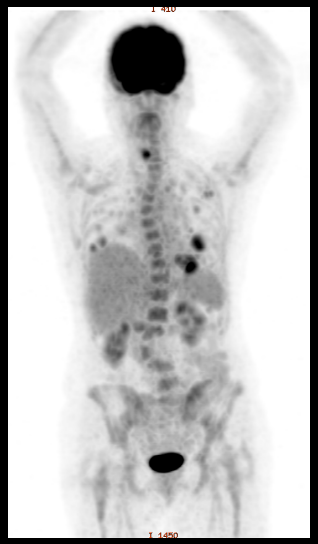
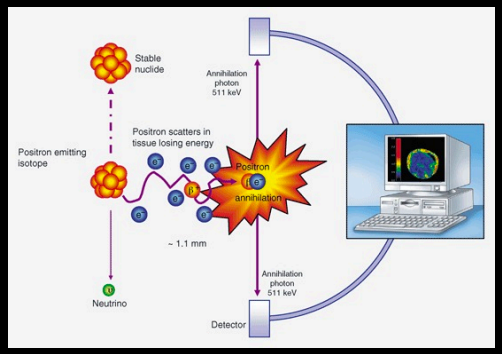
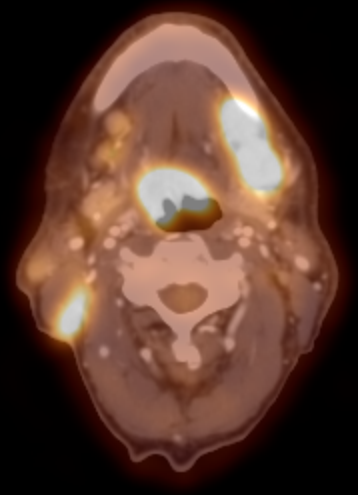
Precision imaging of cancer using positron emission tomography







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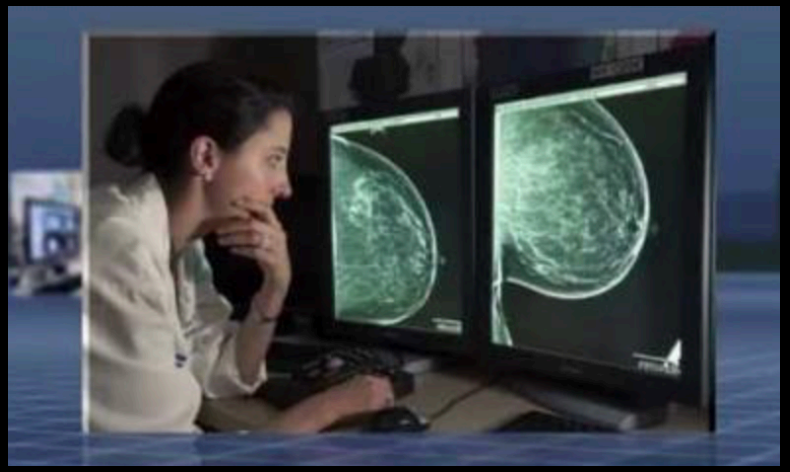
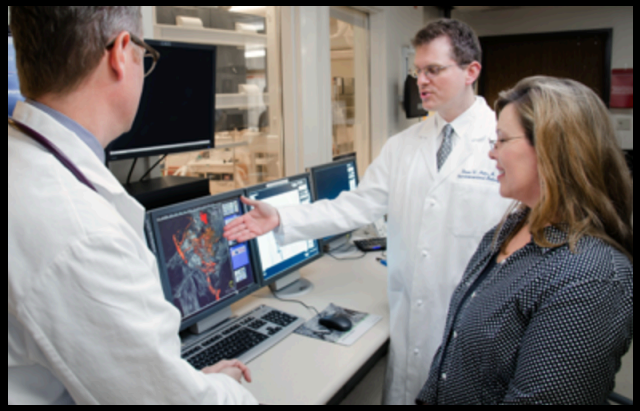
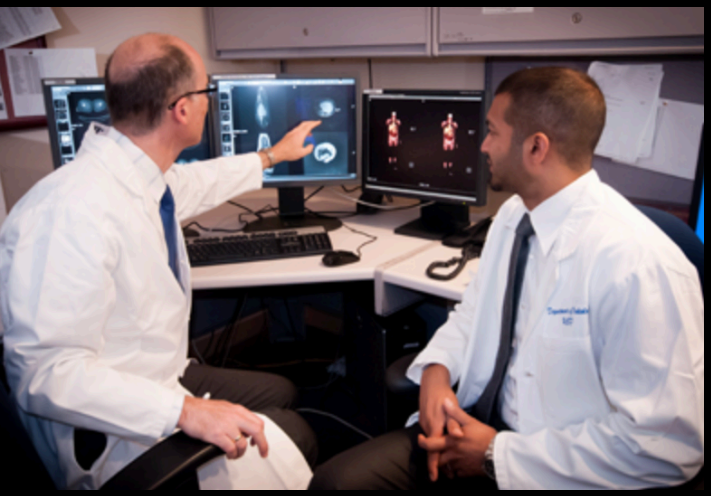
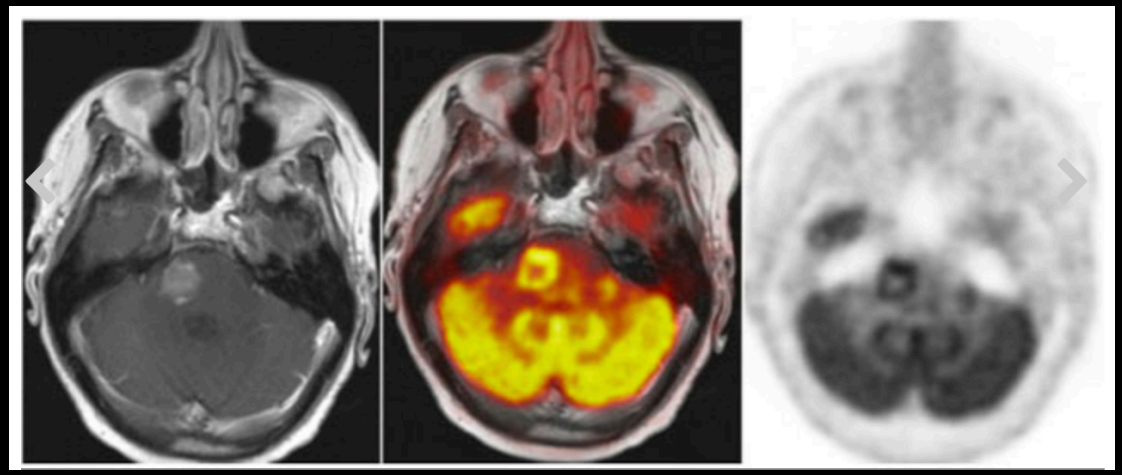
Previous image result









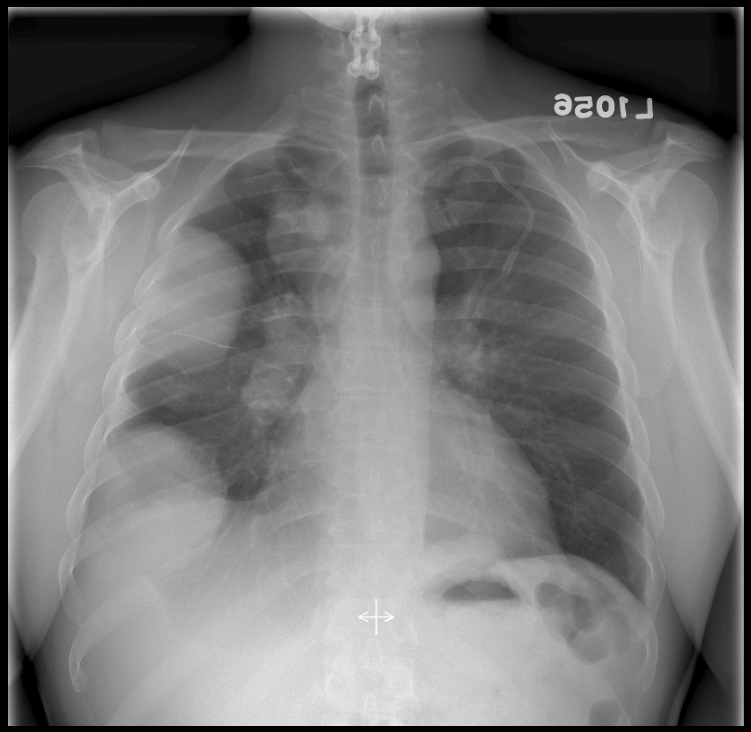
Imaging in cancer

- Radiology is an integral part of modern medicine
- In no area is this more important than oncology
- Imaging allows us to see inside the body, detecting abnormalities underlying symptoms and diseases, and lets us monitor response to therapy

