

FDG PET and PET•CT in the Evaluation of Lymphoma Part I

FDG PET and PET•CT in Lymphoma

Part I

- Lymphoma general epidemiology
- FDG PET in detection of lymphoma
- FDG PET vs conventional imaging in detection
- FDG PET in initial staging of lymphoma
- FDG PET vs conventional imaging in staging
- FDG PET and detection of extranodal disease
- FDG PET vs conventional imaging in extranodal disease
- FDG PET and detection of bone marrow involvement

Source: This presentation contains a comprehensive summary of published data for FDG PET and PET•CT in lymphoma and was provided by Dr. Rick Black, Cleveland, OH

Lymphoma : General epidemiology

Lymphoma: General epidemiology

Non-Hodgkin's Lymphoma

- 5% of all cancer cases
- 80% of all lymphomas
- Increasing number of non-Hodgkin's lymphoma cases in the U.S.
 - 3-4% increase annually for past three decades
- 55,000 to 60,000 new cases annually
- 24,000 deaths per year

Hodgkin's Lymphoma

- Much less common than NHL
- 20% of all lymphomas
- 7,500 – 8,000 new cases annually in U.S.

Non-Hodgkin's Lymphoma: Disease subgroups

Non-Hodgkin's lymphomas

- Low grade lymphoma
 - Accounts for 40% of new cases
 - Generally associated with low rates of metabolism
 - FDG uptake may be minimal
 - Residual disease has 10-12 year survival
 - Role of PET: Patients who convert to high grade subtype
- Intermediate grade lymphoma
 - Accounts for 40% of new cases
 - Extranodal disease common
 - Role of PET: Define extent of disease and treatment response
- High grade lymphoma
 - Accounts for 5-10% of new cases
 - Survival may be measured in weeks
 - Role of PET: Define extent of disease and treatment response

Hodgkin's Disease

- Almost always arises from a single node or nodal chain with characteristic spread to anatomically contiguous nodes; extranodal disease uncommon
- Cell type and stage at presentation determine:
 - Choice of treatment regimen
 - Patient outcome and prognosis
- Extent of disease and tumor burden are the most important prognostic factors:
 - Influences likelihood of relapse and total survival
- Conventional anatomic imaging modalities may underestimate the extent of subdiaphragmic nodal disease
- Accurate staging necessary to facilitate proper treatment

Source: Hoh et al, J Nucl Med 1997; 38: 343 and Moog et al, Radiology 1998; 206: 475

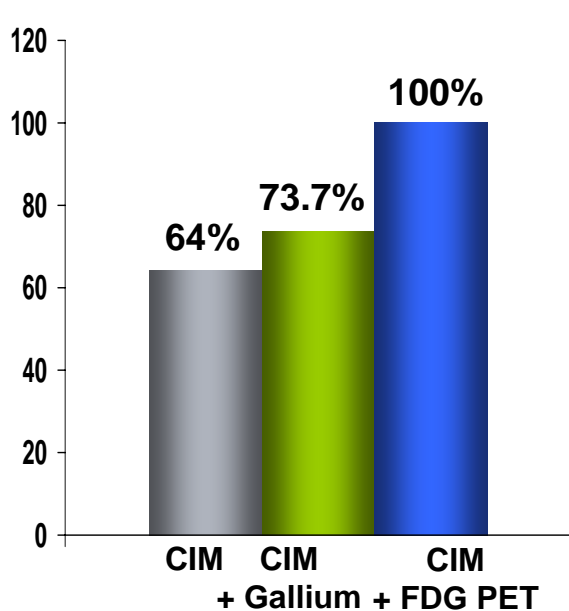
FDG PET in the detection of lymphoma

Detection lymphoma: PET vs. conventional imaging and gallium scintigraphy

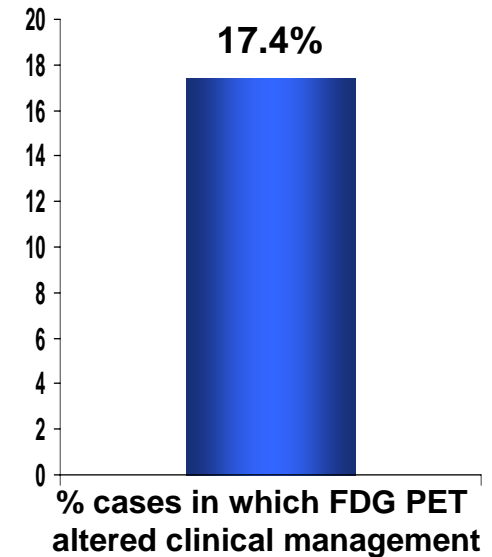
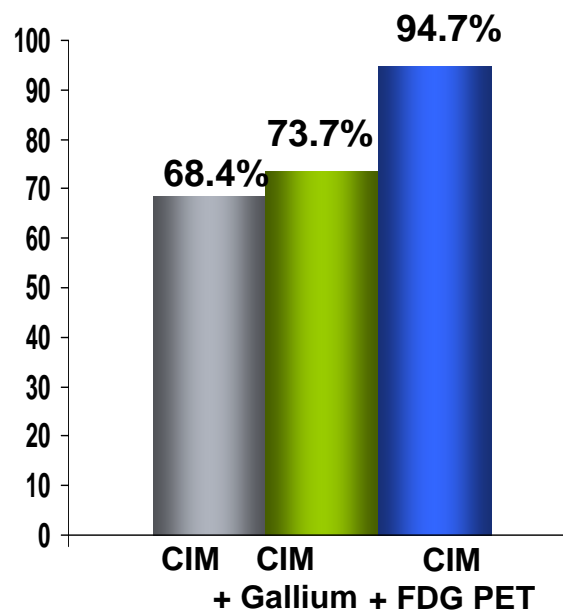
FDG PET combined with CT shows highest detection rate

