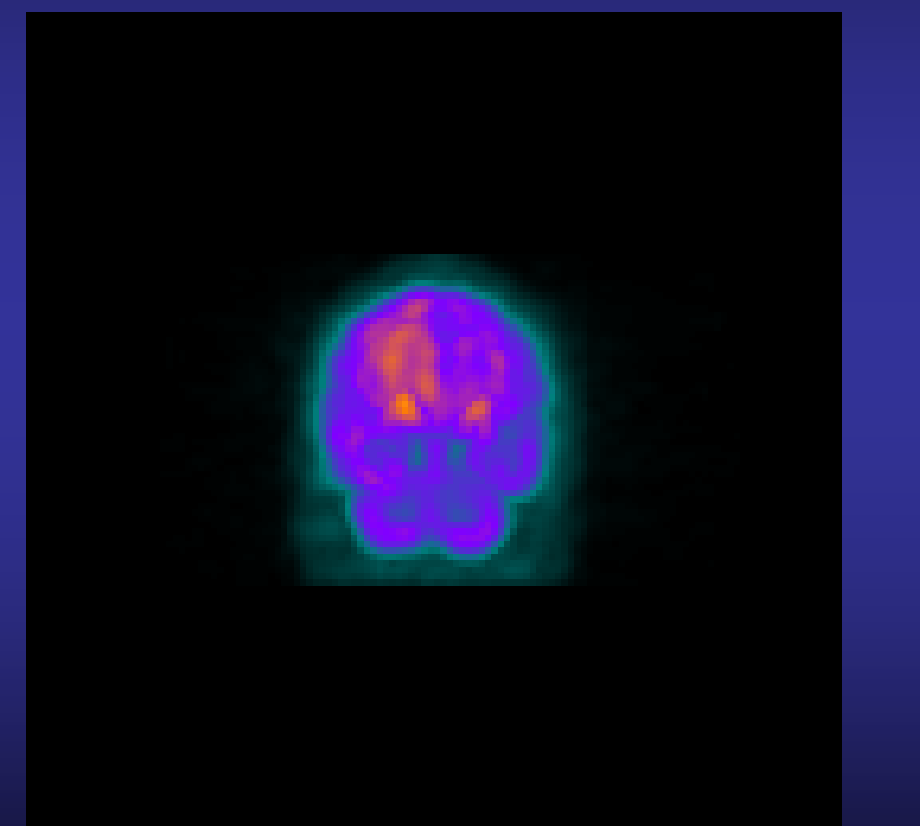


# History of Present Illness

Date	Physician	Tests	Dx	Rx
3/03	PCP	CT - normal r/o tumor, hematoma	Possible Depression	None
12/03	Psychiatrist		Depression r/o pseudo- dementia	Zoloft – No improvement
3/04	Neuropsych- ologist	IQ, memory tests are low	Possible Alzheimer's	Aricept – No improvement
8/04	Neurologist	MRI - normal		Ordered a SPECT scan



