RSNA 96th Scientific Assembly and Annual Meeting
Chicago, IL.
Monday, November 29th, 2010

"Improving Your PET/CT Practice: Lessons Learned in Clinical Practice, with Emphasis on Case Studies, Image Correlation, and PET/CT (RC211)"

Harry Agress Jr., M.D., FACR

Harry Agress Jr., M.D., FACR
Chairman, Department of Radiology
Director, PET/CT Center
Hackensack University Medical Center
Hackensack, New Jersey

Clinical Professor
Department of Radiology
College of Physicians and Surgeons
of Columbia University
New York, New York

Hackensack Radiology Group

http://www.hrgimaging.com

Go to "For Physicians" → "Download" → RSNA 2010

Purpose of Presentation

- To ***highlight*** and ***fine tune*** key aspects of PET/CT in clinical practice (case studies):
  - Improve efficiency of integration and interpretation of PET/CT
  - Emphasis significance of subtle PET/CT findings, their correlation and follow-up

Seminars in Ultrasound, CT and MRI

August 2008 (Vol. 29, No. 4)
Edited by Paul Shreve, MD
http://www.semultrasoundctmri.com

- PET/CT – Best Practices
  - Results of conference Spring, 2008
    - Protocols
    - Patient management and flow
    - Interpretation and reporting

Clinical PET and PET/CT Imaging

Categorical Course in Diagnostic Radiology
Editor, Richard L. Wahl, MD
RSNA 2007 Syllabus

PET-CT

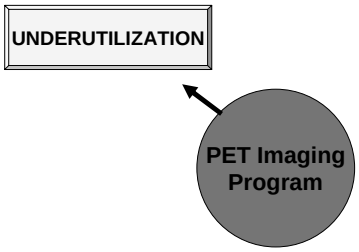
- PET/CT: Protocol Issues and Options. Blodgett TM, Mc Cook BM, and Federle MP. *Semin Nucl Med* 36:157-168; 2006
- Pearls and Pitfalls in Interpretation of Abdominal and Pelvic PET/CT. Blake MA et al. *RadioGraphics* 26: 1335-1353; 2006 (Sept/Oct)
- **PET/CT: Form and Function - State of the ART** Blodgett TM, Meltzer CC, and Townsend DW *Radiology* 2007 (Feb); 242:360-384

Patient Preparation

Clinical 18F-FDG Oncology Patient Preparation Techniques.
Hamblen SM and Lowe VJ.
JNM Tech 2003; 31:3-10

Hackensack University Medical Center

- Began with SPECT MCD (coincidence) imaging 10 years ago.
- 24,000 PET and PET/CTs to date.



Reasons for underutilization of PET by referring physicians

- Have certain expectations of PET/CT…

Expectations

Answers to specific clinical questions to make management decisions:

– What is the extent/stage of the patient's cancer?

– Is the patient's therapy working or not?

– Is a lesion on CT/MR cancer?

Expectations

- Integration of both PET and CT information for overall evaluation of patient.
- Consistency in reporting within a group of interpreters.
- ***Do not*** simply want a list of findings in impression without some specific response to the clinical question asked.
- Only recommend a further study if absolutely necessary or will change therapy.

NOPR

(National Oncology PET Registry)

Impact of Positron Emission Tomography/Computed Tomography and Positron Emission Tomography (PET) Alone on Expected Management of Patients With Cancer: Initial Results From the National Oncologic PET Registry

Bruce E. Hillner, Barry A. Siegel, Dawei Liu, Anthony F. Shields, Ilana F. Gareen, Lucy Hanna, Sharon Hartson Stine, and R. Edward Coleman

J Clin Oncol October 2008

*Lessons from the National Oncologic PET Registry: The Good, the Bad and the Ugly **

* Thanks to Ed Coleman, MD, et al of the NOPR committee

PET Reporting: ***Findings****

- PET abnormal: **76%**
  - Tumor described 98%
  - Correlated with other results 93%
- SUV's reported: **79%**
- CT findings described: **67%**

* Ed Coleman, MD, et al of the NOPR committee

PET Reporting: ***Opinion****

- Clinical indication addressed: **56%**
- Interpretation provided: 88%
- Differential diagnosis provided: 38%
- Need for additional studies: 29%
- Communication to referring MD 2%
- Blood glucose reported: 44%

* Ed Coleman, MD, et al of the NOPR committee

Consultation

- PET report should be more like a consultation than simple dictation.