46 pts with diagnosed lymphoma (42 initial and 4 recurrent) studied with FDG PET, CIM (CT, MRI, US and conventional radiologic procedures) and gallium scintigraphy

Sensitivity for detection of nodal foci disease



Sensitivity for detection of extranodal foci of disease



Source: Sasaki et al, Ann Nucl Med 2002; 16: 337 Kyushu University, Fukuoka Japan

FDG PET in the initial staging of lymphoma

Staging lymphoma: Conventional approaches

- Contrast enhanced CT is the initial staging imaging modality for patients with lymphoma

(Schaefer et al, Radiology 2004; 232: 823)

- Morphologic changes allow for CT detection of disease involvement CT limited in detection of spleen, liver and marrow involvement

(Delbeke and Martin, Radiol Clin North Am 2001; 39: 883 Carr et al, Blood 1998; 16: 603)

- Bone marrow aspiration and biopsy for detection of bone marrow disease in lymphoma is:

Limited by sampling error

Lymphomatous changes present in 22-30% NHL patients

(Juneja et al, J Clin Pathol 1990; 48: 630)

- Bone scintigraphy unreliable for marrow disease
- WB MRI imaging not yet established as a routine for identification of marrow disease

(Althehoefer et al, J Clin Oncol 1997; 15: 1754)

FDG PET in detection & staging of nodal disease

- FDG PET high sensitivity for detection of abnormal lymph nodes

(Hoh et al, J Nucl Med 1997; 38: 343)

- FDG PET identifies virtually all of abnormal lymph nodes on CT
- Small mesenteric lymph nodes missed with CT generally seen with FDG PET

(Moog et al, Radiology 1997; 203: 795)

- FDG PET more accurate than CT in staging lymphoma
 - Detects additional lesions (nodal and extranodal)

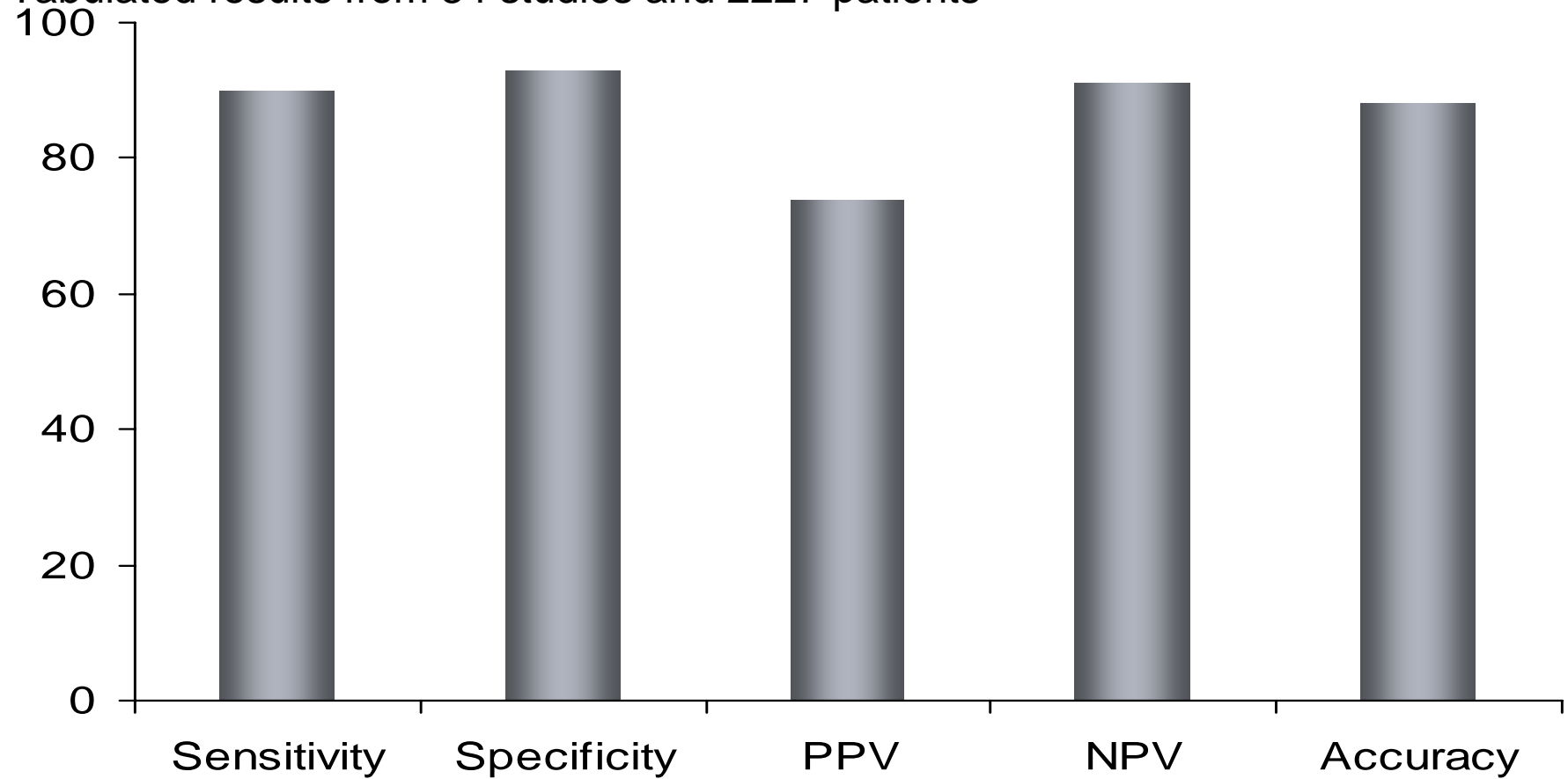
(Römer et al, Clin Pos Imag 1998; 1: 101)