# SPECT: Cinematic display from sagittal and coronal cx. sections

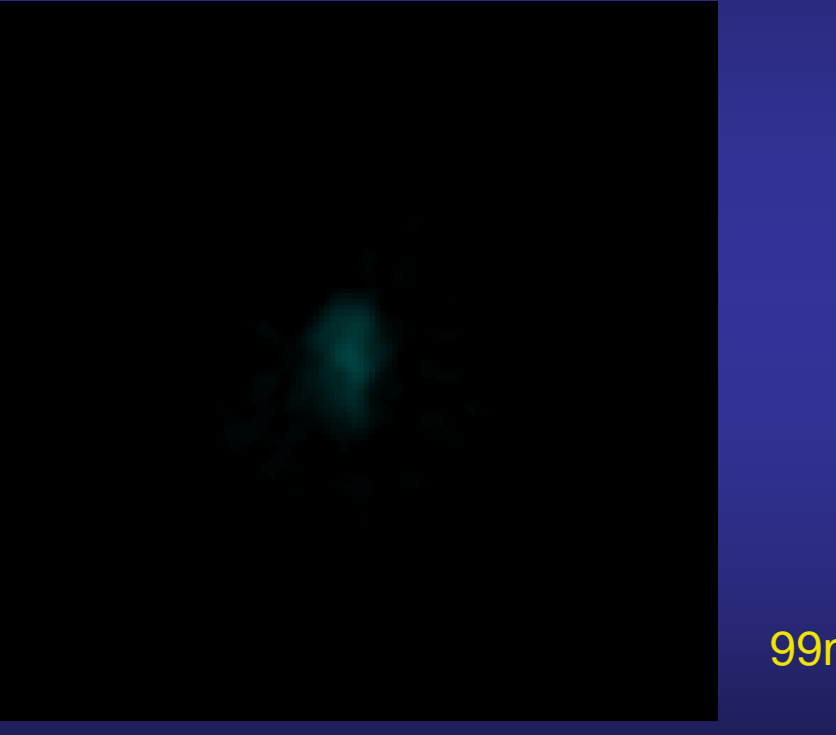


99mTc - ECD

*Beth Israel Deaconess*



# Cinematic Display of axial cx. section

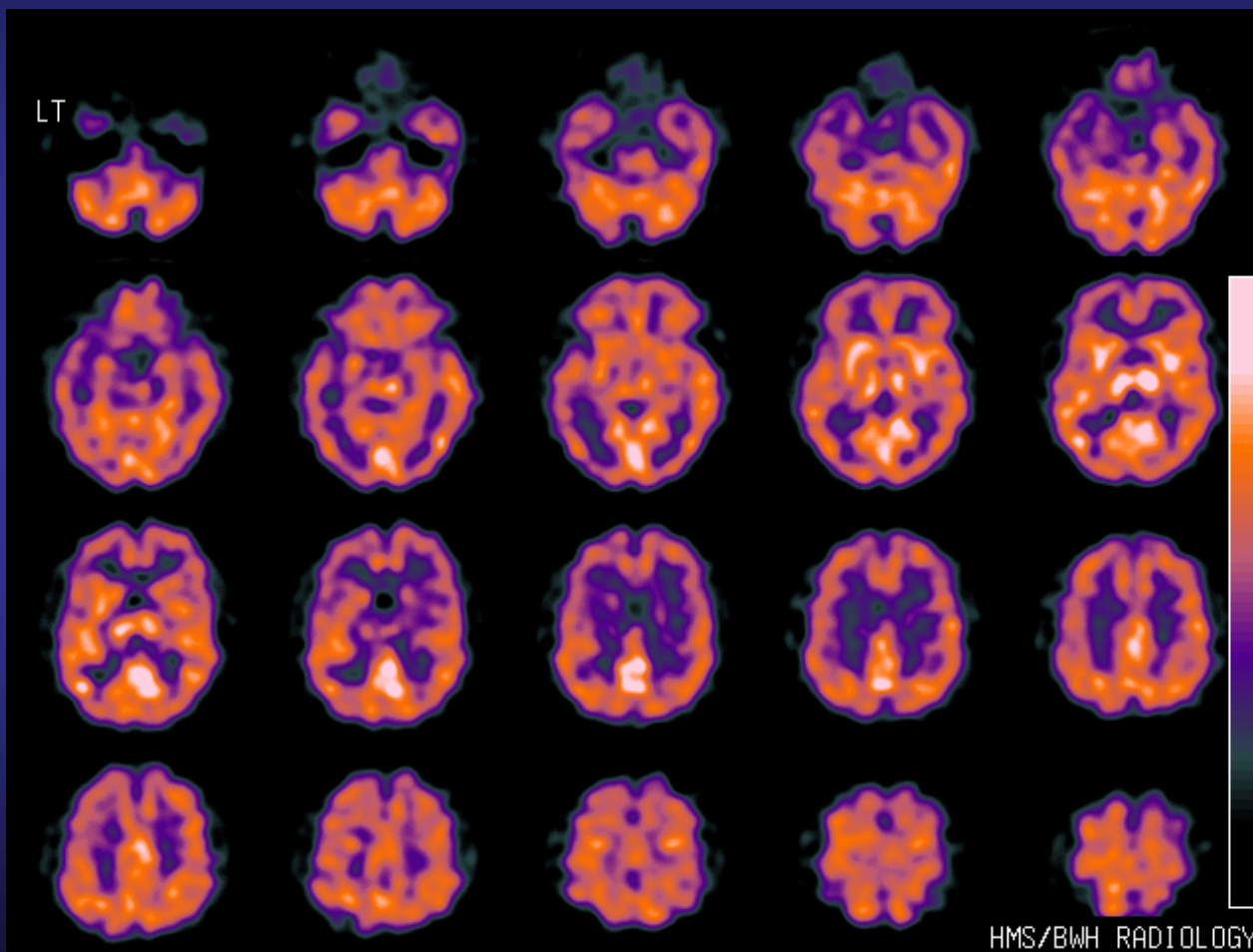


99mTc - ECD

*Beth Israel Deaconess*



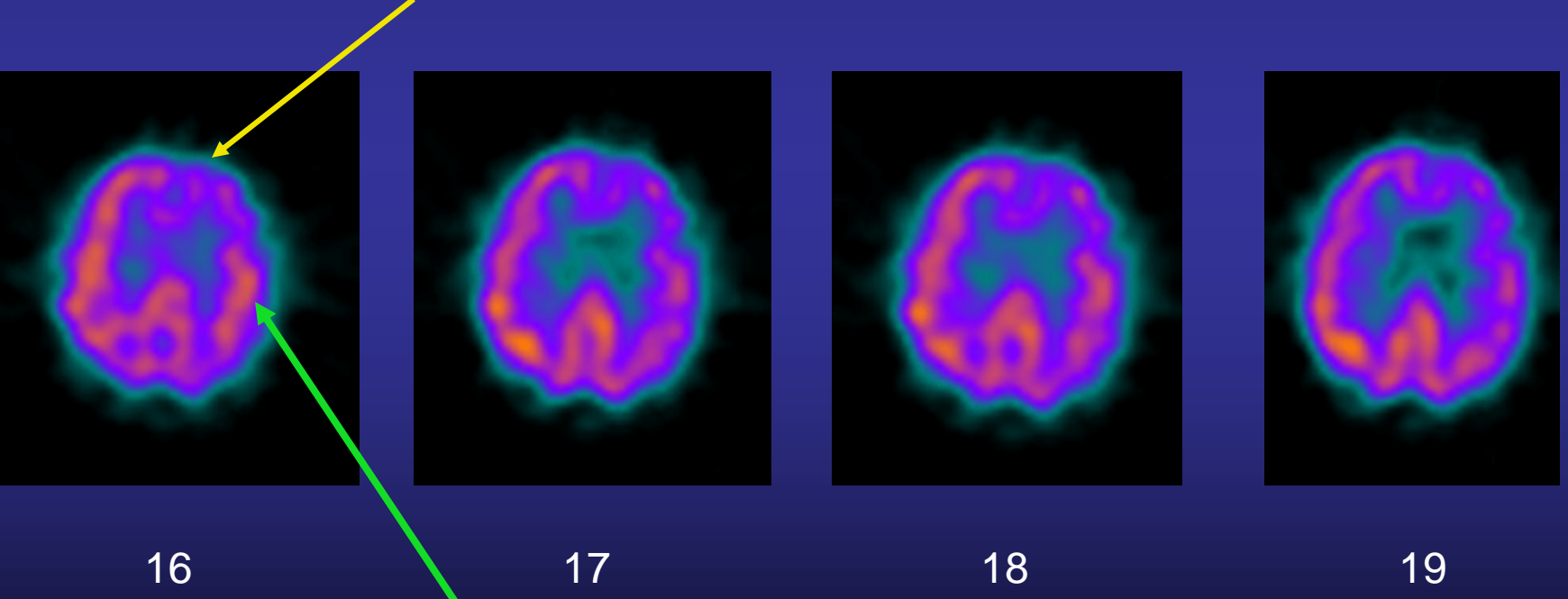