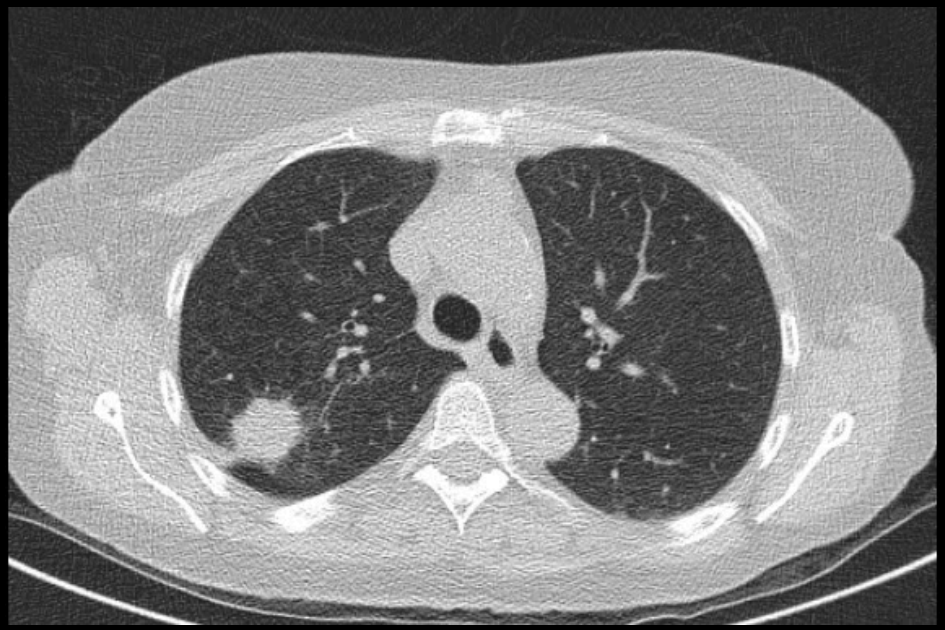
Tonight's lecture outline

- Review the development of oncologic imaging leading to the development of positron emission tomography
- Illustrate fluorodeoxyglucose (FDG) PET technique, and what happens behind the scenes
- Discuss how PET scans matter to patients and what the results can show

Imaging in cancer

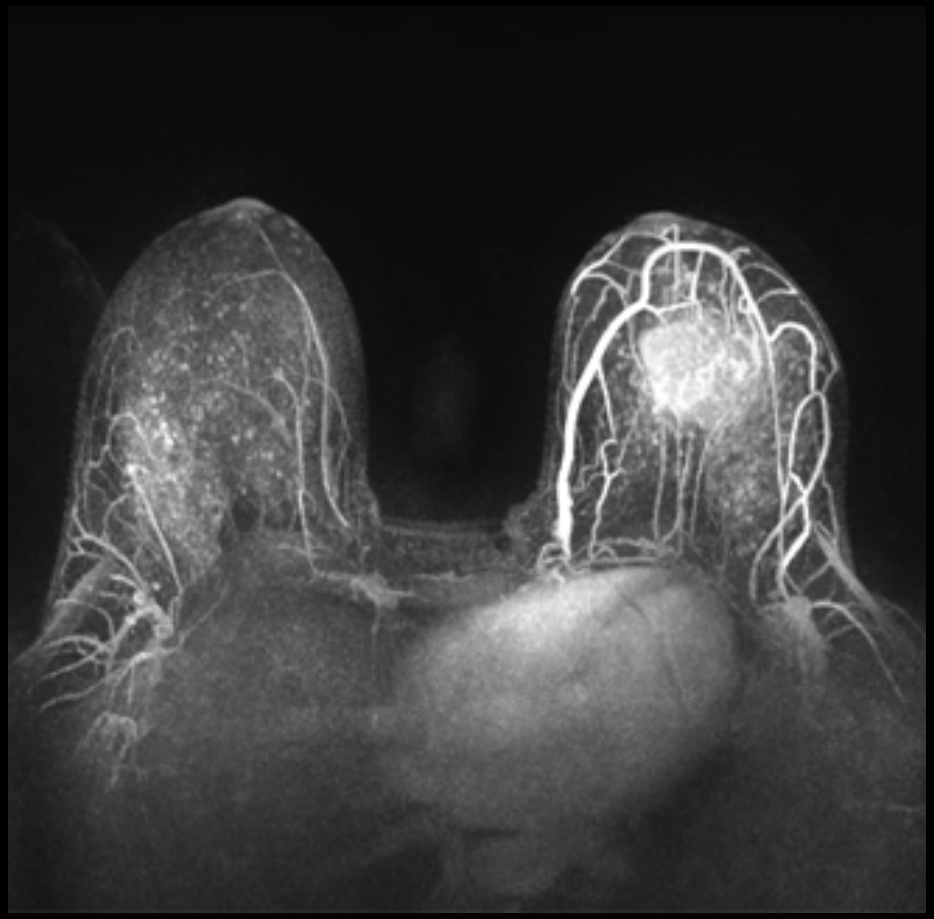


1920's
Chest X ray:
lung masses



1970-80's
CT:
lung cancer

Imaging in cancer



1980 – 90's: MRI – breast mass

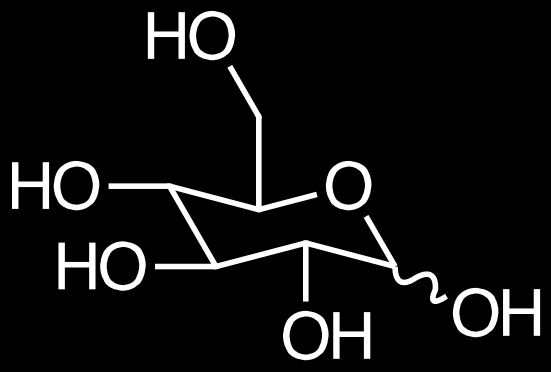
Structural vs. functional imaging

- All these images have features in common: they see alterations in tissue structure
- However, changes in metabolism or tissue function often come before gross alterations in tissue structure
- For this reason, metabolic or functional imaging can be more sensitive for detecting or following response to treatment in cancer

Altered metabolism in cancer

- Cancer cells have profound alterations in metabolism that let them survive in an organism that would like to destroy them
- One of the most well known changes is called the "Warburg Effect" after Otto Warburg
- "Cancer, above all other diseases, has countless secondary causes. But, even for cancer, there is only one prime cause. Summarized in a few words, the prime cause of cancer is the replacement of the respiration of oxygen in normal body cells by a fermentation of sugar"