Format of Dictation

- Clinical information:

The patient is a 51-year-old female with history of lymphoma. Prior PET-CT of 06/08/09 and CT scan of 08/07/08 from HUMC were reviewed for correlative purposes.

Auto-Intros

PROTOCOL INFORMATION:

- Ninety minutes following the intravenous administration of ***10.3 millicuries*** of F-18-fluorodeoxyglucose, a dedicated PET scan was performed from the skull base to the upper thighs in the transaxial, coronal and sagittal planes, as well as with rotating MIP format. The scan was performed with the patient in the fasting state both with and without CT attenuation correction.

Auto-Intros

PROTOCOL INFORMATION (Cont'd)

- With the patient in the same position a low dose CT scan was also performed without intravenous contrast. Interpretation of this examination was made by evaluation of both the anatomic (CT) and metabolic (PET) data which were electronically fused.

Auto-Intros

- **No accompanying CT:**

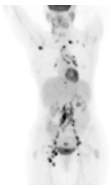
"If routine optimized contrast-enhanced CT, including intravenous and oral contrast, is required, then this should be ordered separately."

→ Final short paragraph of report:
- describing only significant findings on CT component (AAA, gallstones, etc)

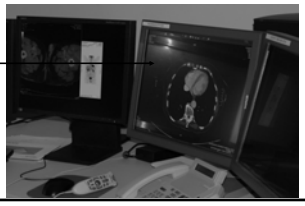
- **Accompanying optimized contrast CT:**

"An accompanying optimized contrast-enhanced CT scan was also requested and performed.
A full interpretation of this CT scan is reported separately."

- Rotating MIP first – good gestalt
  - Look for overall effect of therapy
  - Is the patient better or worse?
- Then go to slices and fusion



Full screen CT/ All windows



Measurement Requirements

- Varies between centers and physicians
- Can get easily overcome by many lesions
- List only significant SUV's
  - If large group of nodes, pick largest or most intense.
  - Protocol cases → specifically required nodes

Mixed Response

⇧	⇩	No Change	New

Format of Dictation (cont'd)

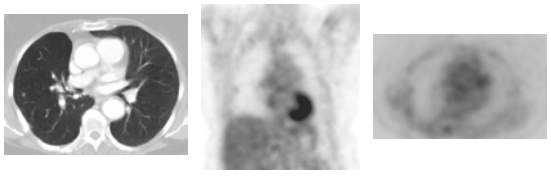
- Summary section:

  The max SUV values are as follows:

  – Right Axillary node = 5.6 compared to 3.2 on prior
  – Right Hilar node = 8.3 compared to 4.5 on prior
  – Left Supraclavicular node = 4.5, etc…

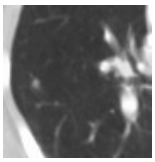
- Impression:
  – take into account all of the imaging findings and be as definitive as possible

