

ПЭТ-КТ ПРИ РАКЕ ЛЕГКИХ

Джеймс О'Донелл

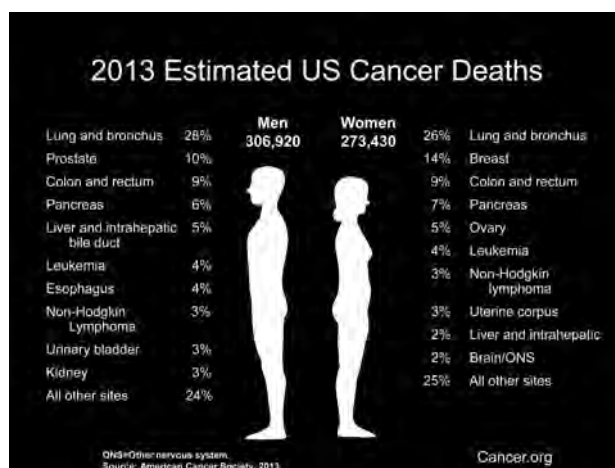
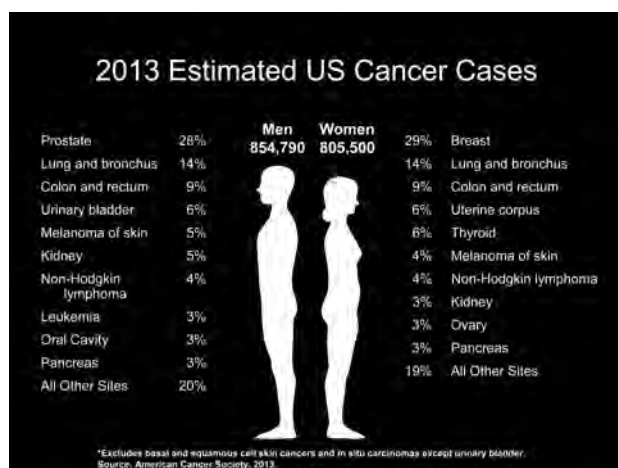
Университетский госпиталь Кливленда, Западный резервный университет Кейза, Кливленд, США

PET-CT IN LUNG CANCER

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Lung Cancer Solitary Pulmonary Nodule

- Clinical Problem:
 - Lung Ca is most frequently fatal cancer in men and women
 - mortality: 157,000/yr in USA (est. 2013)
 - 5year survival still only 15-20%
 - early detection and Rx improve survival
 - CT or MRI cannot distinguish a benign from a malignant lesion definitively
 - PET has a strong role in classifying lung nodules and lymph nodes as benign or malignant

Lung Cancer Solitary Pulmonary Nodule

- Clinical problem:
 - Sputum cytology?
 - Only 10-20% of malignancies are sputum +
 - Transthoracic biopsy?
 - Up to 30% of negative biopsies are really +
 - Likelihood of malignancy...
 - Not low enough for benign neglect
 - Not high enough to remove all surgically

Am J Roentgenol 1995; 165:1111-1117

Lung Cancer Solitary Pulmonary Nodule

- Current standard:
 - FDG PET positive lesion is malignant until proven otherwise
 - FDG PET negative lesion
 - Low (<5%) probability of malignancy
 - But consider all lesion characteristics
 - CT follow-up essential to ensure stability
 - If lesion grows → tissue diagnosis

Radiographics 2000; 20:1182-1185

Pulmonary Nodules Fleischner Society Guidelines

Nodule Size (mm)	Low risk patients	High risk patients
Less than or equal to 4	No follow-up needed.	CT at 12 months. If stable, no further imaging needed.
>4 - 6	CT at 12 months. If stable, no further imaging needed.	CT at 6 - 12 months and repeat at 18 - 24 months if stable.
>6 - 8	CT at 6 - 12 months and repeat 18 - 24 months if stable.	CT at 3 - 6 months and repeat at 9 - 12 and 24 months if stable.
>8	CT at 3, 9, and 24 months, consider PET, and/or biopsy.	Same as for low risk patients.

