Nuclear Medicine in Oncology

Practice
2011

Radiopharmaceuticals

Pharmaceutical	Radionuclide	Function	Tumor type
Diphosphonates	Tc-99m	Osteoblast	Bone tumor & metast.
Ga-citrate	Ga-67	Fe-analogue	Bronchogenous cc., melanoma, lymphoma, primary hepatoma
Labeled antibodies	Tc-99m, I-123, In-111		Colorectal, ovarium carinoma; prostate, lymphoma, melanoma
NaI	I-131		Differenciated thyroid cc.
MIBG	Iodine	Catecholamine	Neuroblastoma pheochromocytoma
Pertechnetate	Tc-99m		Thyroid
Colloids	Tc-99m		Liver
Octreotide	In-111	Somatistatin analogue	Carcinoid, small-cell lung, Gastro Entero Pancreatic tumors
DMSA (V)	Tc-99m		Medullary thyroid cc.
MIBI	Tc-99m	Mitochondrial	Parathyroid, breast, etc.
FDG	F-18	glucose	Many kinds
Methyl-norcholesterol	Se-75		Adrenal cortex

Neuroendocrine tumors

- I-123 (or I-131) MIBG:
  - in catecholamine storage granules (like norepinephrine)
  - adrenal medulla, sympathetic nervous tissue
  - Indications:
    Suspected neuroendocrine tumors
    Pheochromocytoma
    Carcinoid tu.
    Neuroblastoma in children
  - **Not while antihypertensive/antidepressant therapy**
- In-111 Pentetreotide (Somatostatin analog)
  - metastases from neuroendocrine tumors
  - Pheochromocytoma (when antihypertensive/antidepressant therapy cannot be discontinued)
  - Prognosis of possible Sandostatin therapy
- FDG (more expensive)

By tumor types

| Lymphoma	FDG	(Ga-citrate: less sensitive)
Lung	FDG (exclude cancer; staging)	In-111 Pentetreotide (known NSCLC)
Melanoma	Lymphoscintigraphy: staging FDG: metastases	Ga-citrate SPECT: localize tu+met
Breast	MIBI: inconclusive X-ray, US Lymphoscint.: sentinel node	FDG: staging, re-staging, response
Colorectal, Ovarian	FDG: identify tu / met.	
Prostate	Prostascint (mAb): prognosis of planned therapy	Bone scan: met.
Thyroid cc.	NaI	Tl, MIBI, Octreotide, FDG DMSA(V): medullary

The changing focus of PET

PET applications worldwide

mid 80's ➡ 2000

neurology
cardiology
oncology

10%
15%
75%
< 10.000 p.a.

10%
10%
80%
> 250.000 p.a.
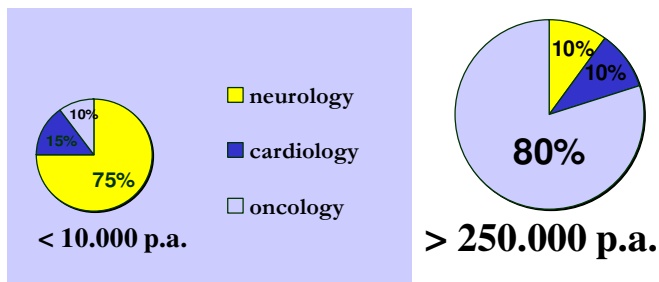
Indications: FDG PET

- Initial (preoperative) staging of cancer
- Differentiation between scar and residual tumor
- Demonstration of suspected recurrences
- Monitoring response to therapy
- Prognosis
- Radiotherapy treatment planning