69 y/o female with SPN - faint on PET

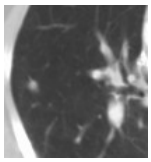


Plan Follow-up

Initial

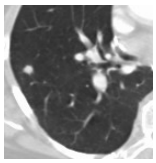


3 mos

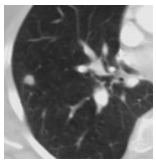


Further follow-up

5 mos

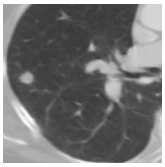


9 mos

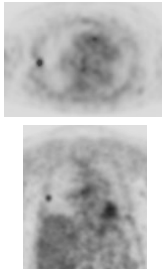


Increase - repeat PET

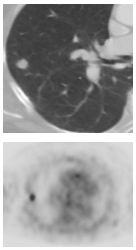
13 mos



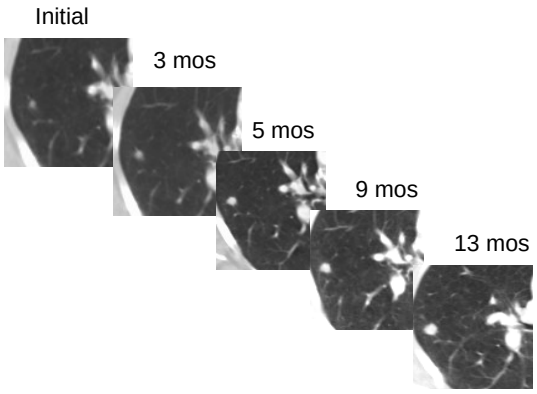
14 mos



69 y/o female with SPN



- RLL wedge resection =
  1.1 cm moderately differentiated adenocarcinoma



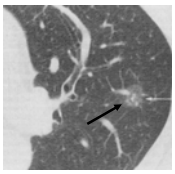
Guidelines for Management of Small Pulmonary Nodules Detected on CT Scans: A Statement from the Fleischner Society

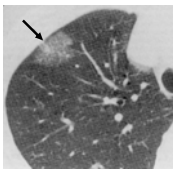
Heber MacMahon, MB, BCh, Bao, John H. M. Austin, MD, Gordon Gamsu, MD, Christian J. Herold, MD, James R. Jett, MD, David P. Naidich, MD, Edward F. Patz, Jr, MD and Stephen J. Swensen, MD

***Radiology* 2005; 237:395-400**

Detection of Lung Cancer on Chest Radiographs: Analysis on the Basis of Size and Extent of Ground-Glass Opacity at Thin-Section CT

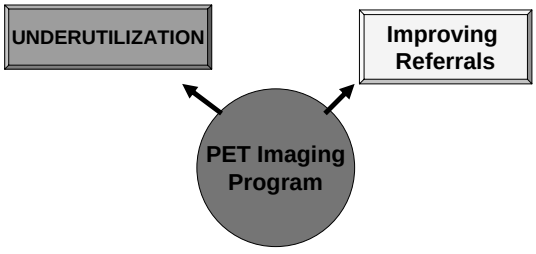
Tsubamoto M, Kurlyama K, Kido S et al.
Radiology 2002; 224:139-144





Subsolid Pulmonary Nodules and the Spectrum of Peripheral Adenocarcinomas of the Lung: Recommended Interim Guidelines for Assessment and Management

Myrna C.B. Godoy, MD and
David P Naidich, MD.
Radiology 2009 (Dec); Vol 253:
No 3: 606-622



Improving referrals

- Referring MDs:
  - One-on-one discussions of individual cases with referring physicians.
- Other imagers in group:
  - Nuclear Medicine and Radiologists
    - major source of referral

Tumor Boards

- Key to go to conferences where PET cases will be discussed:
  - misrepresented by others who know less
  - 23 tumor board conferences/month
- Cases often very complex and all aspects of imaging and specific patient presentations have major impact on therapy decisions.
- Improves relationships with peers.
- Be clear about limitations of PET…

SAM Question

Clinical limitations of FDG-PET imaging include each of the following *except:*

1. Bronchoalveolar and carcinoid lung cancers.
2. Prostate and renal cancer.
3. Monitoring breast cancer treatment.
4. Mucinous ovarian and colonic metastases.
5. Early breast cancer.

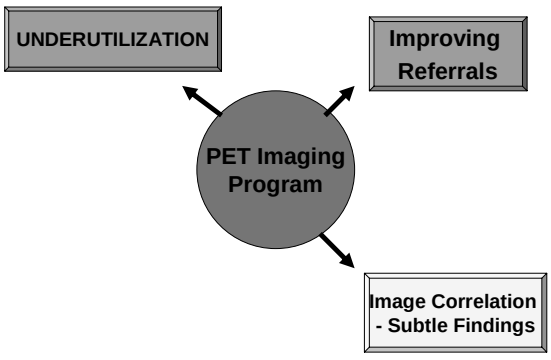
SAM Question

Clinical limitations of FDG-PET imaging include each of the following *except:*

1. Bronchoalveolar and carcinoid lung cancers.
2. Prostate and renal cancer.
3. ***Monitoring breast cancer treatment.***
4. Mucinous ovarian and colonic metastases.
5. Early breast cancer.