FDG-PET – imaging the Warburg Effect



Glucose

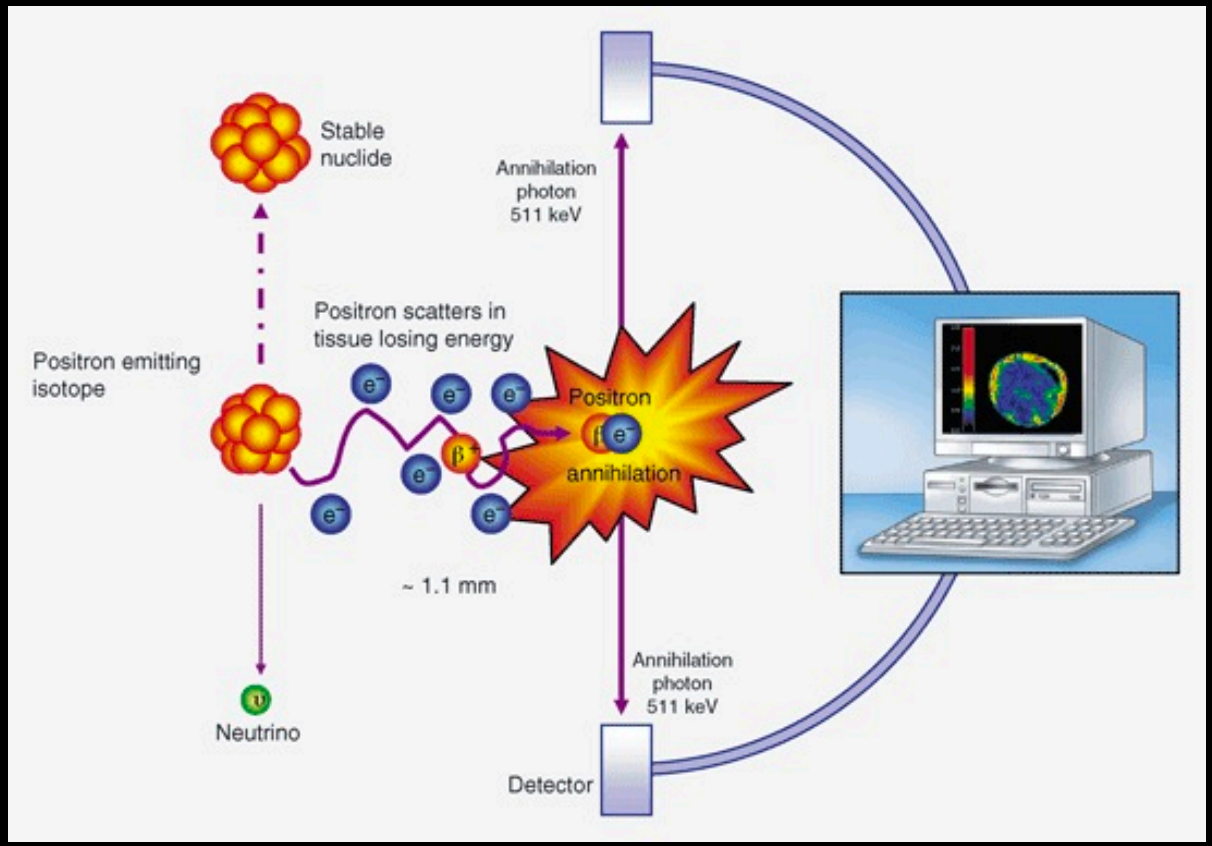
How to image?

Image label on F atom (^{18}F)

1980-90s

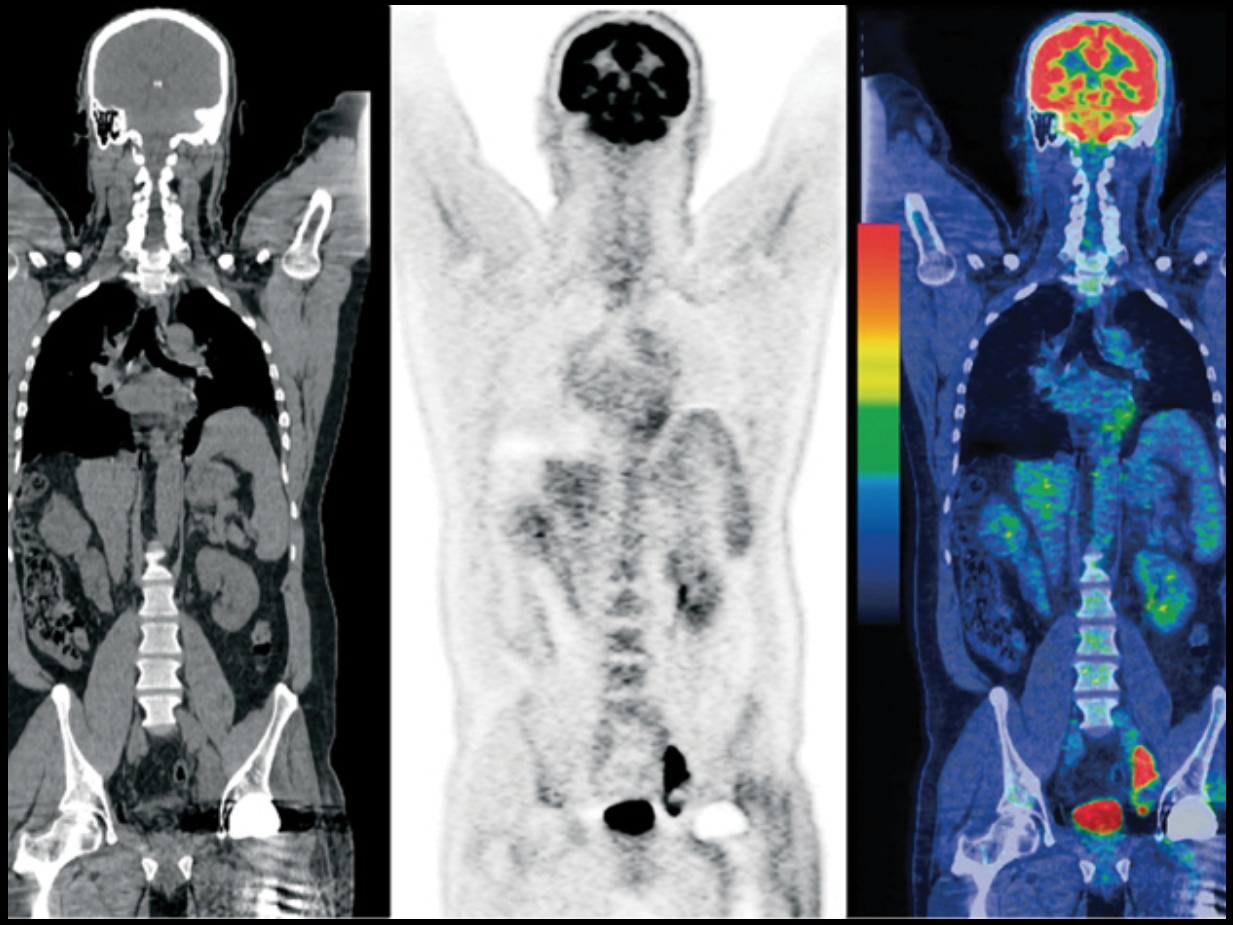
Positron emission tomography

Positron emission tomography or “PET” lets us visualize the biodistribution of an administered radiopharmaceutical