Note—
 *Newly detected indeterminate nodule in asymptomatic patients 35 years of age or older
 +Low risk: Minimal or no history of smoking or other risk factors
 +High risk: History of smoking or other known risk factors: Fam Hx lung Ca or exposure to asbestos, radon, uranium
 +Nonsolid, partially solid, GGO nodules may require longer follow-up
 +New recommendations for subsolid nodules in Radiol 2013;266:304

Radiol 2005;237:395


Lung Cancer and PET Solitary Pulmonary Nodule

- **False Positives** (macrophage glucose uptake)
 - Granulomas: TB, Histo, Crypto, Anergillus
 - Inflammation: Sarcoid, Wegener's
 - Rheumatoid nodules
 - Aggressive neurofibroma
- **False Negatives**
 - Bronchoalveolar Ca (57%) Carcinoid (85%)
 - Very small lesions (<1cm...but limits shrinking)
 - Hyperglycemia

What is "positive"? SUV pitfalls

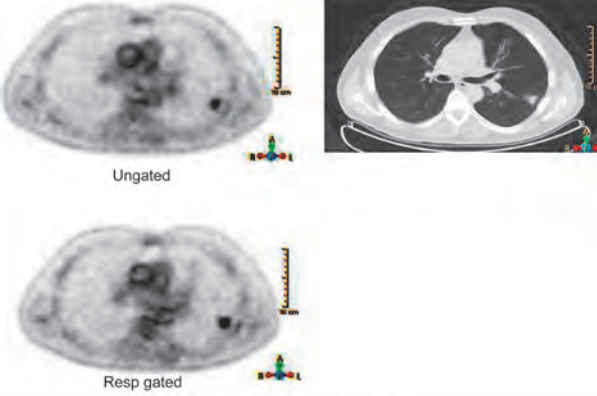
- A semi-quantitative target:background ratio
- Lesion size critical
- Published values based on old reconstruction algorithms and are pre PET-CT
- Affected by documentation of dose, time, BMI
- Best used as adjunct to, not replacement for, image interpretation
- Used to characterize **LESIONS**
- Normal high SUV in:
 - brain - heart - kidneys - bladder
 - bowel artifact - infiltrated dose

Tumors move

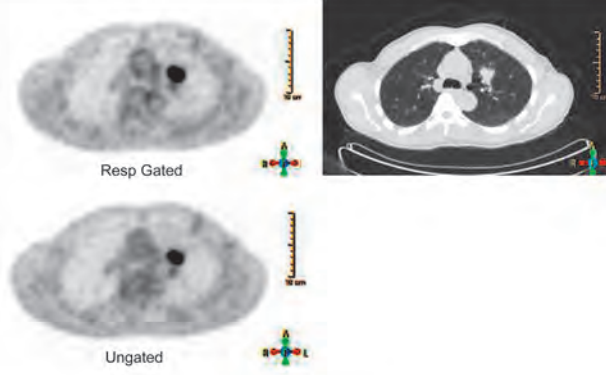


Problems for:

- Localization
- Quantification (SUV)
- Correlation PET/CT
- Therapy planning



Peripheral Lung Nodule



Central Lung Nodule

Solitary Pulmonary Nodule

- Meta-analysis of 1,474 lesions
- FDG PET detected SPN malignancy:

Sensitivity 97%
Specificity 74%

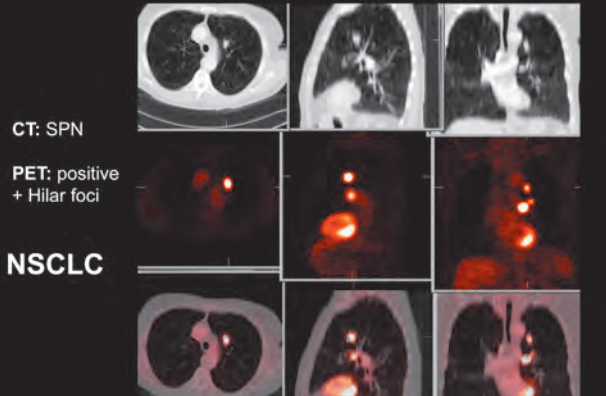
JAMA 2001;285:914

Solitary Pulmonary Nodule

CT: SPN

PET: positive + Hilar foci

NSCLC



Solitary Pulmonary Nodule

CT: SPN

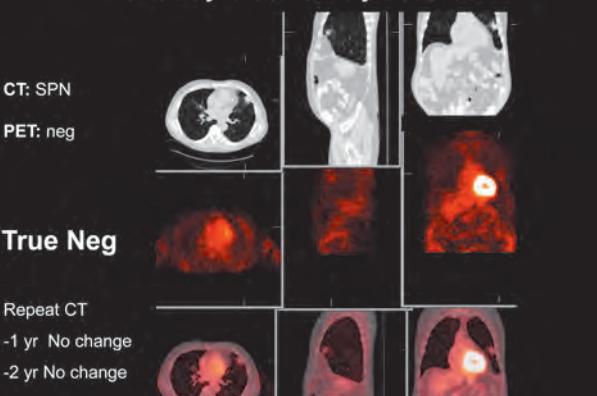
PET: neg

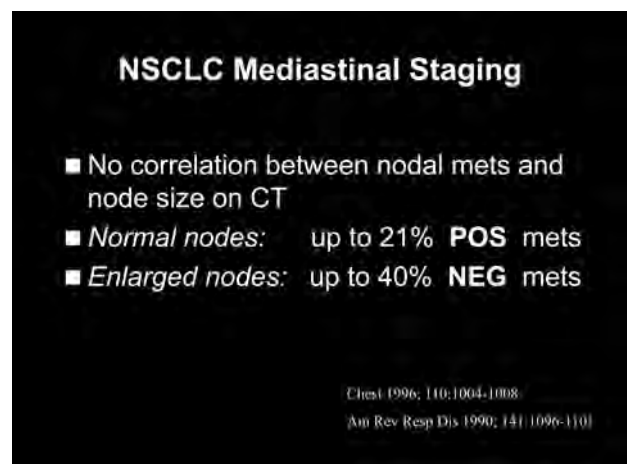