Some other issues

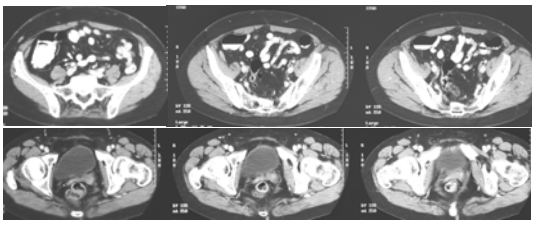
- Mediastinal/hilar activity:
  - Nodes are frequently non-specific
  - Use PET/CT as road map for biopsy site
- Knowledge of normal variants
- Histologically confirming PET positive lesions that will effect therapy decisions

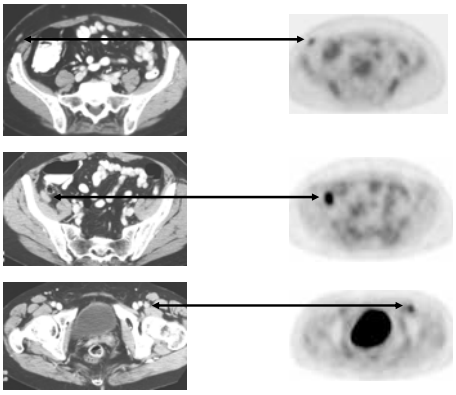


PET has improved the way we read CT

- Pay more attention to subtle CT findings.

64 y/o female with NHL
CT reported negative





Thoughts

- When dictating PET or PET/CT, be aware of how you comment on findings overlooked or difficult to see on prior CT
- When reading oncology CT case, always check if there has been prior PETCT

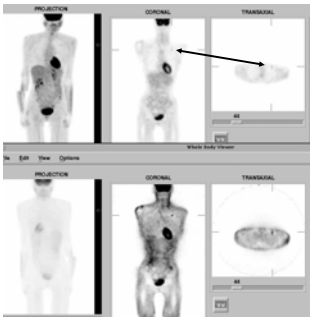
PET has improved the way we read CT

- Pay more attention to subtle CT findings
- Subtle or unexpected PET and CT findings: use combination to push harder for biopsy

54 y/o female f/u for NHL.
PET → left anterior chest wall focus

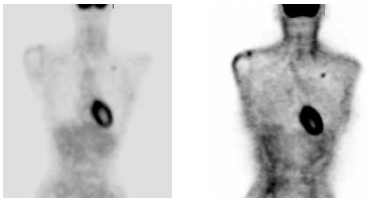
AC

NAC



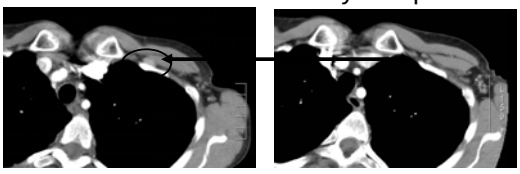
54 y/o female f/u for NHL.
PET → left anterior chest wall focus