1980-90s

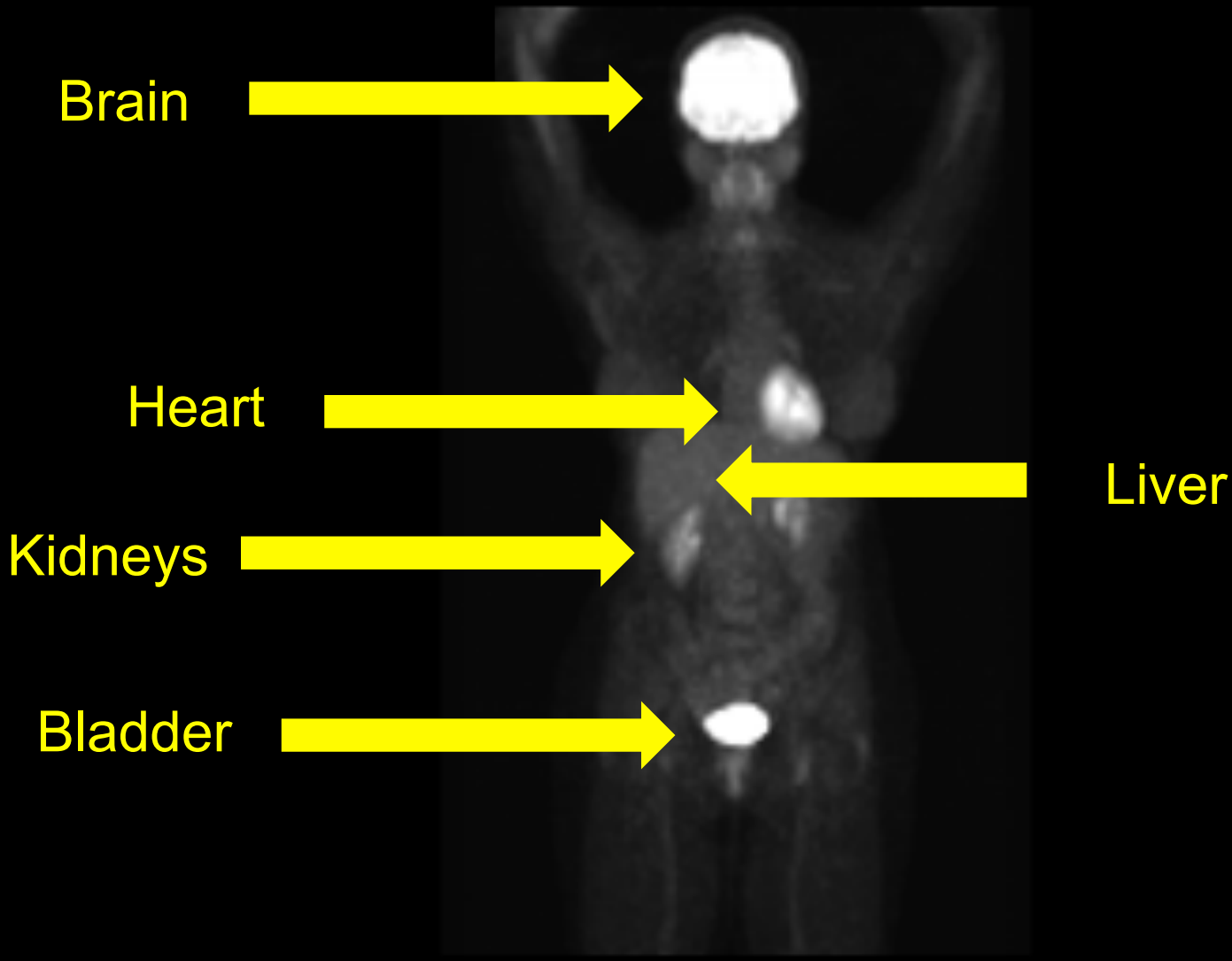
PET/CT and PET/MRI – the final part of the puzzle



PET/CT – 00's PET/MRI – last 5-10 years

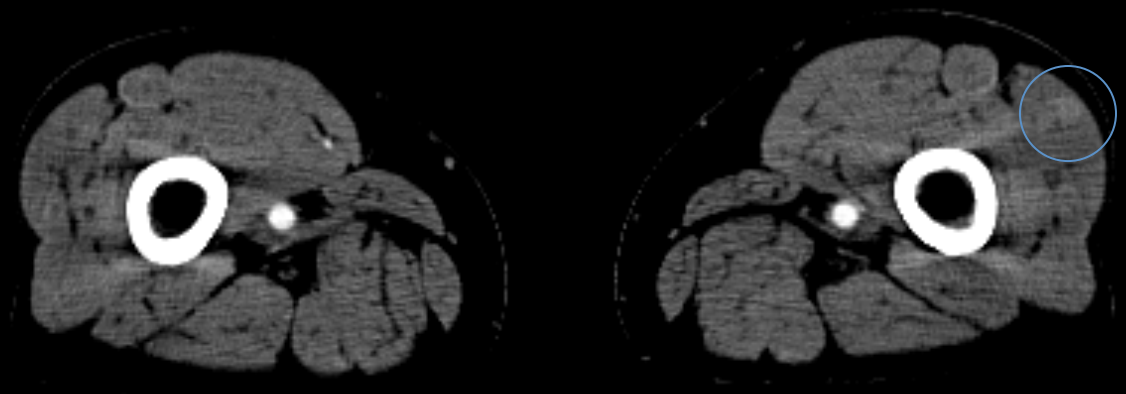

SIEMENS

FDG PET

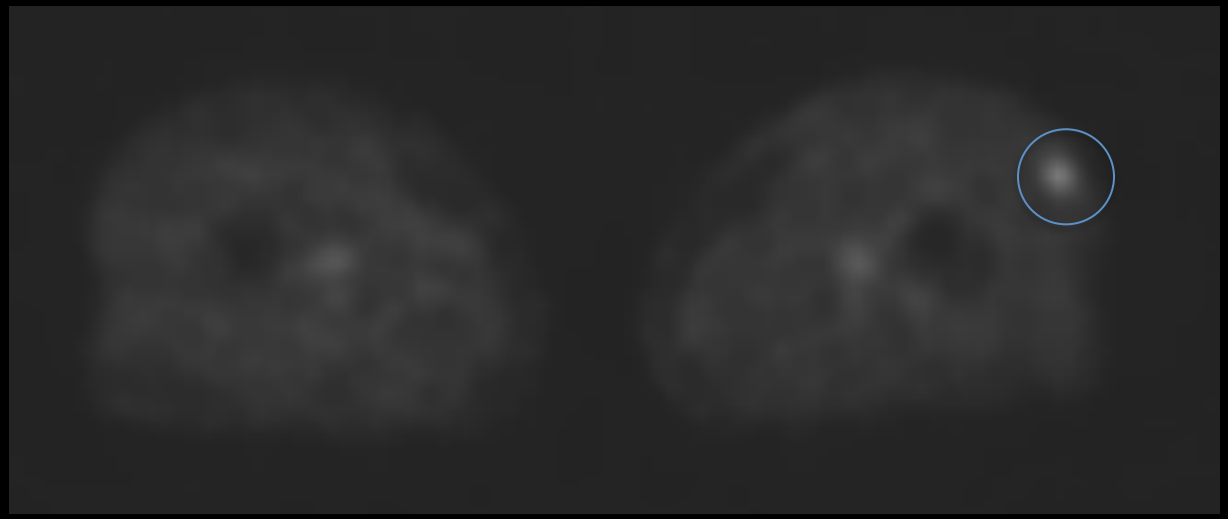


Example: Added value of PET

70 yo M with melanoma in remission



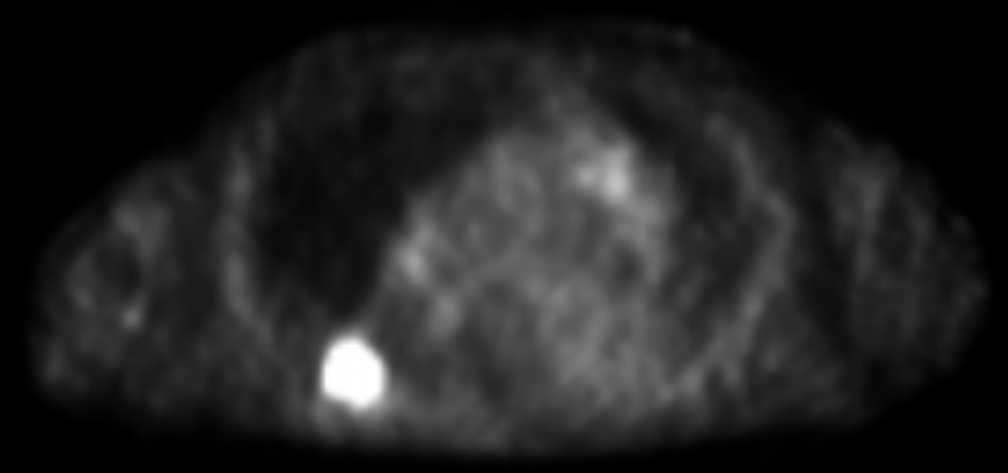
Finding?