- FDG PET may result in 8 - 44% change in patient stage

(Moog et al, Radiology 1997; 203: 795)

Staging of lymphoma: FDG PET statistics

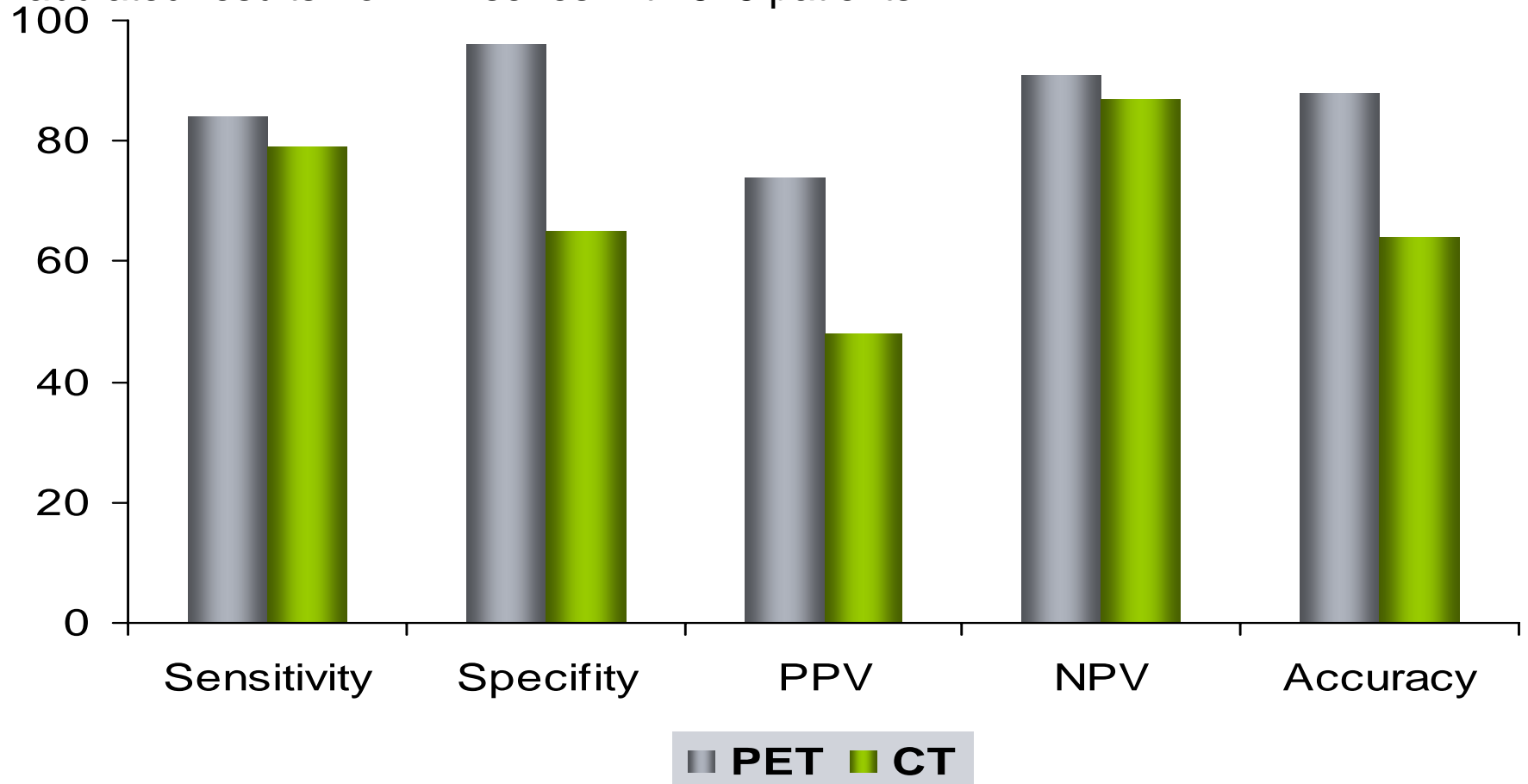
Tabulated results from 34 studies and 2227 patients