AC NAC



54 y/o female f/u for NHL.
PET → left subpectoral focus

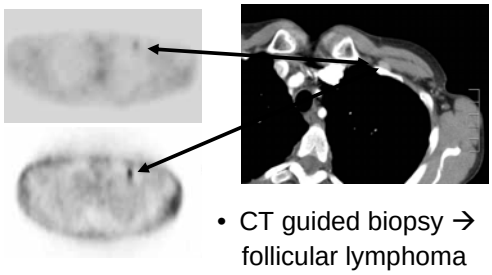
2 years prior



54 y/o female with NHL.
PET → left subpectoral focus

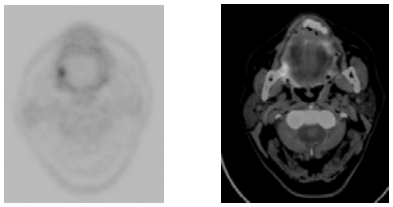
AC

NAC

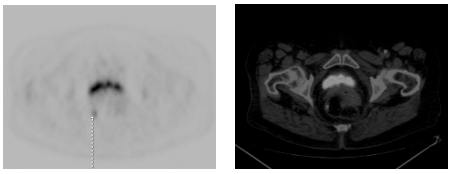


- CT guided biopsy → follicular lymphoma

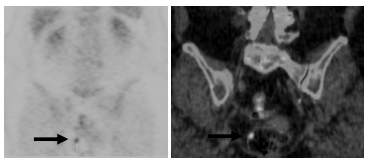
67 y/o female - initial staging
for tongue cancer.



67 y/o female - initial staging
for tongue cancer.

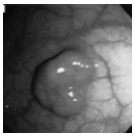


67 y/o female - initial staging
for tongue cancer.



67 y/o female - initial staging for tongue cancer.

- Endoscopy = tubular adenoma



Different approaches to CT component.

Sometimes the CT component is most important…

SAM Question

Careful evaluation of the CT portion of the PET/CT exam is important, as additional findings might include each of the following *except:*

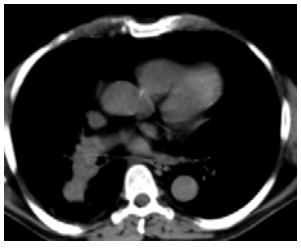
1. Aortic Aneurysm
2. Gallstones
3. Renal calculi
4. Small liver metastases
5. Small pulmonary nodules

SAM Question

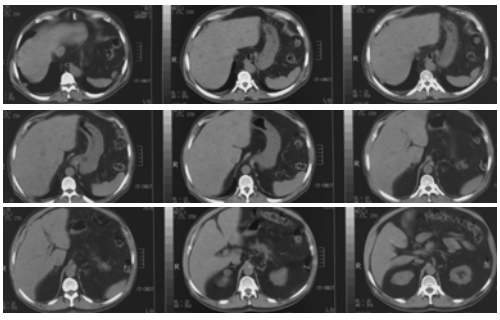
Careful evaluation of the CT portion of the PET/CT exam is important, as additional findings might include each of the following *except:*

1. Aortic Aneurysm
2. Gallstones
3. Renal calculi
4. ***Small liver metastases***
5. Small pulmonary nodules

78 y/o male with lung mass on CT (contrast allergy) Reported = "No evidence of metastases or adenopathy."



CT



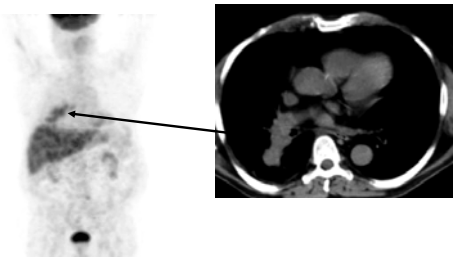
Surgical plan →

Mediastinoscopy and resection of lung mass

PET ordered for staging →

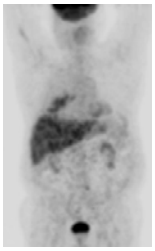
Is this an operable candidate?

1) Yes 2) No

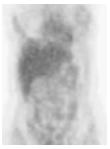


No, no, no, no, no…

Patient had no abdominal pain or elevated LFTs.



Normal for comparison



Ultrasound = multiple lesions

- USG biopsy = large cell metastases

- Staging and management change to chemotherapy.

If full contrast CT scan…

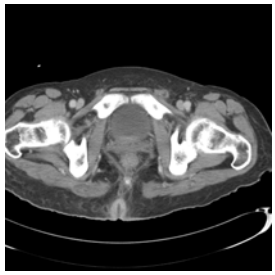
Pulmonary emboli

Venous thrombosis

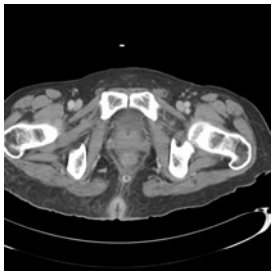
Improved guidance for biopsies

36 y/o male with history of lymphoma.