# Normal SPECT





# Axial Cross Sections

Decreased perfusion in frontal lobes



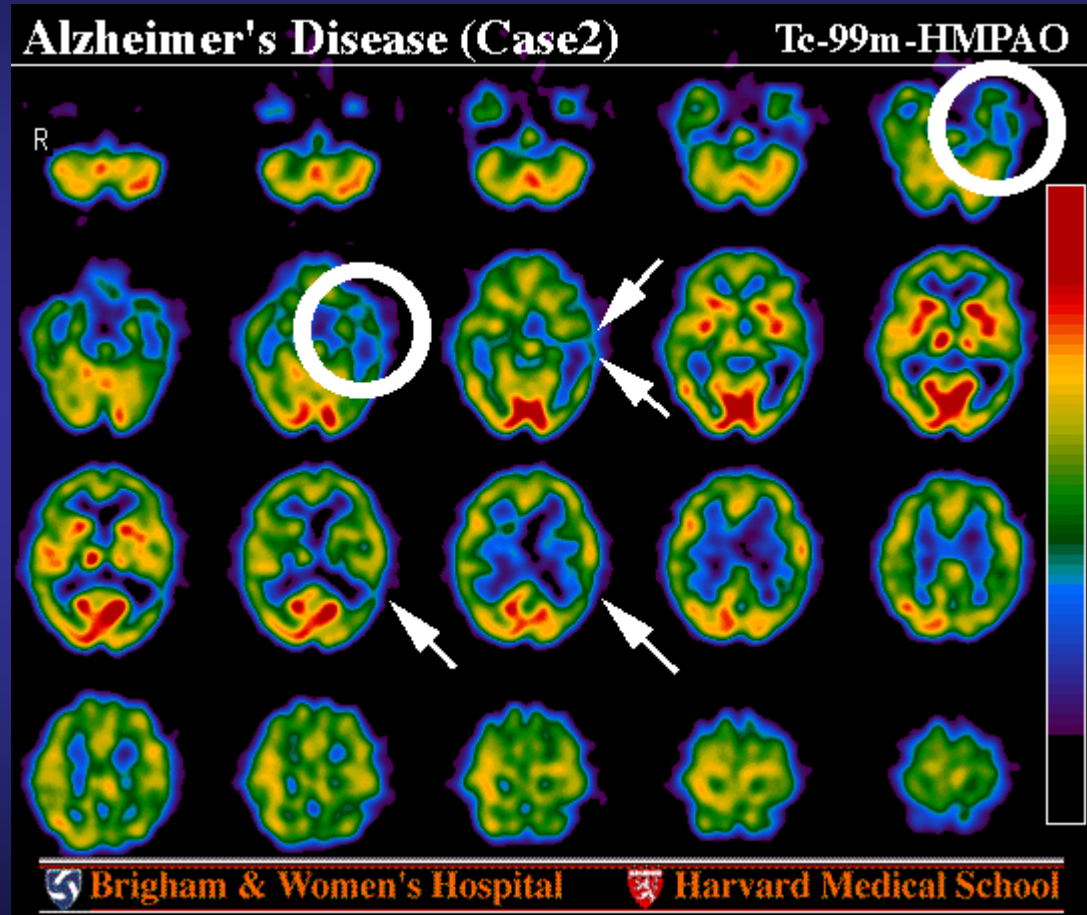
*Beth Israel Deaconess*

Normal perfusion in temporal-parietal lobes





# Characteristic AD SPECT



Decreased perfusion in temporal-parietal lobe



# SPECT and Dementia

- SPECT: useful in differentiating types of dementia, though literature is controversial.
- Our patient's perfusion studies:
  - Significant decrease in frontal lobe
  - Normal temporal-parietal lobe: r/o Alzheimer's
- Dx: frontal lobe dementia or Pick's disease.
- Benefits: psychological and more effective Rx.



# References

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