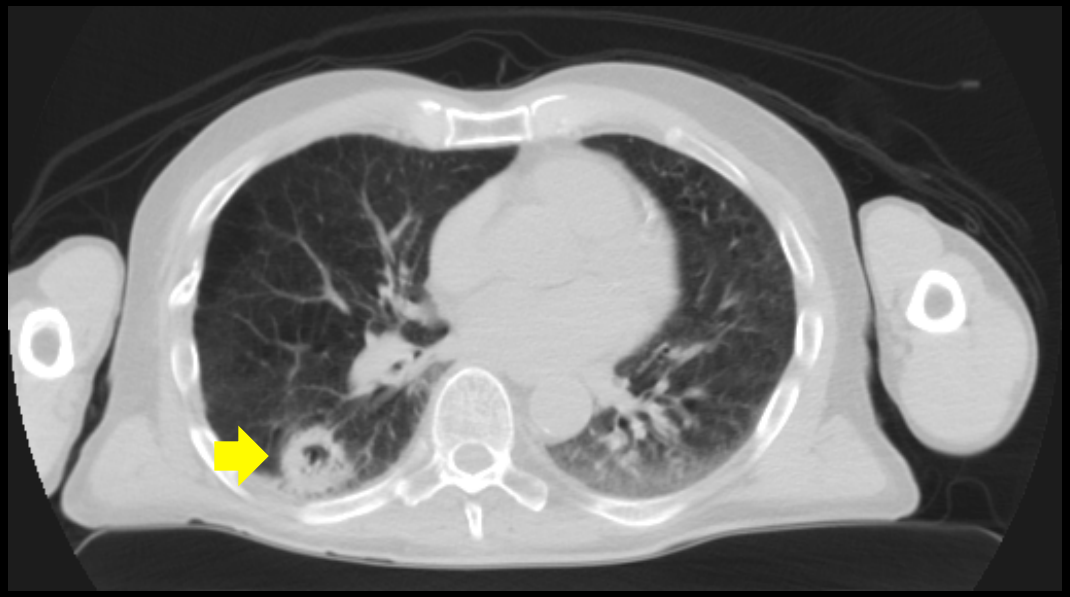
Diagnosis:

New skeletal muscle metastasis

Example: Added value of CT



Where is this mass located?
-Lung
-Rib
-Pleura
-Chest wall

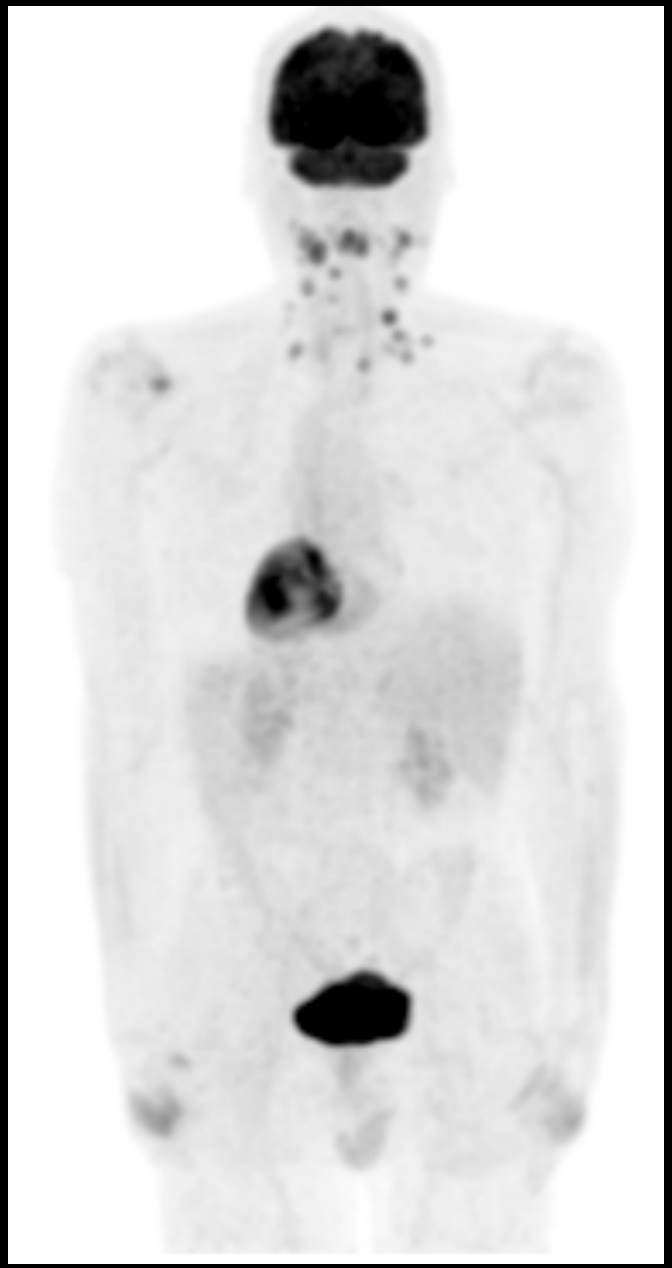


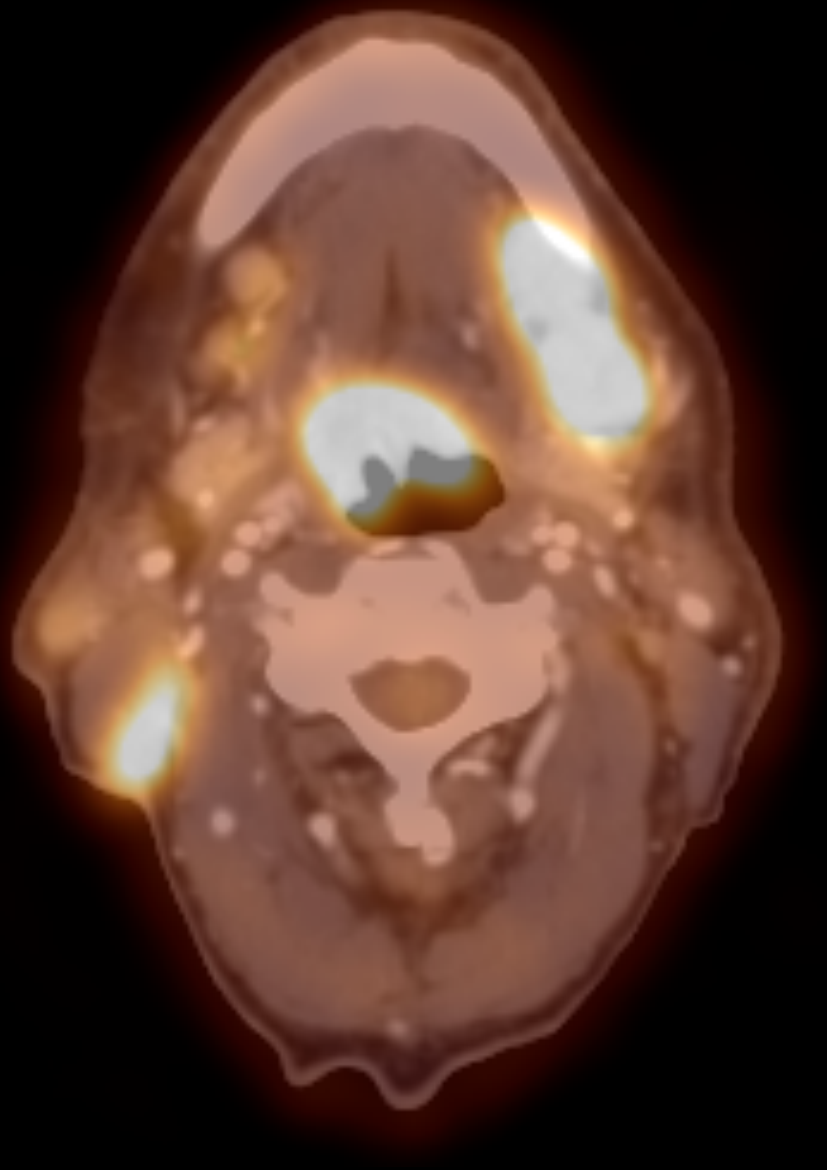
Clinical utility of FDG PET

- Initial staging
- Restaging and monitoring response to therapy
- Surveillance in patients with a history of cancer