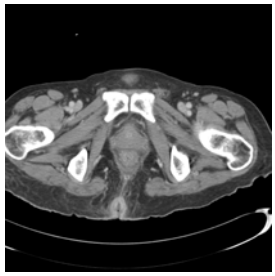
Initial



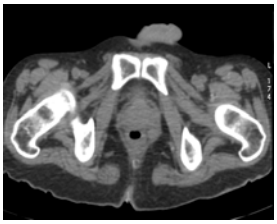
Initial



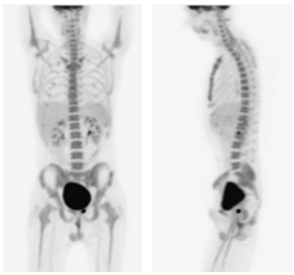
Initial

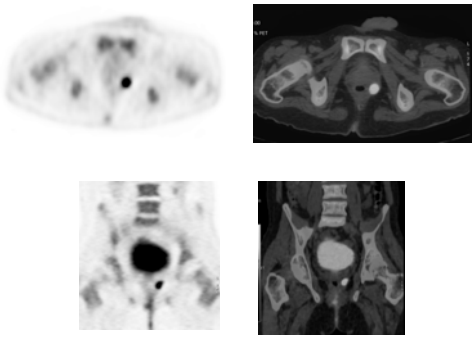


One month f/u



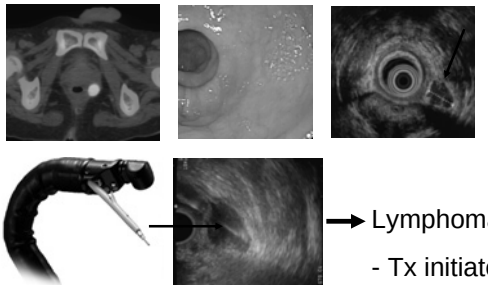
One month f/u





Endoscopic Ultrasound Biopsy

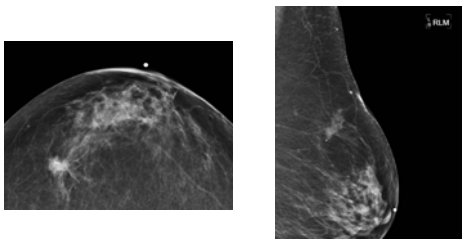
Endoscopic Ultrasound Biopsy



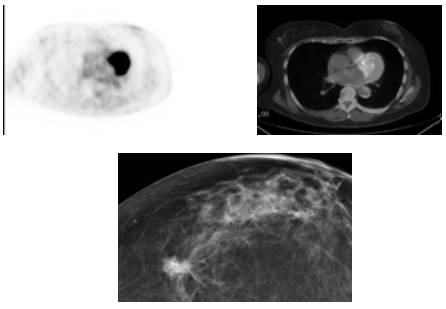
Lymphoma

- Tx initiated

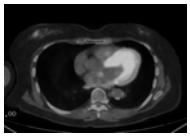
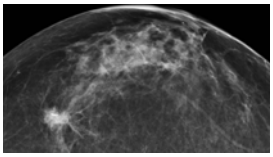
74 y/o female with right lateral breast mass.
No other evidence of tumor
on mammography or USG



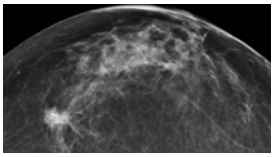
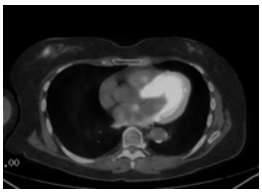
Faintly FDG avid lateral lesion.



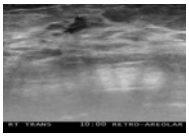
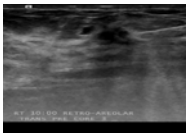
PET/CT showed additional more medial focus with no correlate on initial mammogram or USG.

Reviewed all imaging with our mammographer.

Targeted USG → additional medial lesion

- Biopsy → cancer
- Treatment changed from lumpectomy to mastectomy.

