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PET Scanning for Malignant Melanoma: An Evidence Based Approach

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Patient SW

- 40 yo woman s/p melanoma resection on right arm, who presented in 1999, one year after chemotherapy and radiation, with a subcutaneous nodule and mass in her right axilla.
- Biopsy of the nodule indicated melanoma recurrence.
- Chest CT scan reported as "irregular soft tissue density in right axilla, . . . Presumed due to post-surgical change. Metastatic melanoma, however, cannot be excluded."
- Head, abdomen, and pelvic CT scans were unremarkable.

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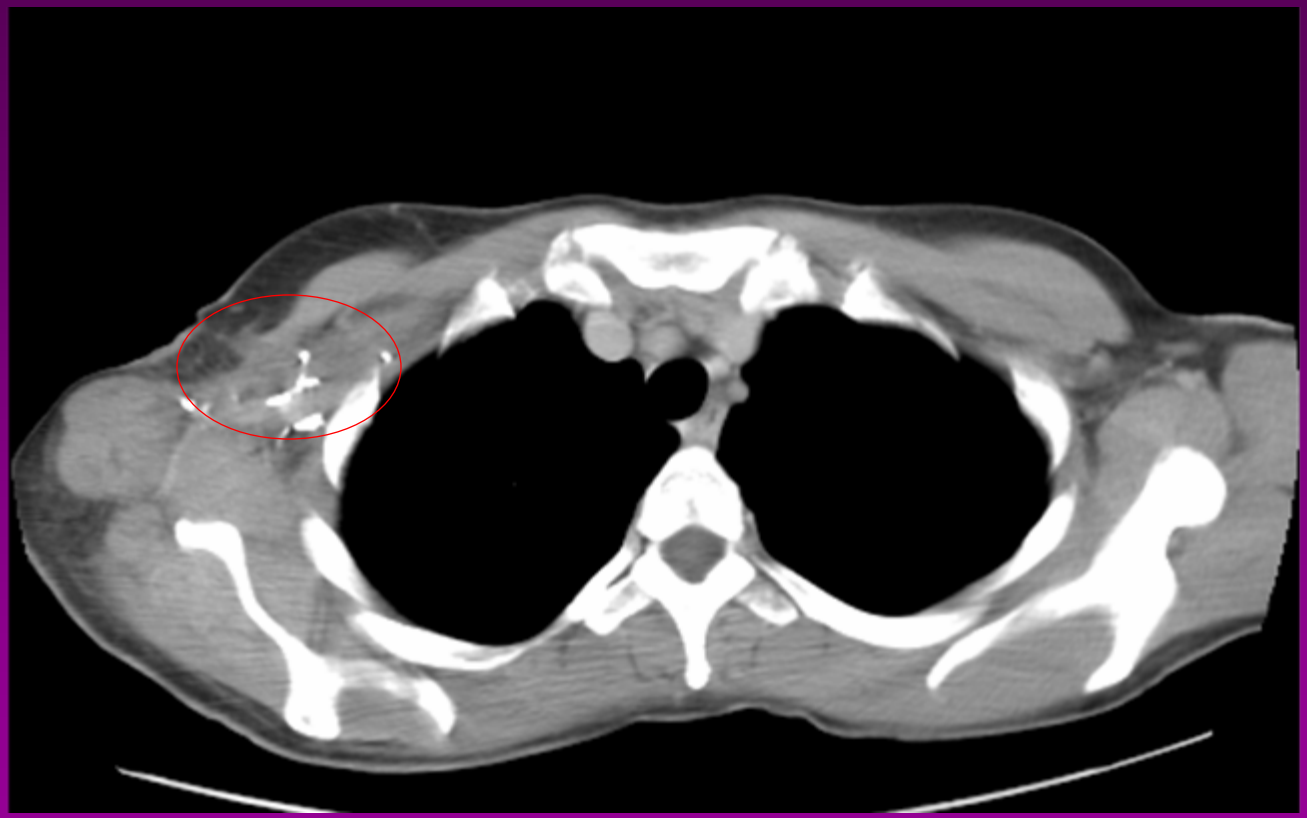
CT Scan of SW Left Unanswered Questions:



BIDMCPACS

- Residual tumor or scar?
- Any metastases?