Source: Gambhir et al, J Nucl Med 2001; 42:1S

Staging of lymphoma: FDG PET statistics

Tabulated results from 11 series with 616 patients



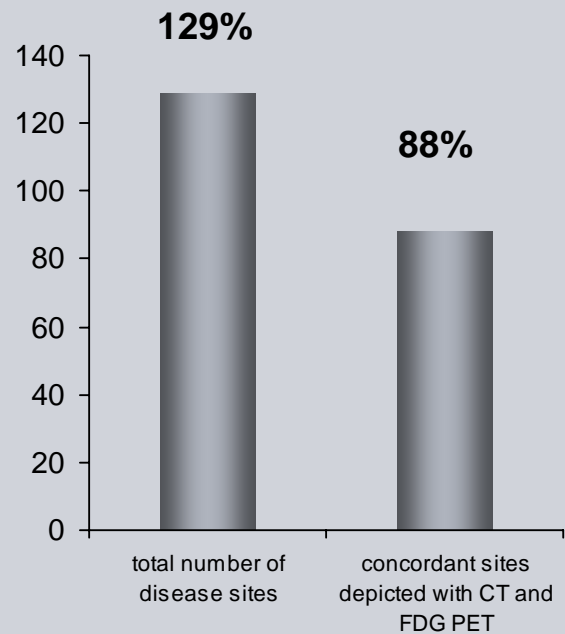
Source: Gambhir et al, J Nucl Med 2001; 42:1S

Staging lymphoma : FDG PET vs. CT

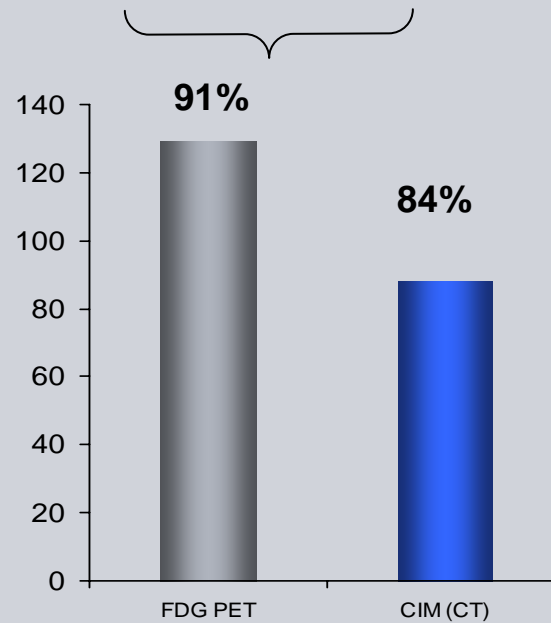
FDG PET has higher accuracy for correct staging and impact on management than CT

45 patients with lymphoma studied with FDG PET and CT in initial staging

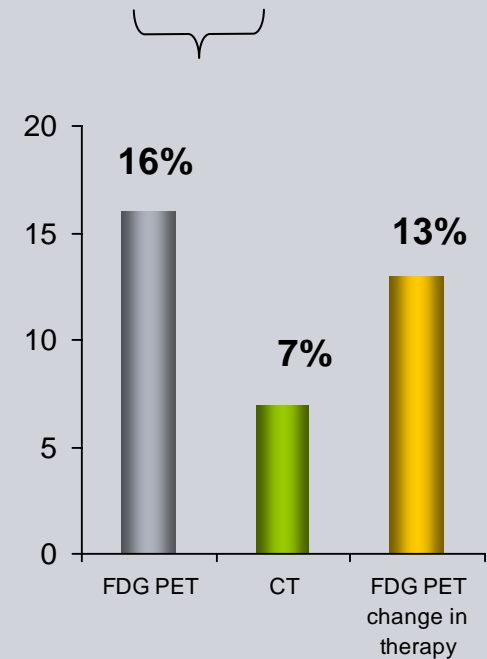
Number of disease sites



Accuracy in staging of disease



Change in stage of disease



Source: Delbeke et al, Mol Imag Biol 2002; 4: 105 Vanderbilt University Nashville, TN USA