Medicare Covered Indications

Approved under certain conditions

Clinical Condition FDG-PET	Coverage
Breast Cancer*	Staging*, restaging*, and monitoring response to therapy*
Colorectal Cancer	Diagnosis*, staging* and restaging*
Esophageal Cancer	Diagnosis*, staging* and restaging*
Head & Neck Cancers (excluding CNS and thyroid)	Diagnosis*, staging* and restaging*
Lung Cancer (Non-Small Cell)	Diagnosis*, staging* and restaging*
Lymphoma	Diagnosis*, staging* and restaging*
Melanoma (Excludes evaluation of regional nodes)	Diagnosis*, staging* and restaging*
Myocardial Viability*	Primary or initial diagnosis, or following an inconclusive SPECT prior to revascularization*
Refractory Seizures	Covered for pre-surgical evaluation only
Solitary Pulmonary Nodule	Characterization of indeterminate single pulmonary nodule
Thyroid Cancer*	Restaging
Cervical Cancer*	Staging as an adjunct to conventional imaging
Dementia	Differential diagnosis of fronto-temporal dementia (FTD) and Alzheimer's disease (AD) - or - CMS approved practical clinical trial
Clinical Condition NON FDG-PET	Coverage - is subject to additional guidelines set forth below and in the conditions and requirements of the CMS National Coverage Determination described below
Perfusion of the heart using Rubidium 82 tracer*	Covered for noninvasive imaging of the perfusion of the heart*
Perfusion of the heart using ammonia N-13 tracer*	Covered for noninvasive imaging of the perfusion of the heart*

What is PET good for?

„Traditional" imaging:

- Shows only major structural changes
- Relatively not sensitive to identify neoplasms
- Only delayed visualization of response to therapy

FDG PET:

- „Enlights" cancer
- Sshows metabolic response to therapy

From P. Vernon, GE

Role of PET in diagnosing tumors

Gambhir S.S. et al, J. Nucl. Med. 2001; 42: 1S-93S
Review of literature on FDG PET (26 000 studies, all kinds of tumor)

Sensitivity	Specificity	Accuracy	Impact on therapy
86 %	90 %	89 %	30 %

SENSITIVITY AND SPECIFICITY OF PET AND CT IN CANCERS

	Sensitivity (Detects cancer?)		Specificity (Detects only cancer?)		Change in Patient Management Due to PET
	PET	CT	PET	CT	
Lung					
• Diagnosis	98%	67%	73%	-	
• Staging	82%	61%	91%	76%	37%
• Recurrence	98%	72%	92%	95%	
Colorectal					
• Recurrence	93%	77%	85%	68%	31%
Lymphoma					
• Staging	89%	80%	93%	73%	21%
• Recurrence	83%		95%		10%
Melanoma					
• Staging	84%	88%	91%	75%	26%

From P. Vernon, GE

Why PET/CT ?

Limitations of PET:

- Limited anatomical details
- Low spatial resolution
- Time consuming (related to CT and X-ray)
- Not generally acknowledged among

PET/CT advantages:

- Adds anatomic details to PET
  ➔ less false positive
- Shorter imaging time (decay correction)
- Better known by docks

NEMA - US Shipments ($M)
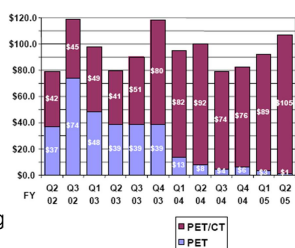
From P. Vernon, GE

CT, or PET + CT?

Vansteenkiste et al: mediastinal staging of 68 lung cancer patients.

	PET+CT	CT alone
Diagnostic accuracy	87 %	59 %

Stadium (N2/N3)

	PET+CT	Only CT
Sensitivity	93 %	75 %
Specificity	95 %	63 %
Accuracy	94 %	68 %

Better Delineation of Physiological Uptake

- Appreciation of normal or variant FDG uptake
- Better understanding and interpretation of FDG PET scans