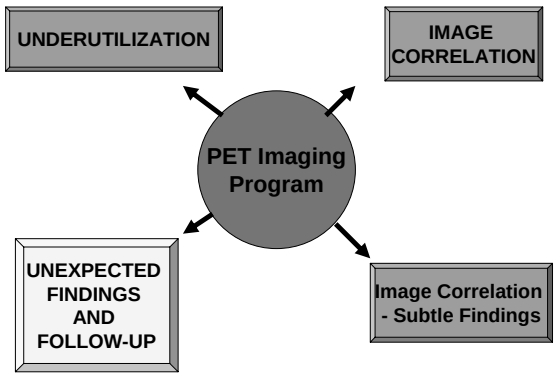
A Radiologic Review of the New TNM Classification for Lung Cancer

Seth Kligerman and Gerald Abbott
- Univ of Maryland and MGH

***AJR* 2010 (March);194:562-573**

Lung Cancer Staging
Essentials: The New TNM Staging System and Potential Imaging Pitfalls

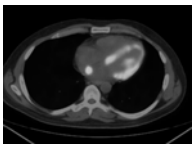
Stacy J. UyBico, MD, et al.
RadioGraphics (September) 2010; 30:1163-1181



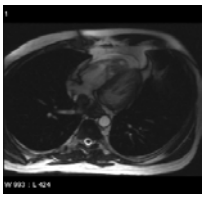
Unusual sites of tumor recurrence

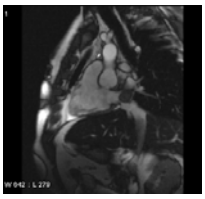
40 y/o male with history of lymphoma.
New mediastinal focus.

40 y/o male with history of lymphoma.

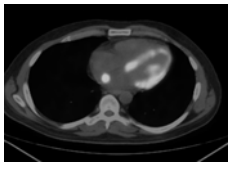


Right atrial mass





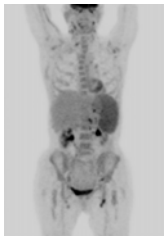
40 y/o male with lymphoma.
New right atrial focus.



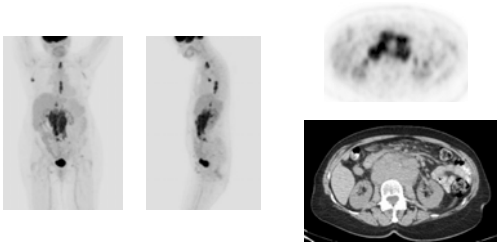
Surgery → lymphoma

Therapy initiated.