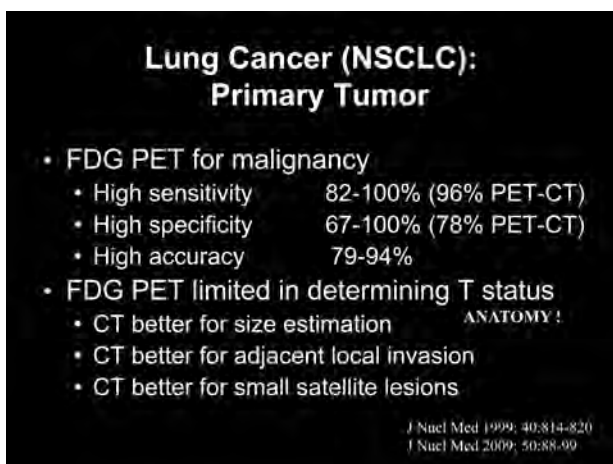
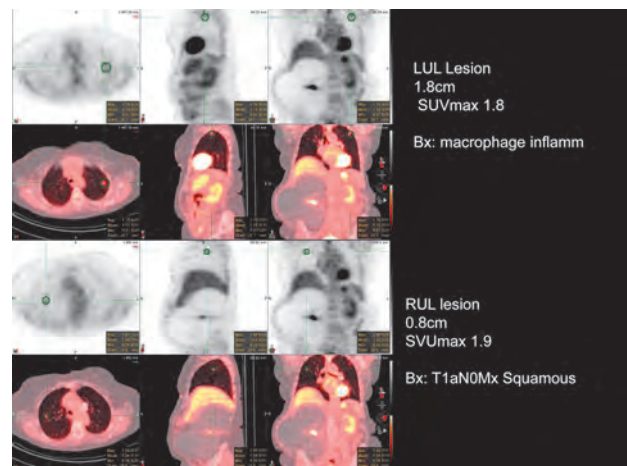
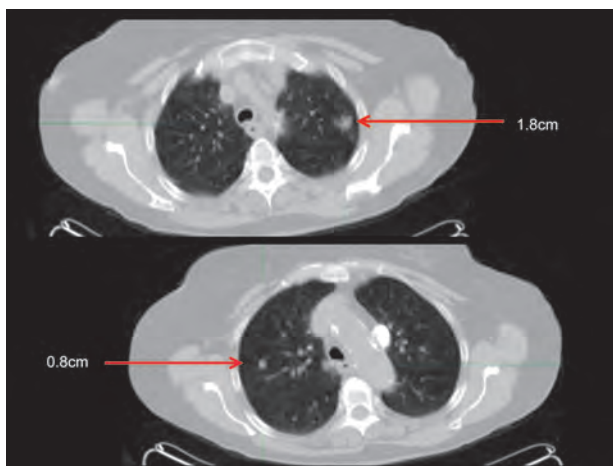
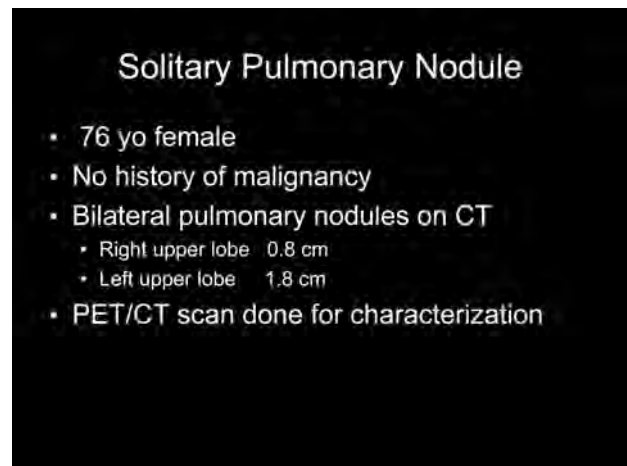
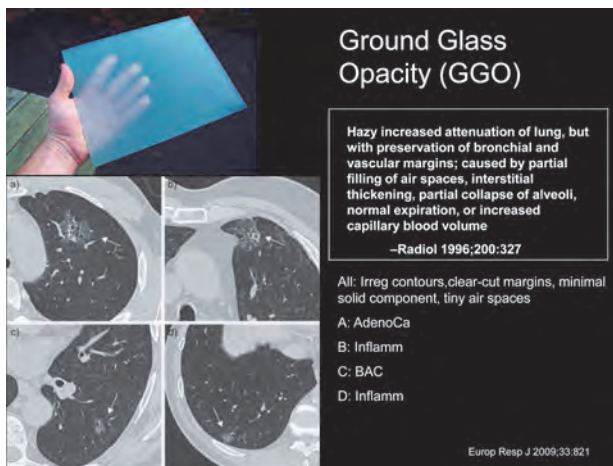
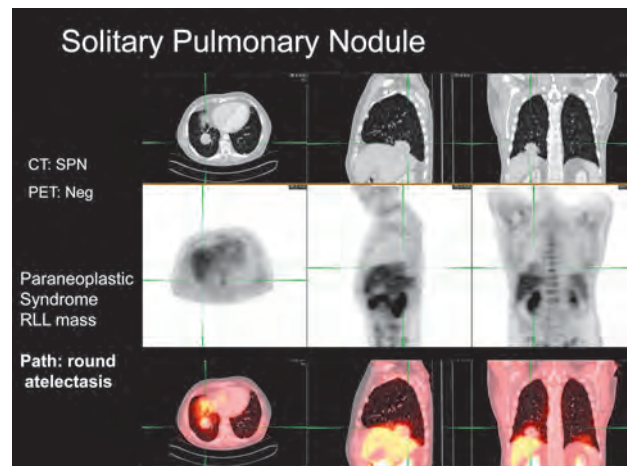
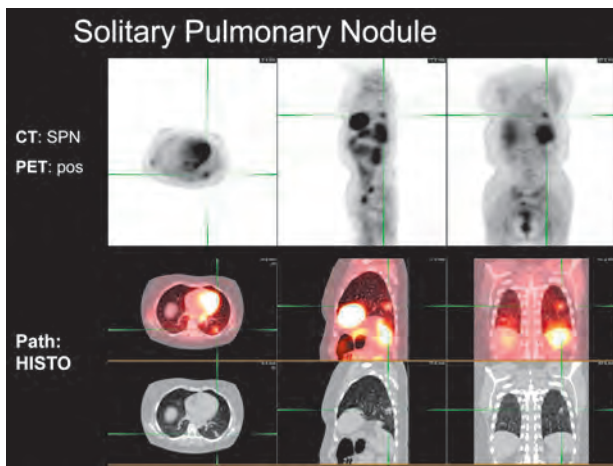
True Neg