Extraocular muscular uptake
Brown fat
Diaphragmatic cural uptake
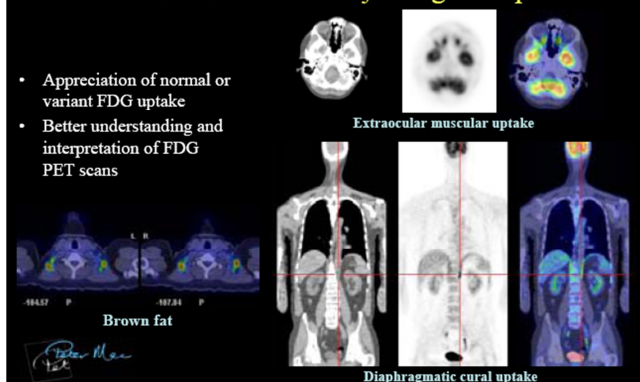
Better Localisation Equals Better Treatment Planning

- Newly diagnosed NSCLC
- PET/CT used to guide radiation treatment volume
- Discrepancy between PET and CT volumes related to respiratory excursion

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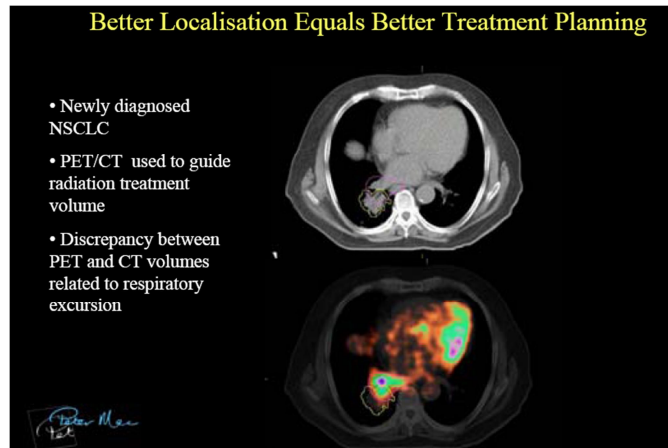
Questions:

- Which function?
- Organ or tissue?
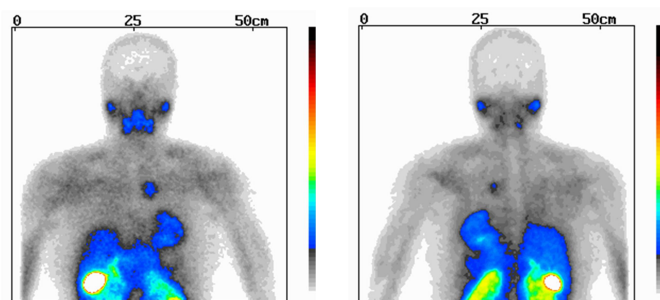- Planar or tomographic?
- View / slicing
- Abnormality
- Opinion

Tu #1
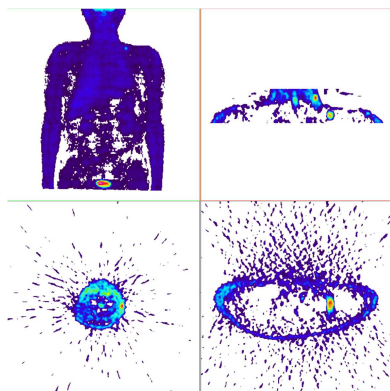Dg.: Papillary carcinoma of thyroid gland. Met?
99mTc MIBI

Anterior

Posterior

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Tu. #2 Medullary thyroid carcinoma. Met?
^{18}F-FDG PET

DEOEC PET Centrum

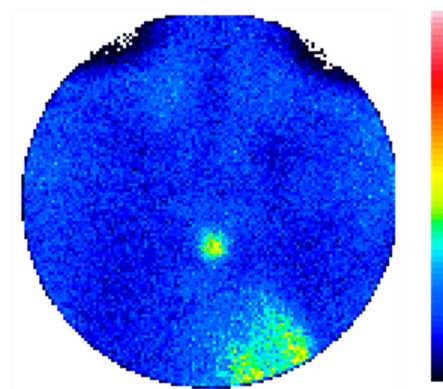Tu. #3. Parathyroid adenoma?