Analysis of a PET•CT study : FDG PET vs. CT

Positive FDG PET highly accurate indicator of disease presence

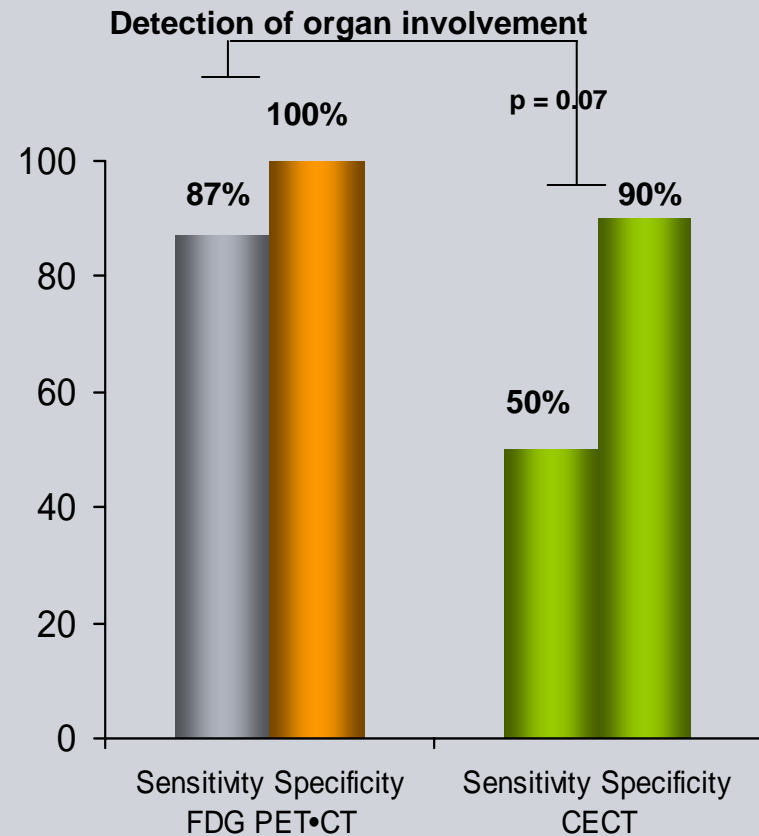
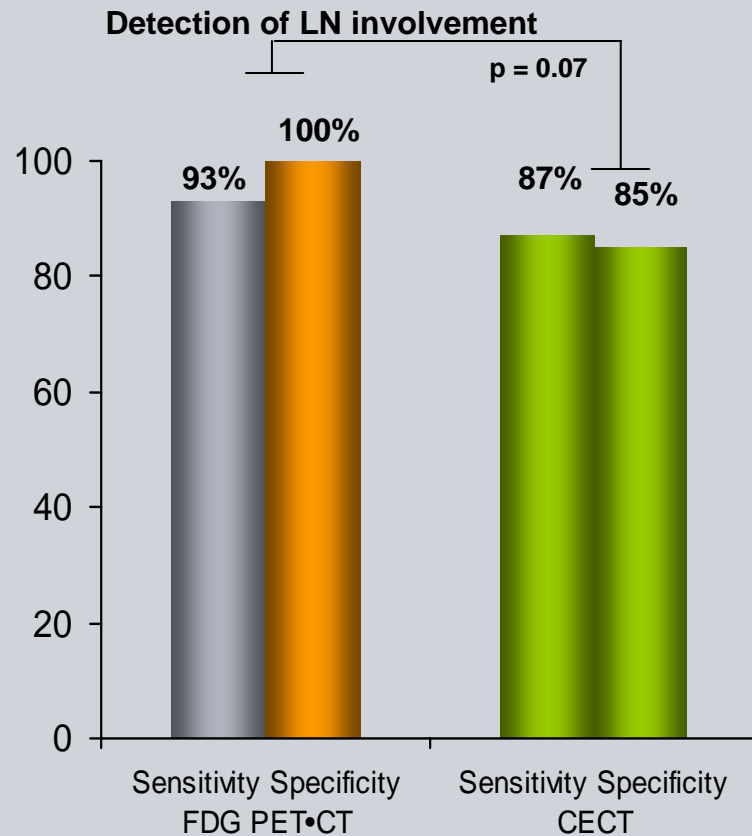
CT shows significant false positive and false negative

- 53 patients underwent combined FDG PET•CT - 1537 sites analyzed
- 20 pts with HD & 33 pts with NHL; 12 pts for initial staging; 41 pts for restaging
- 48 discordant sites - 34 PET positive CT negative; 14 PET negative CT positive
- 34 PET positive CT negative: All positive for lymphoma (biopsy & follow up)
 - 10 sites were <10 mm in size
- 14 PET negative CT positive: 5 sites positive for lymphoma (progressive disease)
- False negative FDG PET findings related to nodes <1 cm in size and presence of tumor necrosis

Source: Tatsumi et al, Radiology 2005; 237:1038-1045 John Hopkins

Staging lymphoma: Combined PET•CT vs. contrast enhanced CT

60 patients with Hodgkin's disease (n=42) or aggressive NHL (n=18) were studied with FDG PET•CT and contrast enhanced CT (CECT) for comparison of staging disease. All pts studied with both examinations within 24 days with no treatment between both studies