Patient scenario: Initial staging

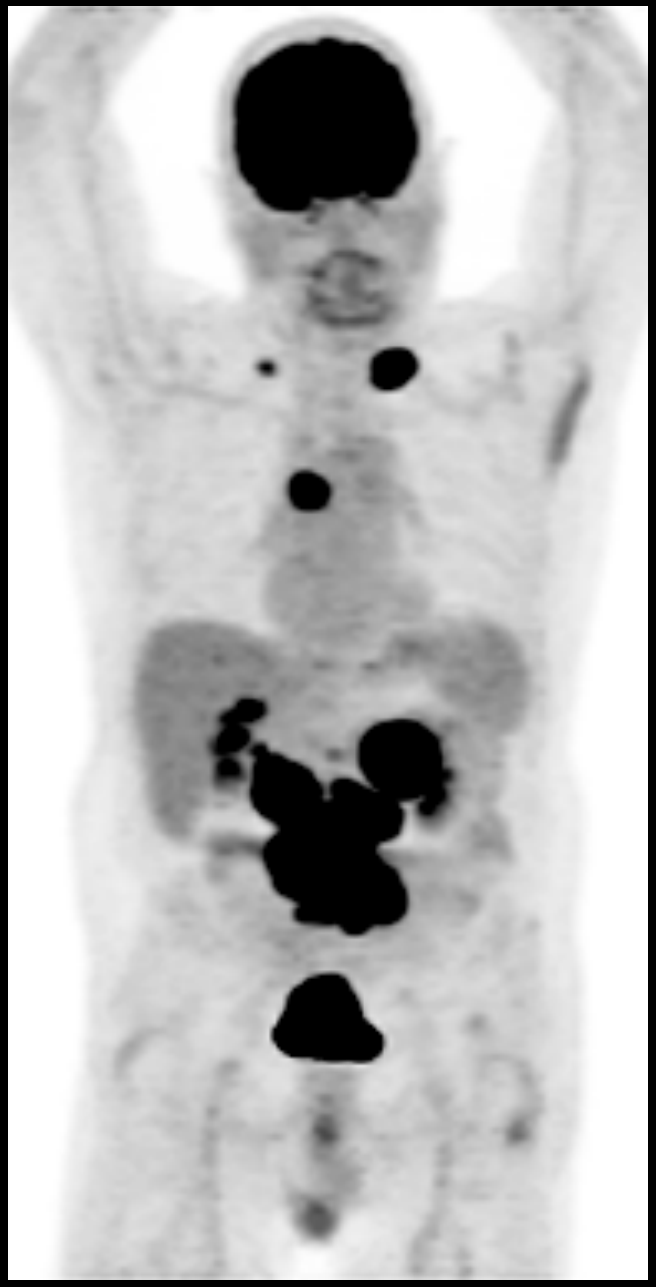
A 67 year old man with a history of smoking was referred to head and neck surgery for enlarging masses in his neck. On exam, the patient had firm palpable masses in his neck consistent with enlarged lymph nodes. Biopsy of a lymph node demonstrated squamous cell cancer.

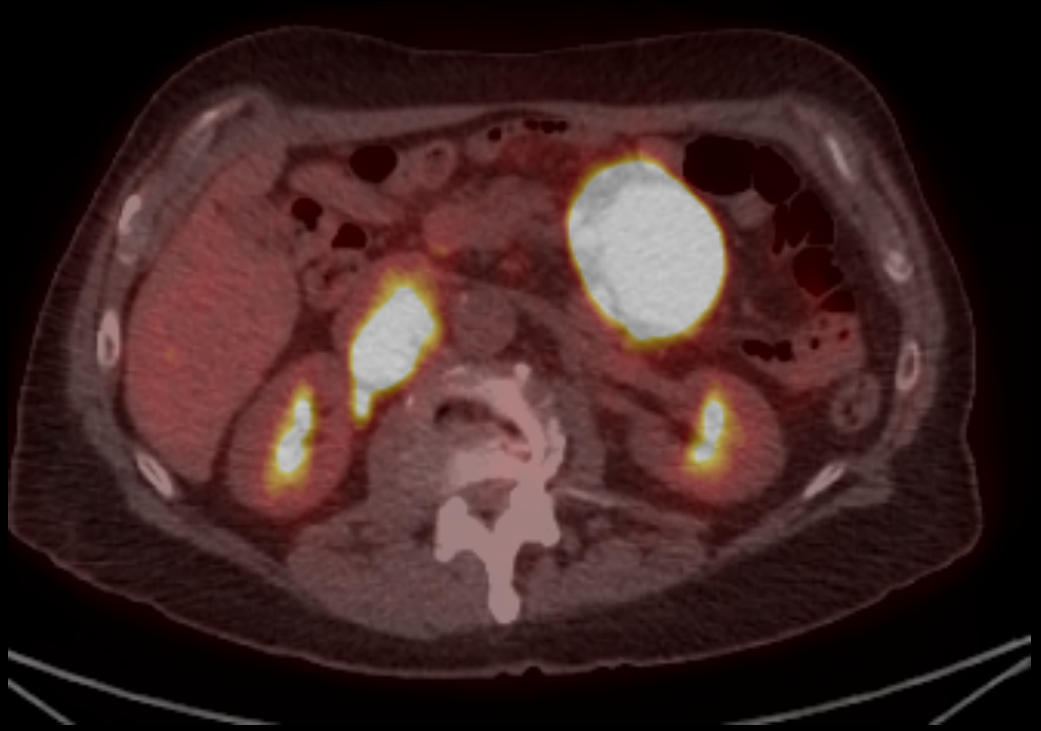




Patient scenario: monitoring response to treatment

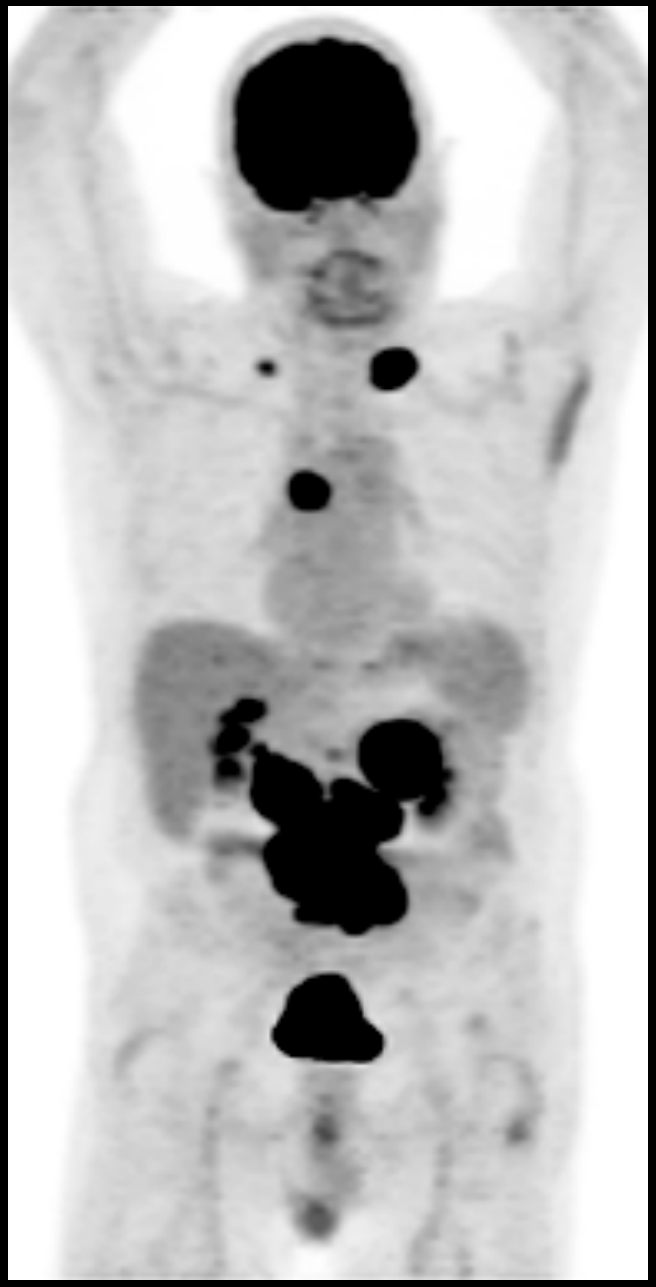
An 86 year old man presented to his primary care doctor with complaints of weakness, fatigue, fevers, night sweats and abdominal bloating. An abdominal CT demonstrated abdominal masses concerning for malignancy. CT guided biopsy then demonstrated high grade diffuse large B-cell lymphoma.