Repeat CT

-1 yr No change

-2 yr No change





NSCLC Mediastinal Staging

- FDG-PET
 - sensitivity: 88%
 - specificity: 93%
- CT alone
 - sensitivity: 63%
 - specificity: 76%

Semin Nucl Med 2004; 34:134
 Ann Thorac Surg 1998; 65:181

NSCLC Mediastinal Staging

- Meta-analysis of 14 published series
 - 514 PET patients
 - 2,226 CT patients
- Mediastinal nodal metastases:

PET	Sens 79%	Spec 91%
CT	Sens 60%	Spec 77%

p < .001

Pre PET-CT I

Radiol 1999;213:53M

NSCLC staging: Adrenal Metastasis

- Benign vs malignant adrenal lesions difficult by conventional imaging (CI)
- MRI somewhat more useful
- FDG-PET Sens 100% Spec 80%
- positive uptake in an adrenal mass is an indication for biopsy to confirm metastatic disease

Am J Roentgenol 1997;168:1357

NSCLC Staging

Adrenal Met

PET/CT
Rad Rx
Planning CT

NSCLC Staging: Distant Metastases

- FDG PET finds unsuspected extra-thoracic spread in 6-24% of cases
 - More likely in stage III (locally advanced)
- May equal or exceed bone scan sensitivity
- FDG-avid effusion is likely malignant
- CNS and GU sensitivity limited
 - High background in these areas

NSCLC Staging

Unsuspected liver met

01

NSCLC Staging

57 yo male
Rt. lung mass
Staging

Unsuspected
T-12 met

02

NSCLC Staging

MRI: neg

Unsuspected
T-4 met

03

NSCLC Staging before & after PET

- 153 consecutive pts with new Dx
- Treatment plans +/- PET compared
- PET staged: **33% up 10% down**
- PET impact:
 - High 54pts (35%)
 - Med 39pts (25%)
 - Low 46pts (30%)
 - No 14pts (9%)

J Nucl Med 2001; 42:1596

NSCLC Staging before & after PET

Impact of PET

- **High** 54 pts (35%)
 - 34 pts curative → palliative
 - 6 pts palliative → curative
 - 15 pts modality change
- **Medium** 39 pts (25%)
 - Changed radiation Rx volume

NSCLC Staging before & after PET

Impact of PET

- **Low** 46 pts (30%)
 - PET results concordant with conventional
 - Treatment proceeded as planned
- **NO** 14 pts (9%)
 - PET information not considered in plan
 - Accuracy of PET confirmed by follow-up
 - 13/14 death from mets
 - 1/14 later chest wall resection