66 y/o female with lymphoma.
11 months post more chemotherapy

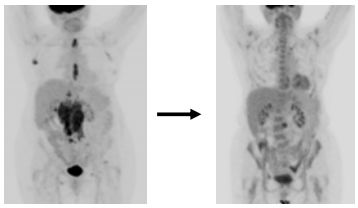


76 y/o female with lymphoma
Initial



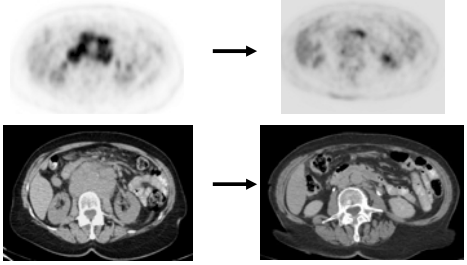
76 y/o female with lymphoma
3 months

Initial 3 mos



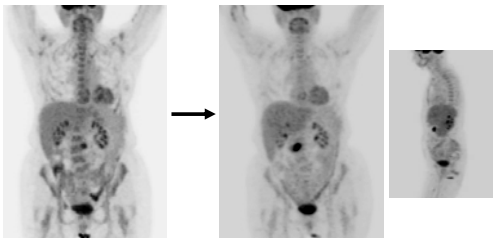
76 y/o female with lymphoma
3 months

Initial 3 months

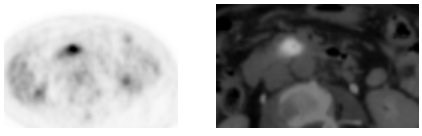


76 y/o female with lymphoma
4 ½ months

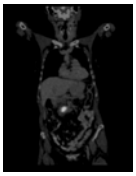
3 mos 4 ½ mos



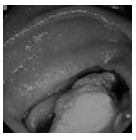
76 y/o female with lymphoma
4 ½ months



76 y/o female with lymphoma

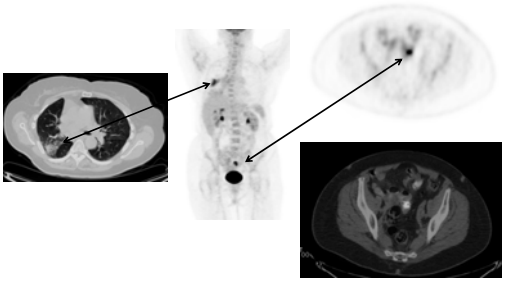


Endoscopic biopsy →
duodenal *adenocarcinoma* arising in villous adenoma

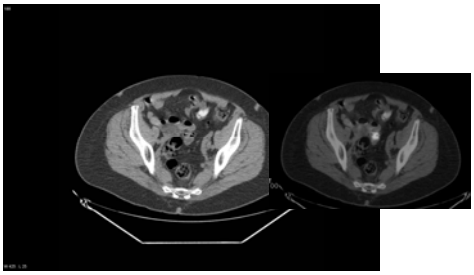


Surgery → duodenal resection

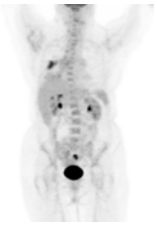
72 y/o female F/U lung cancer.
RUL pneumonia.
Incidental mid-pelvic focus.



Incidental focus with no abnormality on CT.



72 y/o female with lung cancer. Incidental cecal focus with no abnormality on CT.



- Endoscopy → cecal polyp
  - too large to remove
- F/U Surgery → frozen = benign polyp
- Final path = ***TVA with high grade dysplasia and intramucosal adenocarcinoma***

SAM Question

What percentage of pathologically confirmed unexpected findings on PET scans represents either malignant or potentially pre-malignant neoplasms?

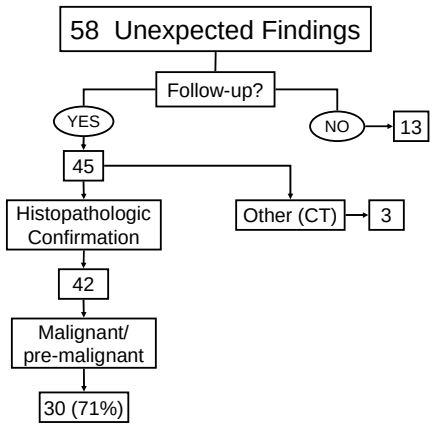
1. 5%
2. 20%
3. 50%
4. 70%
5. 90%

Detection of Clinically Unexpected Malignant and Premalignant Tumors with Whole-Body FDG PET: Histopathologic Comparison

Agress H. and Cooper B.
Radiology 2004 (February); 230:417-422

Unexpected FDG Findings

- Examined 1750 dedicated FDG-PET scans to determine the significance of unexpected hypermetabolic foci



SAM Question

What percentage of pathologically confirmed unexpected findings on PET scans represents either malignant or potentially pre-malignant neoplasms?

1. 5%
2. 20%
3. 50%
4. ***70%***
5. 90%

Follow-up Documentation

- For PET/CT and now all important unexpected findings.
- Installed service which documents that ordering physician received notification (phone, fax, email, PDA, etc.).
- Better patient care and decreases potential litigation.

Summary

Ideas and approaches to fine tune your PET/CT practice

- Consistent and definitive interpretation
- Full evaluation/correlation of both PET and CT
- One-on-one communication
- Follow-up of subtle and unexpected findings
  - Builds confidence in PET/CT interpretation
  - Makes PET/CT more intellectually stimulating

Reward

PET/CT provides the ability to have major impact and personal involvement in better patient management and care.

The End