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of Nucl. Med.
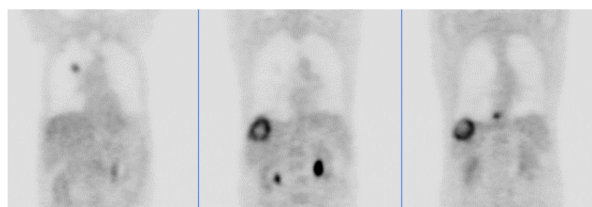
Tu #4. FDG PET
Right middle lobe NSCLC. Met?
Liver CT: suspicious lesion   CT-guided biopsy: non diagnostic
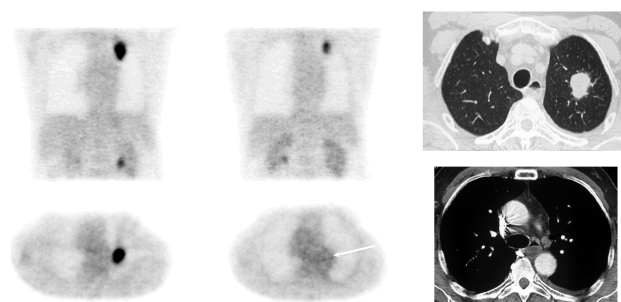Bone scan: suspicious accumulation in a thoracal vertebra

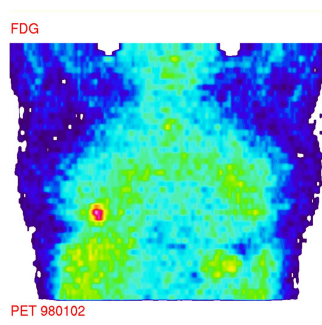images courtesy of F. Benard, M.D., HUP Philadelphia

Tu. #5 FDG PET

images courtesy of F. Benard, M.D., HUP Philadelphia

Tu. #6 Solitary melanoma. Met?
FDG PET

FDG

PET 980102

DEOEC PET Centrum

Tu #7
Breast scintigraphy: ^{99m}Tc-MIBI
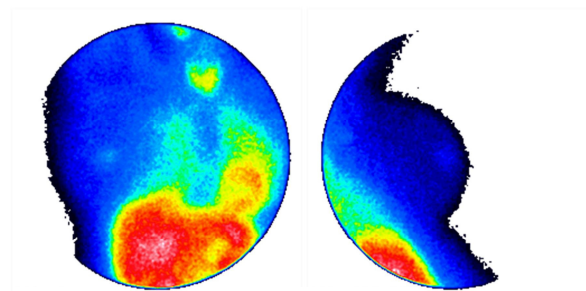
Ant   RPO 30

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Tu #8
Breast scintigraphy: ^{99m}Tc MIBI
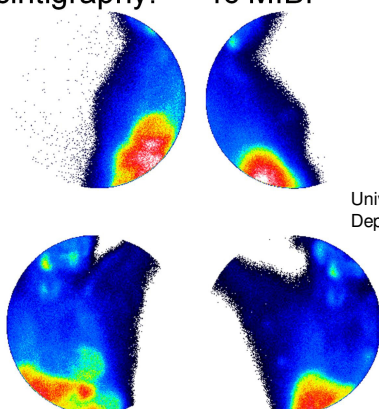
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Tu #9
Breast tu?
FDG-PET
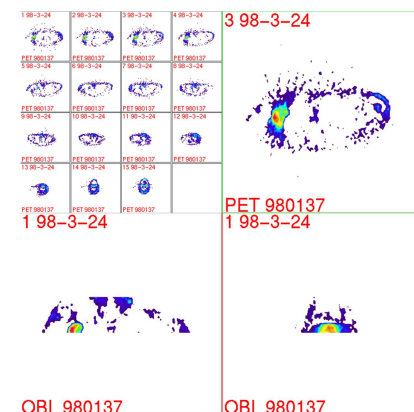
DEOEC PET Centrum