NSCLC Staging before & after PET

Pre PET Stage	Post PET Stage				Total	% down	% up
	I	II	III	IV			
I	24	3	13	5	45	0	47
II	1	9	8	2	20	5	50
III	6	4	51	19	80	13	24
IV	2	1	1	4	8	50	0
Total	33	17	73	30	153	10	33

J Nucl Med 2001; 42:1596

NSCLC Staging before & after PET

- Clinical impact of PET (Summary):
- Treatment plan changed in 60/153 patients
 - 39% Overall
 - 22% General treatment plan modified
 - Usually curative to palliative
 - Due to unsuspected lesions found at PET
 - 25% Radiation treatment volume modified

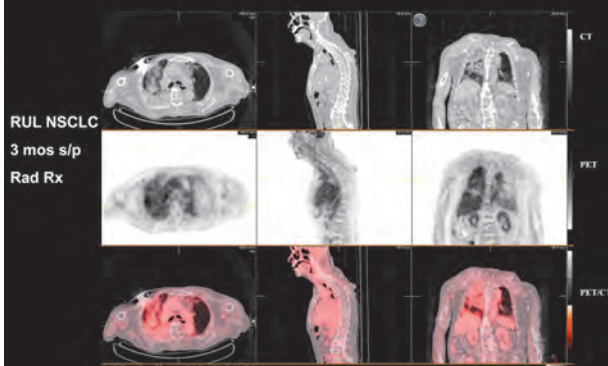
J Nucl Med 2001; 42:1596

NSCLC Restaging: Residual or Recurrent Disease

- 126 Pts with FDG PET before and after therapy
 - PET Sens 100% Spec 92%
 - CT Sens 71% Spec 95%
- Dx confirmed by Path (31) or progression by imaging (29)
- PET more accurate than CT alone to distinguish recurrence from scar

Eur Resp J 1999; 14: 1375-1380

Radiation Pneumonitis

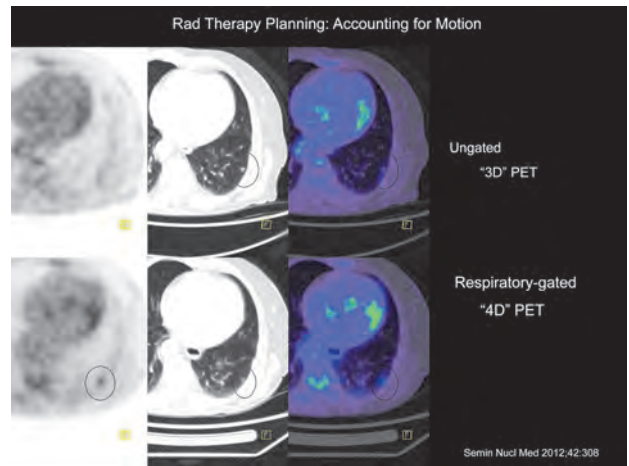
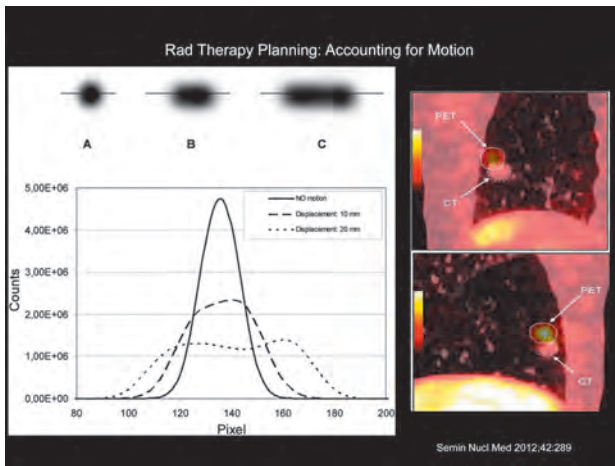