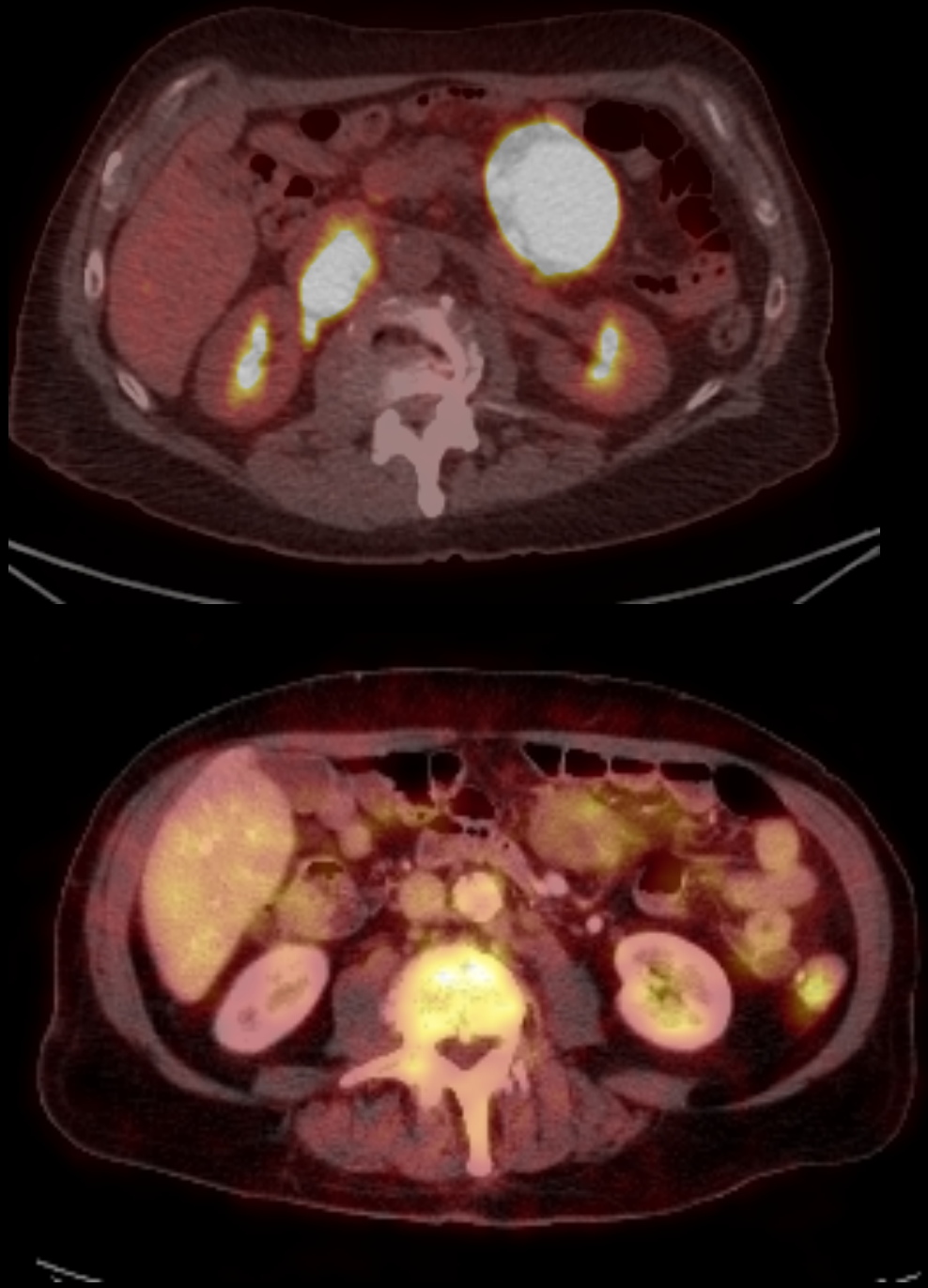




Patient scenario: monitoring response to treatment

Based on aggressive histology and molecular markers as well as widespread disease on PET/CT, the patient was treated with an aggressive chemotherapy regimen. He felt better after six cycles of chemotherapy.



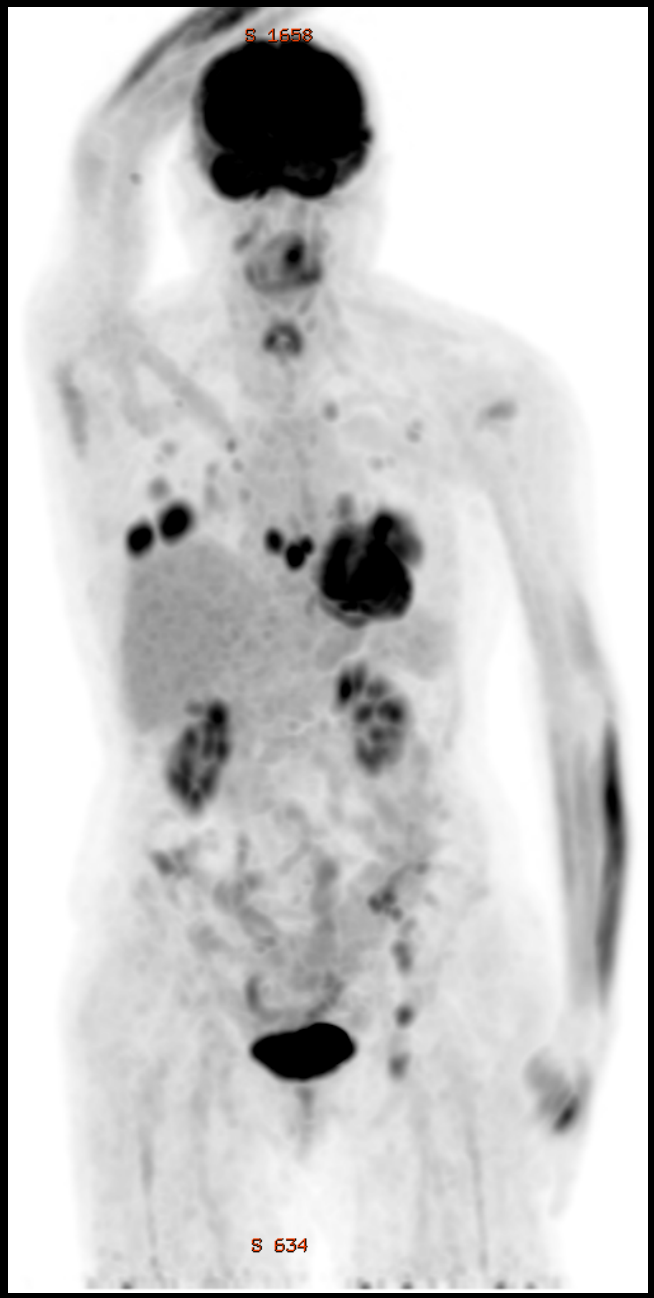


Patient scenario: monitoring response to treatment

A 64 year old woman with a longstanding history of metastatic breast cancer was placed on a clinical trial for management of metastatic disease to bones, lungs, and brain.