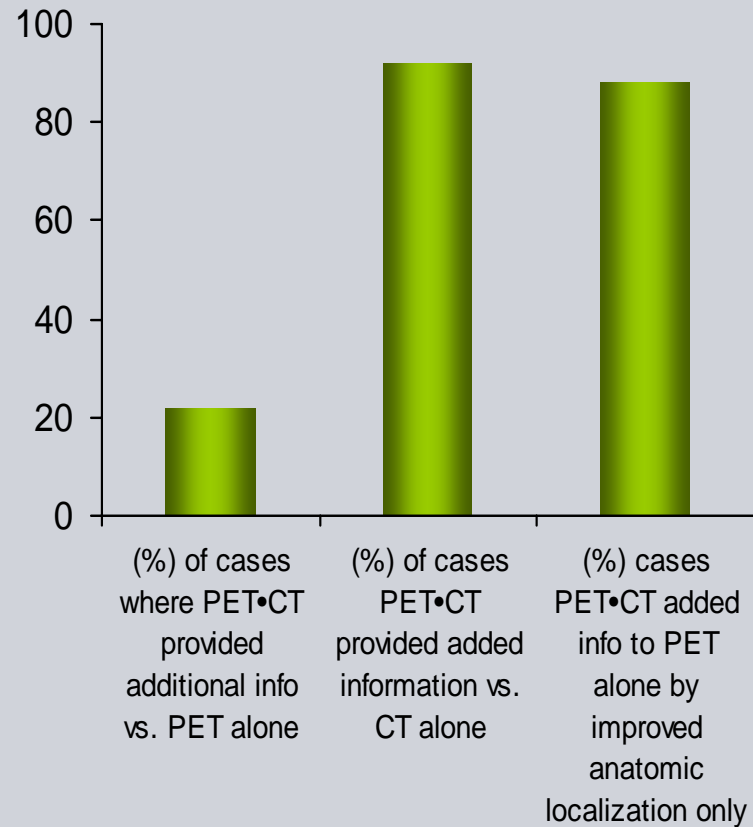
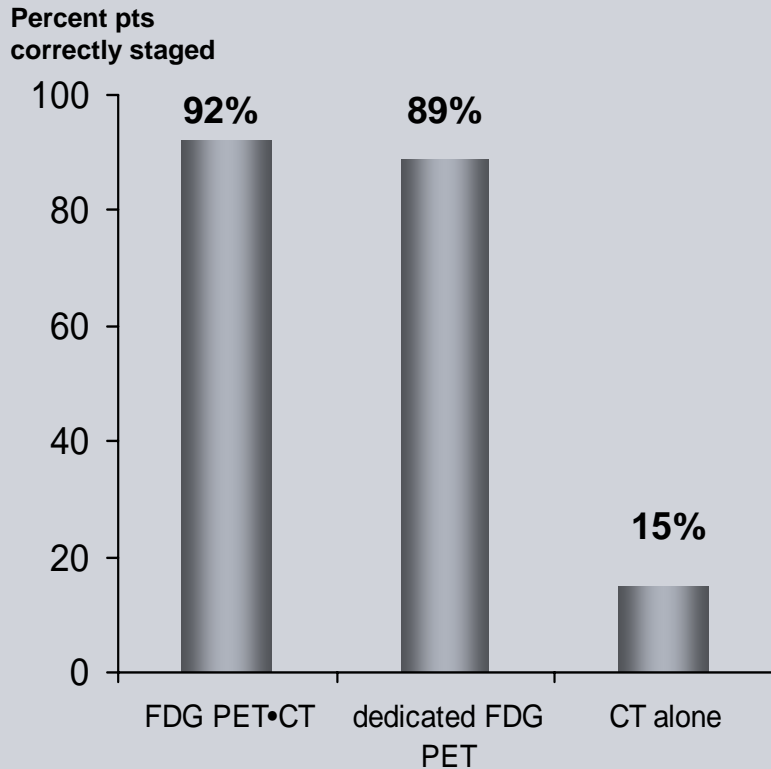


Source: Schaefer et al, *Radiology* Sep 2004; 232(3): 823-9

Staging lymphoma: PET•CT vs. dedicated PET and CT in staging and pt. management

36 pts with lymphoma (20 HD and 16 NHL) were studied with FDG PET•CT, FDG PET alone and CT alone for comparative staging and impact on pt mgt

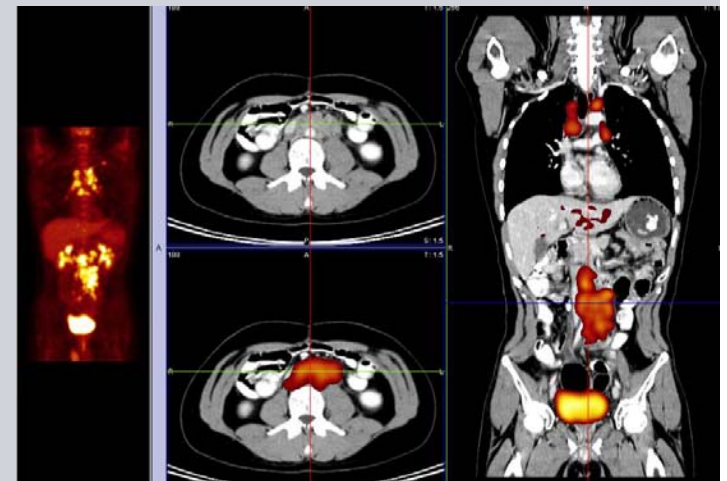
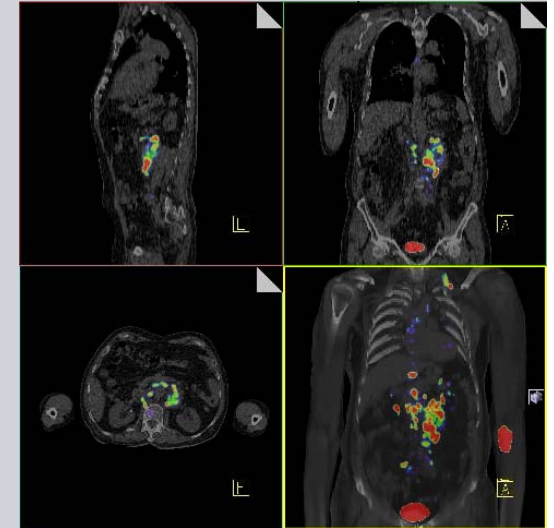
Accuracy in the depiction of correct stage of disease