Radiotherapy Treatment Planning

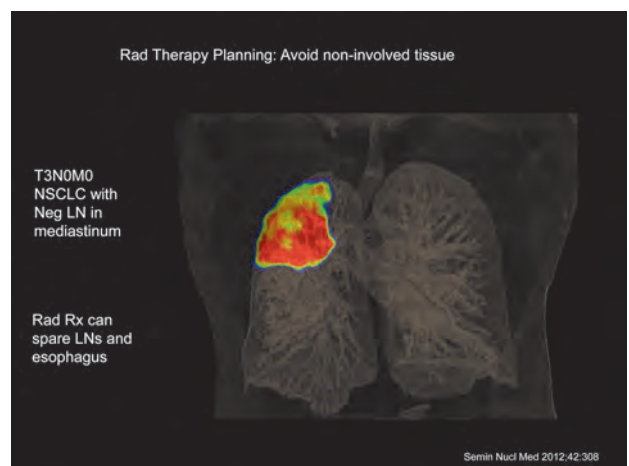
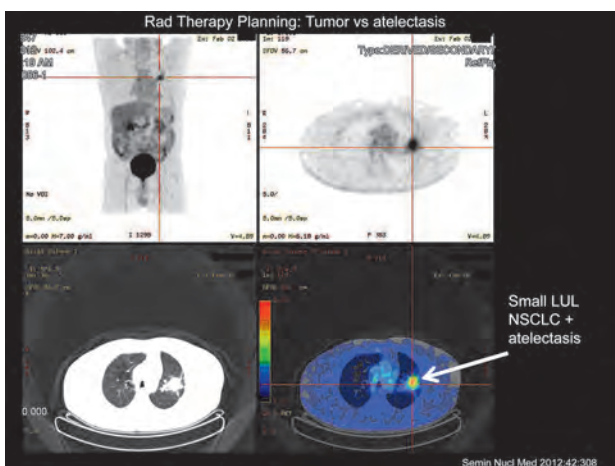
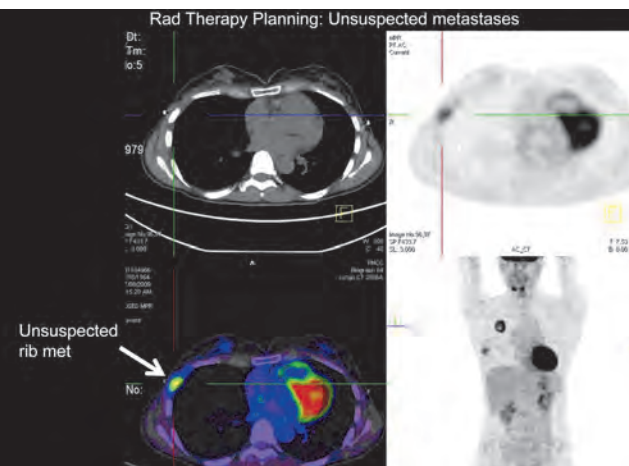
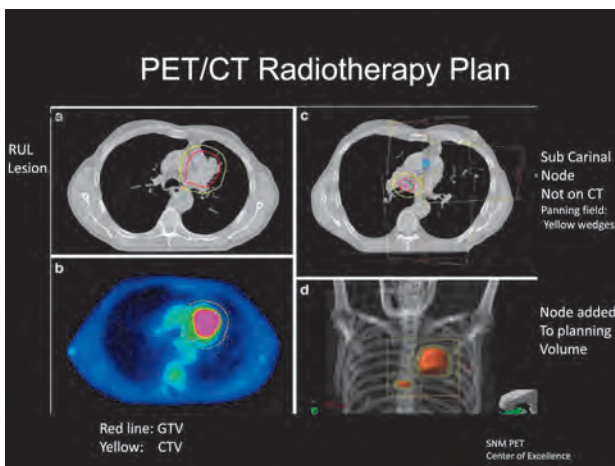
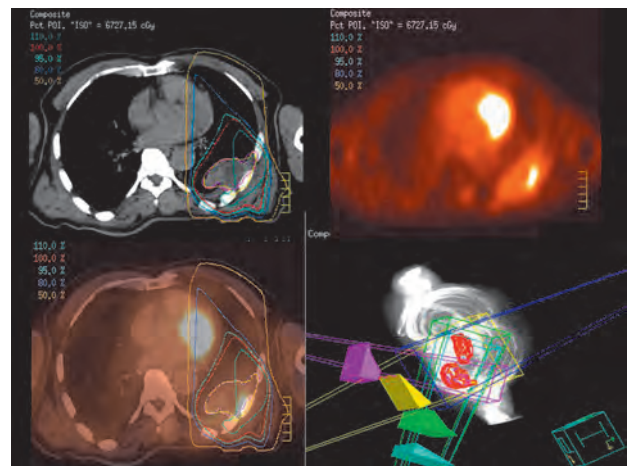
Effect of Image Registration Accuracy on Plan