As part of the clinical trial, she underwent an initial and follow up PET/CT.


I 410
I 1450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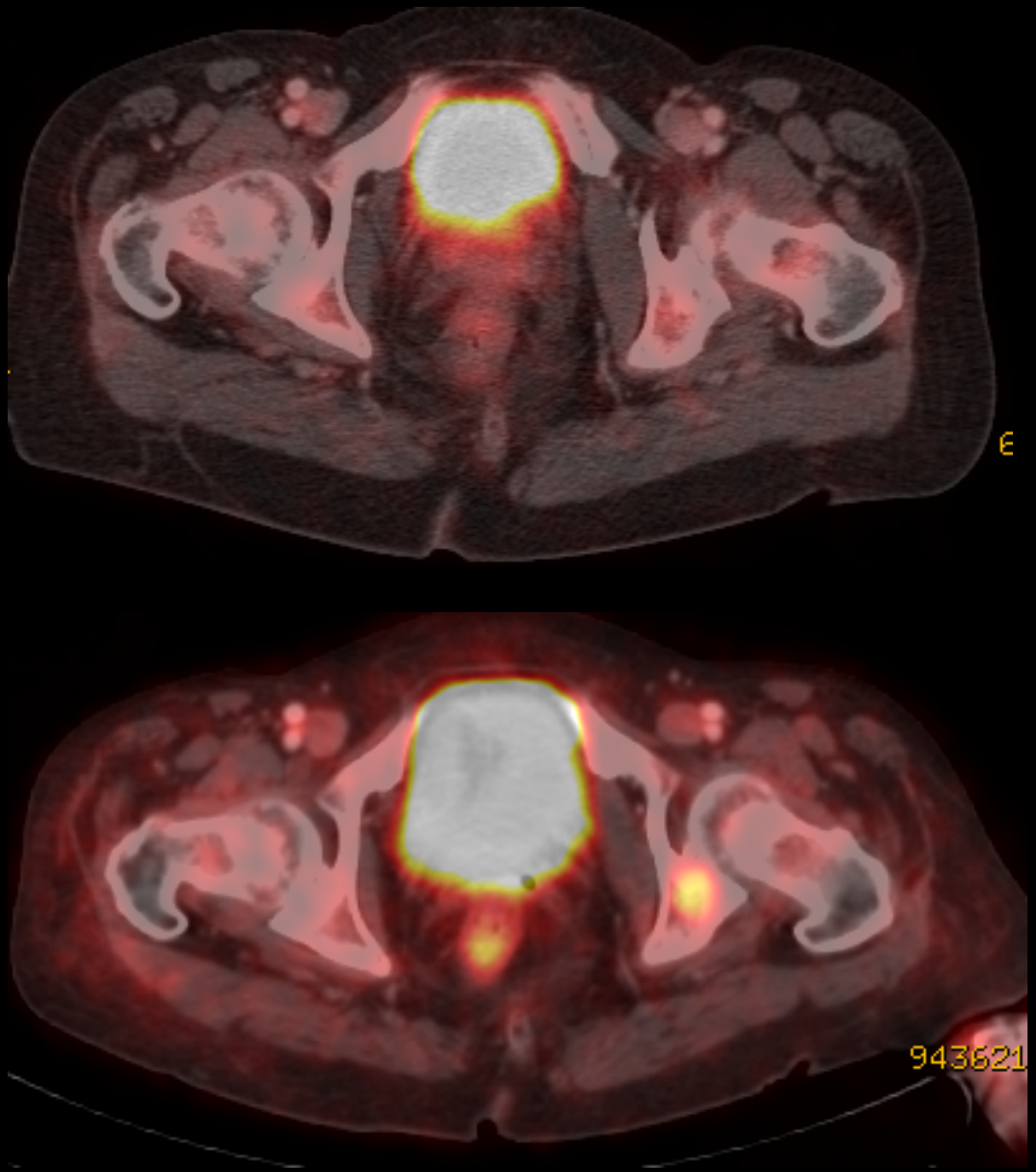
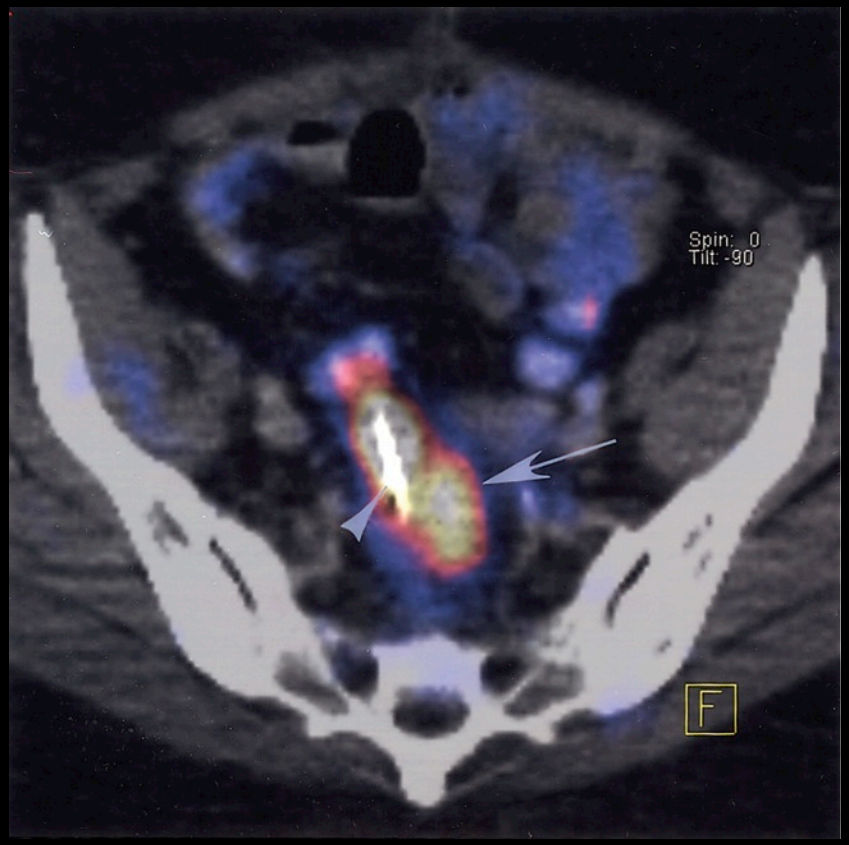


Patient scenario: Surveillance

A 55 year old woman with history of colon cancer presents to her oncologist's office for routine surveillance, six months after hemicolectomy. She is asymptomatic. A CT scan performed two weeks ago demonstrated postsurgical changes but was otherwise unremarkable.

55-year-old woman with colon cancer status post resection



Recurrent colon cancer

Cancers in which FDG PET works well

- Lung
- Breast
- Melanoma
- Colorectal
- Esophageal
- (high grade) lymphoma
- Head and neck squamous cell cancer
- High risk, undifferentiated subtypes of other malignancies

Key take home points

- Metabolic and functional imaging can improve sensitivity for detecting cancer and response to treatment
- PET/CT was developed over 80's – 00's and was a result of key technological developments in engineering, physics, and chemistry
- PET/CT is now the gold standard method for imaging and studying response to therapy in many of the common cancers

Thank you
for your
attention!