Tu #10. Sentinel node
Preoperative imaging

Anterior   Lateral
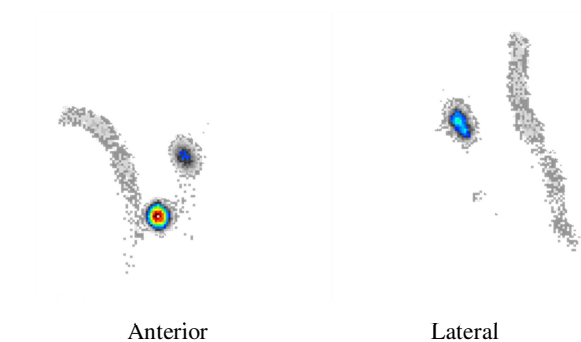
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Tu #11
Tu mammae. Met?
Methionine PET
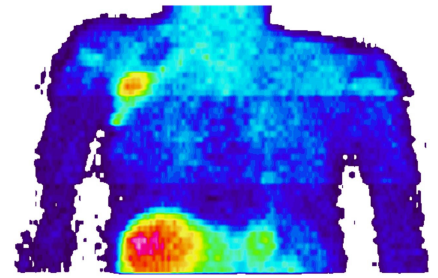
DEOEC PET Centrum

Tu #12. FDG PET
St. p. op. Colorectal carcinoma
Recurrence?
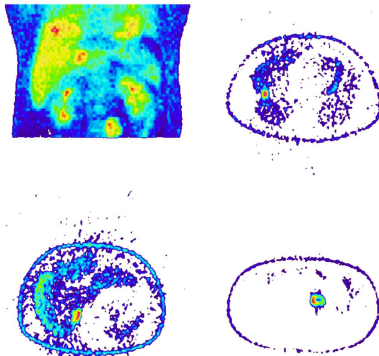
DEOEC PET Centrum
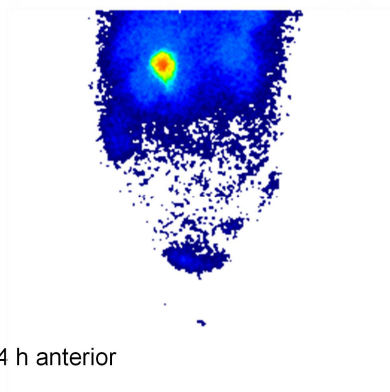
Tu #13
Pancreas carcinoma?
FDG PET

R   L
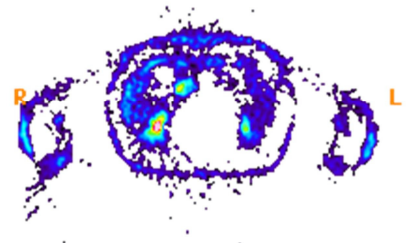
SZOTE Nukl. Med. Intézet - DEOEC PET Centrum

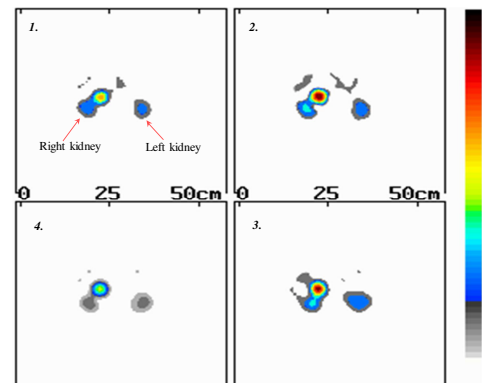## Tu #14 Octreotide scintigraphy

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Dep. of Nucl. Med.   24 h anterior
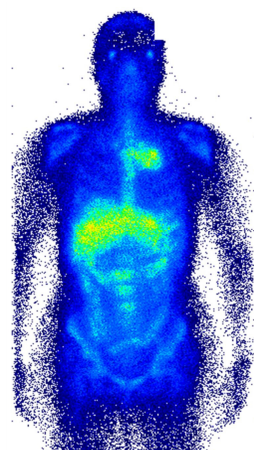
Tu #15: [111]In Octreotide SPECT slices

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Tu #16

Hodgkin's lymphoma

[67]Ga-citrate whole body scintigram

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Dep. of Nucl. Med.   et990376