- Plan
 - **GTV** – Gross Tumor Volume - defined by Therapist
 - **PTV** – Planned Target Volume - includes added volume to account for micro-metastases
 - **CTV** – Clinical Tumor Volume - includes simulation setup error





- ## Respiratory-Gated Radiotherapy
- Motion compensation methodologies:
 - Breath hold
 - monitored with patient feed back
 - Respiratory Gating
 - exposure during part of respiratory cycle
 - Tumor Tracking
 - dynamic exposure with moving beam



PET/CT Therapy Response

- Delay PET evaluation after Rad Rx:
 - 8-10 weeks optimal
 - Avoid active radiation pneumonitis
- Response Criteria: not always well defined
 - Consider EORTC criteria for response
 - >25% change in SUV_{max}
- SUV change is useful criterion of response
 - especially if no size change on CT

Rad Therapy Planning: Assessing Tumor proliferation (F-18 FLT)

Baseline Week 2 Week 4

ChemoRad to 20Gy tumor + marrow NEG

Semin Nucl Med 2012;42:308

Rad Therapy Planning: Assessing Tumor hypoxia (F-18 FMISO)

NSCLC cervical LN metastasis

F-18 FDG
-metabolically active

F-18 FMISO
- hypoxic (radiation resistant)

Semin Nucl Med 2012;42:308

Lung Cancer and PET: Referring Physician Perspective

- Questionnaire to 292 docs of 744 pts
- Responses on 274 pts (37%)
- Reason for referral:
 - Diagnosis 20%
 - Staging 61%
 - Monitor Rx or f/u 6%
- Clinical stage decision changed in **44%**
- PET Staging:
 - Upstaged 29%
 - Downstaged 15%
- PET changed management:
 - INTER modality 39%
 - INTRA modality 15%

J Nucl Med 2002; 43:752-756

Научно-клинический и образовательный центр «Лучевая диагностика и ядерная медицина» медицинского факультета Санкт-Петербургского государственного университета

В 2012 году на медицинском факультете Санкт-Петербургского государственного университета открылся Научно-клинический и образовательный центр «Лучевая диагностика и ядерная медицина», директор профессор Т. Н. Трофимова.

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В 2014 году Научно-клинический и образовательный центр «Лучевая диагностика и ядерная медицина» совместно с ESR проводит серию образовательных семинаров. Так, 23–24 мая 2014 года состоится двухдневный образовательный семинар ESSR Sports Imaging Subcommittee, посвященный лучевой диагностике заболеваний верхней конечности (руководитель проф. И. Крамер), 10–11 октября 2014 года – программа STAR (руководитель проф. Г. Рингерц).

Подробную информацию можно получить на сайтах медицинского факультета СПбГМУ <http://med.spbu.ru> и сайте НК и ОЦ «Лучевая диагностика и ядерная медицина» <http://spb.radiomed.ru>.

Для участия в профессиональных образовательных программах необходимо зарегистрироваться по телефонам: 8 (905) 288-02-17
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