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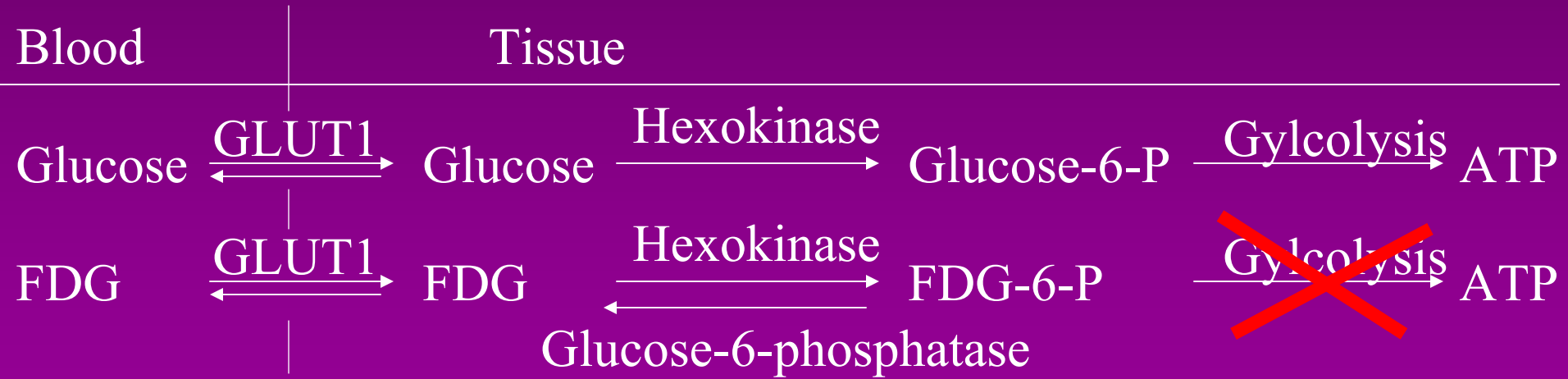
FDG-PET Shows Metabolism?

- FDG (2-^{18}F-2-deoxy-D-glucose) accumulates in cells that take up glucose but do not have glucose-6-phosphatase.



- Many malignant cells rely mostly on glycolysis and usually lack glucose-6-phosphatase.

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Physiologic Positives with PET

- Brain and myocardium always positive, particularly in a fed state
- Muscle that has been recently exercised
- Excreted FDG in urinary system
- GI system: lymphoid tissue or activity
- Lactation
- Thymus
- Epiphysis
- Post-chemotherapy bone marrow hyperplasia

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Other False Positives

- Inflammation
  - Post-surgery, post-radiation, or post-chemotherapy
  - Infection
  - Auto-immune
  - Stoma
  - Injury
- Benign neoplasms

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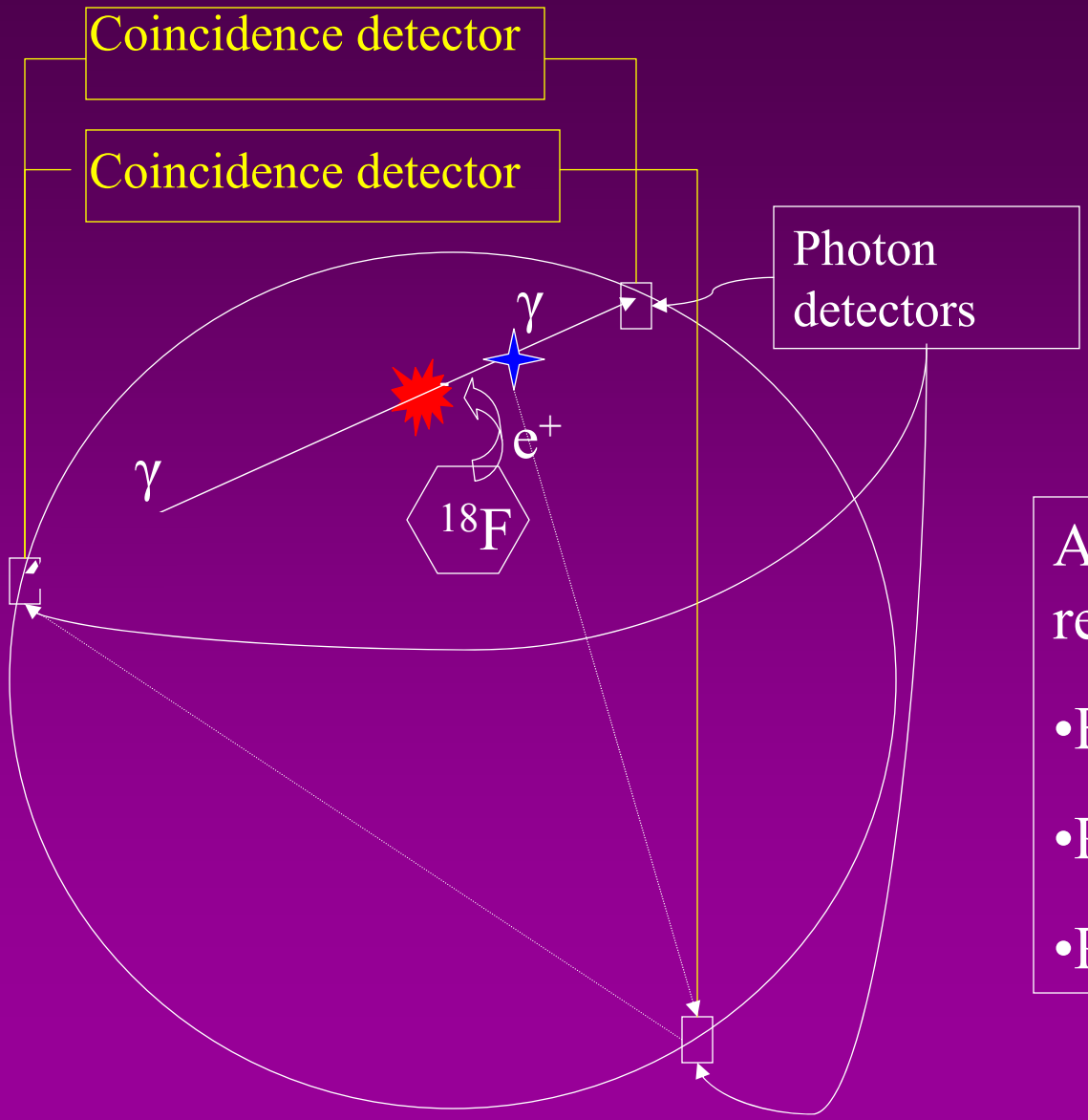
Detection of FDG