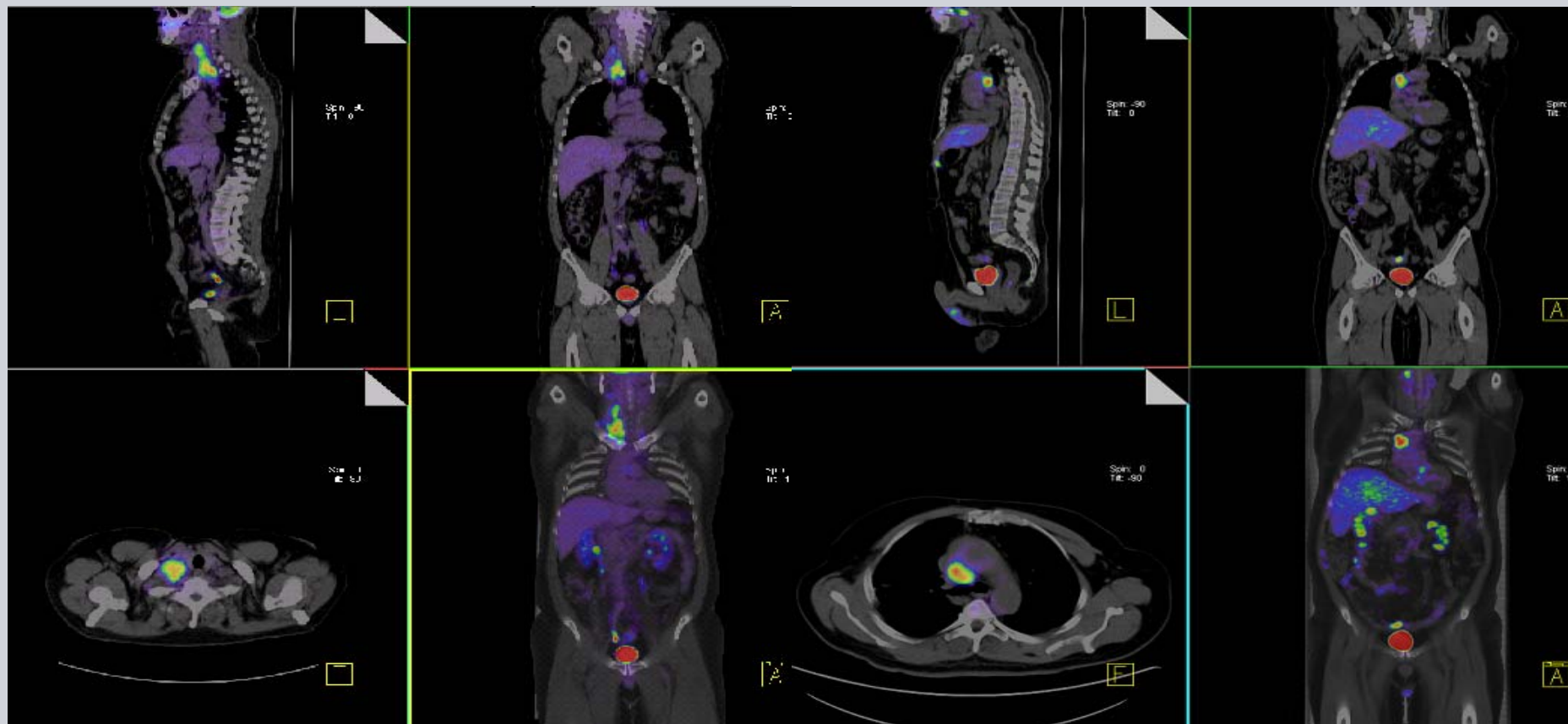
Source: Mari et al, J Nucl Med 2004; 45: 92P Stanford University Medical Center, Palo Alto CA USA

Accurate staging determines treatment options

- Involvement of periaortic, abdominal and retroperitoneal lymph nodes.
- Disease confined to one side of diaphragm
- Involvement of bilateral mediastinal and hilar nodes, as well as multiple abdominal nodes.
- Disease on both sides of the diaphragm.