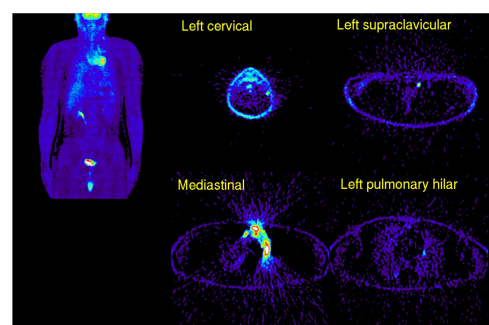## Tu #17 Hodgkin's lymphoma FDG-PET

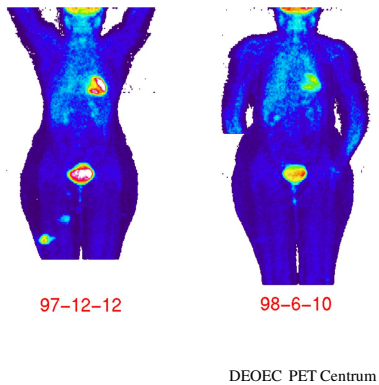Left cervical   Left supraclavicular

Mediastinal   Left pulmonary hilar

DEOEC PET Centrum

Tu #18. Malignant melanoma?
FDG PET

97-12-12   98-6-10

DEOEC PET Centrum

Tu. #19. Prostata cc. Met?

Tc-99m HEDP
bone scintigram
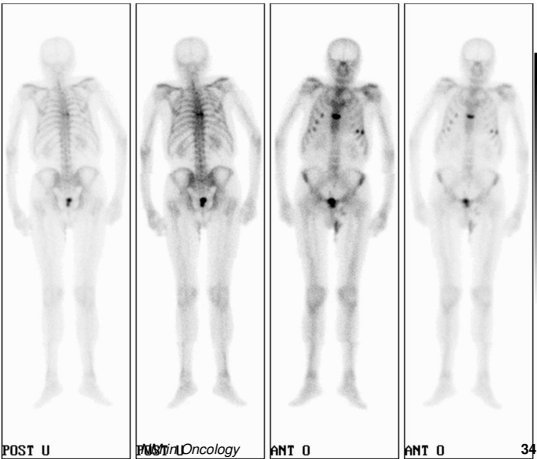
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Tu. #20. Mamma cc. Met?

Tc-99m HEDP
bone scintigram
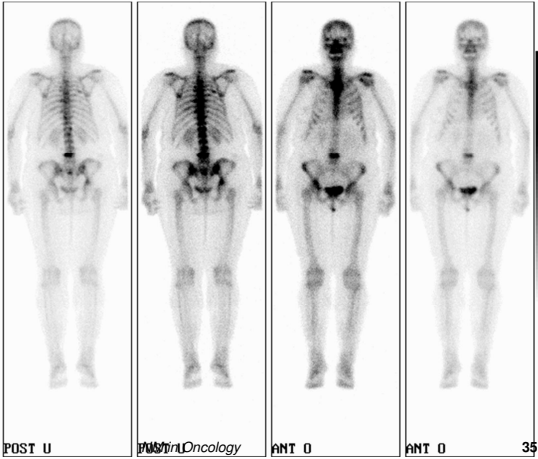
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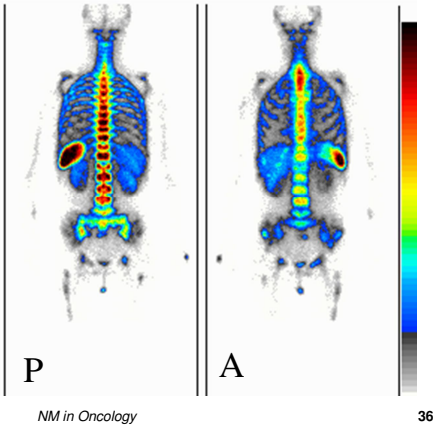## Tu #21. Anti-granulocyte MoAb scintigram
Met.?

P   A

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