Accuracy and resolution depend on:

- Electron density
- Photon scatter
- Photon attenuation

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Detection of FDG

A Gamma Camera

http://radiology.bidmc.harvard.edu/kinds_of_exams/nuclear/nucmed.html

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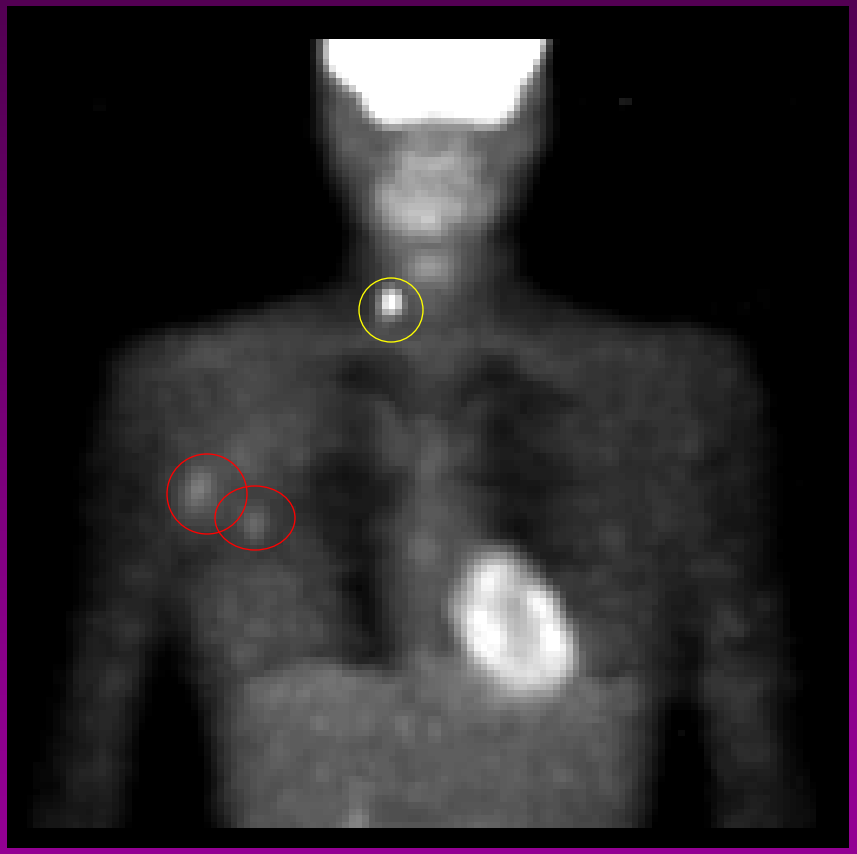
PET Scan of SW



Courtesy of Dr. Kevin Donohoe, BIDMC

- There are two positive areas in the right axilla and one positive area in the right neck.
- These are all melanoma.

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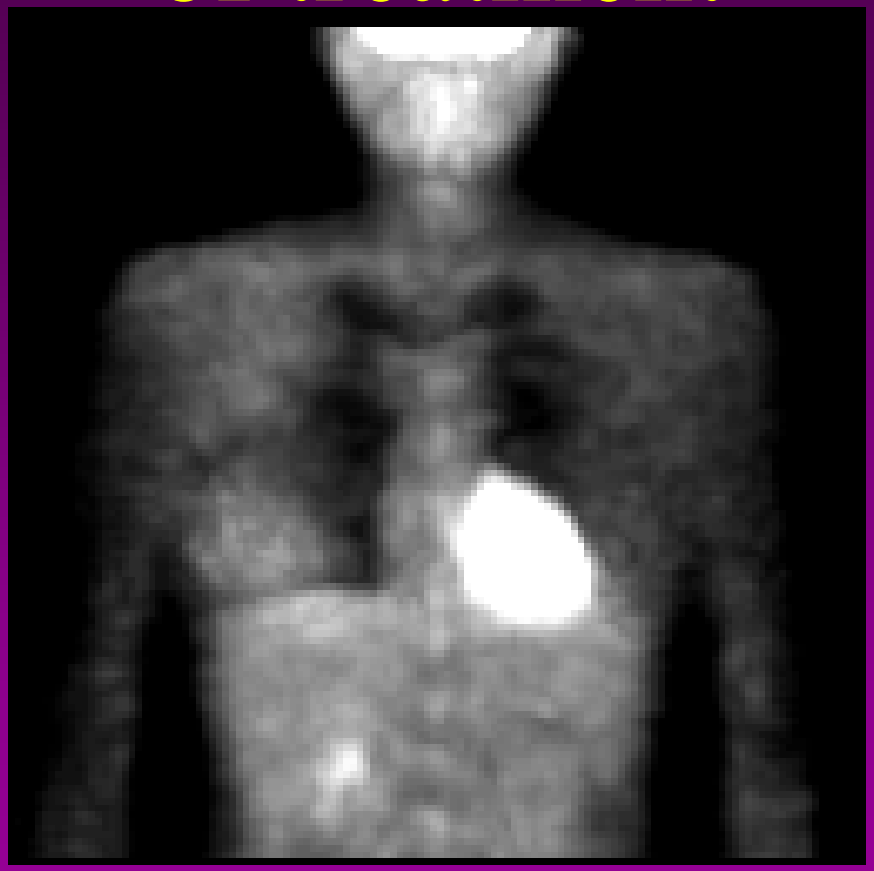
PET Scan of SW after 4 months of treatment



Courtesy of Dr. Kevin Donohoe, BIDMC

- CT scan at same time showed no change in size.
- PET scan shows no evidence of active tumor cells.

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PET vs. CT

PET	CT
• Physiologic resolution	• Anatomic resolution

•How do you decide which to use?

•How do you assess a new imaging technology?

New Technology Assessment

1. Technical Performance
2. Diagnostic Performance
3. Diagnostic Impact
4. Therapeutic Impact
5. Impact on Health

Diagnostic Study Design

- The imaging technique under study must not influence the final diagnosis
- The final diagnosis should be based on a gold standard, particularly pathological.
- The final diagnosis and/or results of competing modalities should not influence imaging interpretation.
- Imaging should be performed in the environment in which it will be used.
- Uninterpretable test results must be reported.
- Subject number should be chosen for statistical reasons.

Technical Performance

- Does PET produce high quality images that are reliable and valid?
  - Resolution
  - Reproducibility
  - PET-Histology Correlation

- A number of studies have shown that PET can reliably show the uptake of FDG with a resolution of about 4 mm.
- Melanoma cells take up and retain FDG

Diagnostic Performance

- Do PET images allow accurate diagnoses to be made?
  - Sensitivity
  - Specificity
  - Positive predictive value
  - Negative predictive value
- There is only one published study comparing PET and a gold standard in an independent, blinded fashion.
  - Sensitivity 85%; Specificity 92%
- Recent meta-analyses found sensitivity to be 78% (CI =70-84%) and specificity to be 88% (CI = 82-92%) for whole body and sensitivity to be 55% (CI = 40-71) for regional lymph nodes.

Diagnostic Impact

- Does PET change diagnoses and reduce the need for other tests?
  - Randomized trial with and without PET would be ideal but unlikely
  - Compare testing plans before and after PET
  - Measure diagnostic confidence before and after PET
- One complete, prospective study reported completely: PET changes stage in 22% of cases of metastatic melanoma.

Therapeutic Impact

- Do PET results change therapy?
  - Assess treatment plans with and without PET
- One complete, prospective study reported completely: PET changes management in 22% of cases of metastatic melanoma.
  - Surgery is not used if PET indicates that distant lesions are not metastases or if PET indicates need for systemic therapy because of multiple metastases (as in SW)
- Because of these changes, PET has been estimated to save about $1800 per scan in Stage II and III melanoma.

Impact on Health

- Does PET impact positively on people's health?
  - Increased survival
  - Increased quality of life
- No studies.

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