FDG PET•CT confirms disease



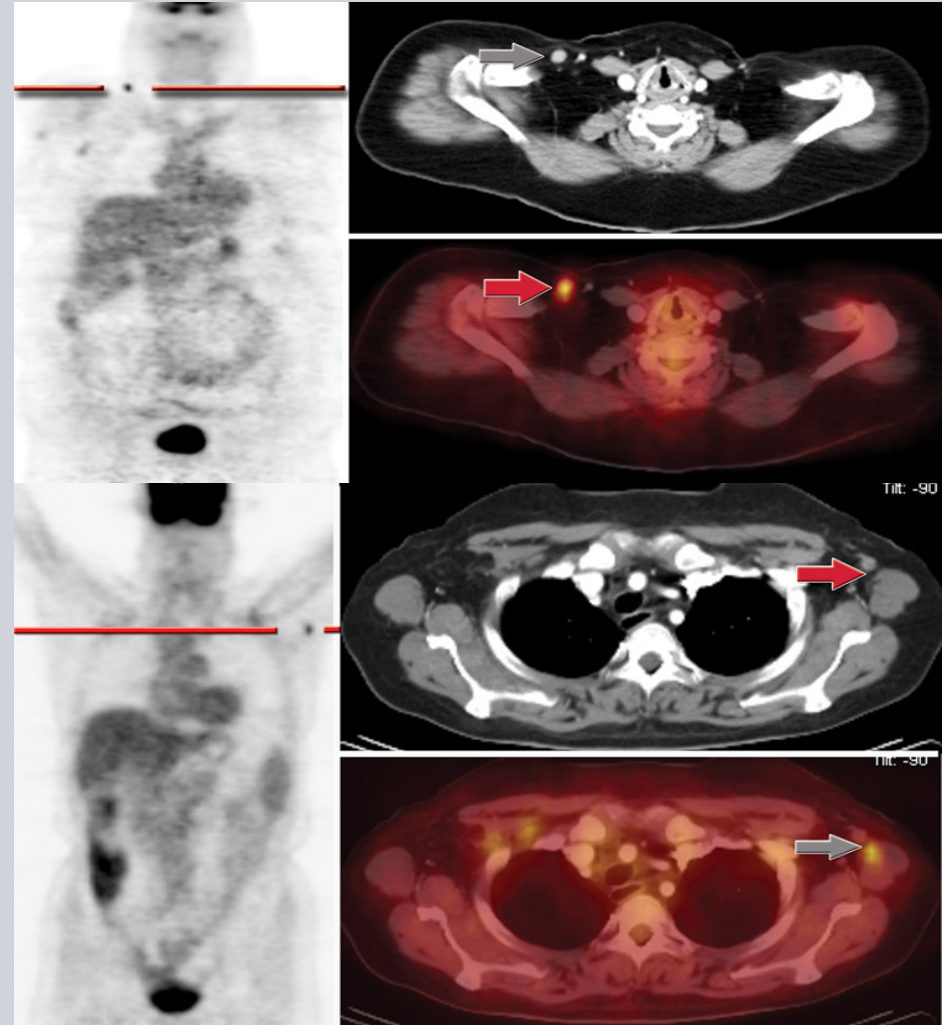
■ Hodgkin's lymphoma-
Supraclavicular lymph node
mass at presentation

■ Hodgkin's lymphoma-
Solitary mediastinal node
mass at presentation

FDG PET can detect disease in nodes that appear normal by CT

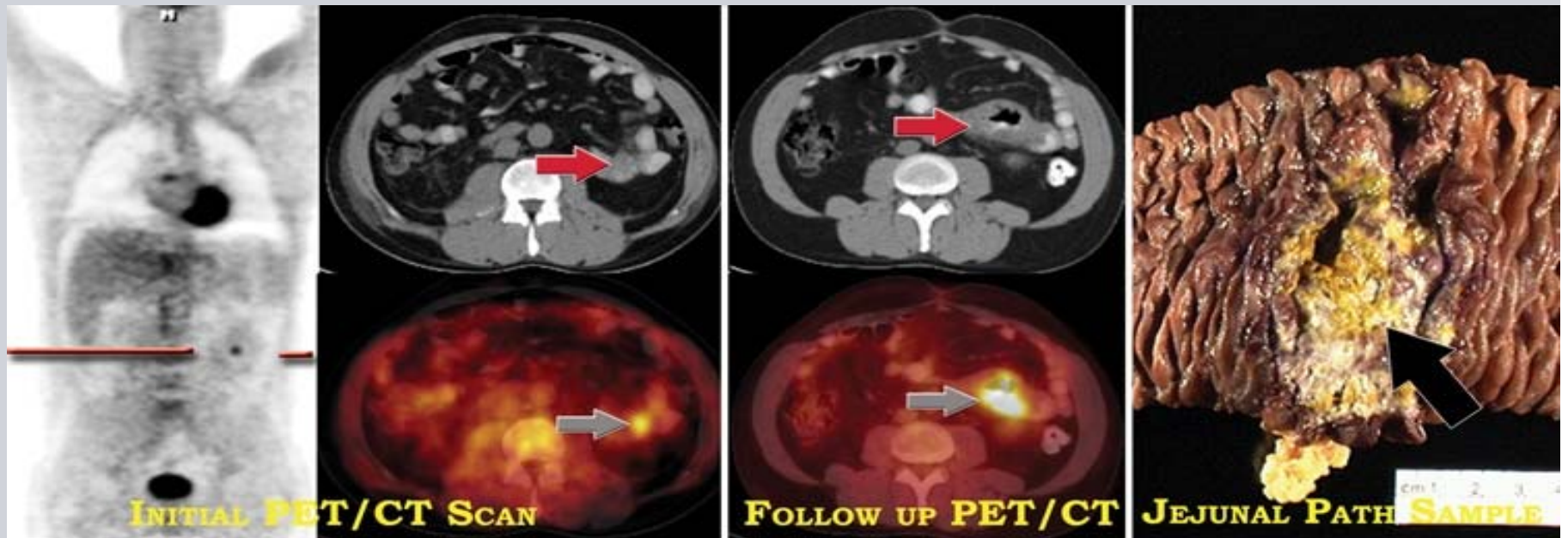
- HD- solitary supraclavicular node on FDG PET
- CT- normal sized node

- HD- solitary axillary nodal involvement on FDG PET
- CT- normal sized node



Source: Data courtesy of Todd Blodgett, MD

FDG PET can detect disease

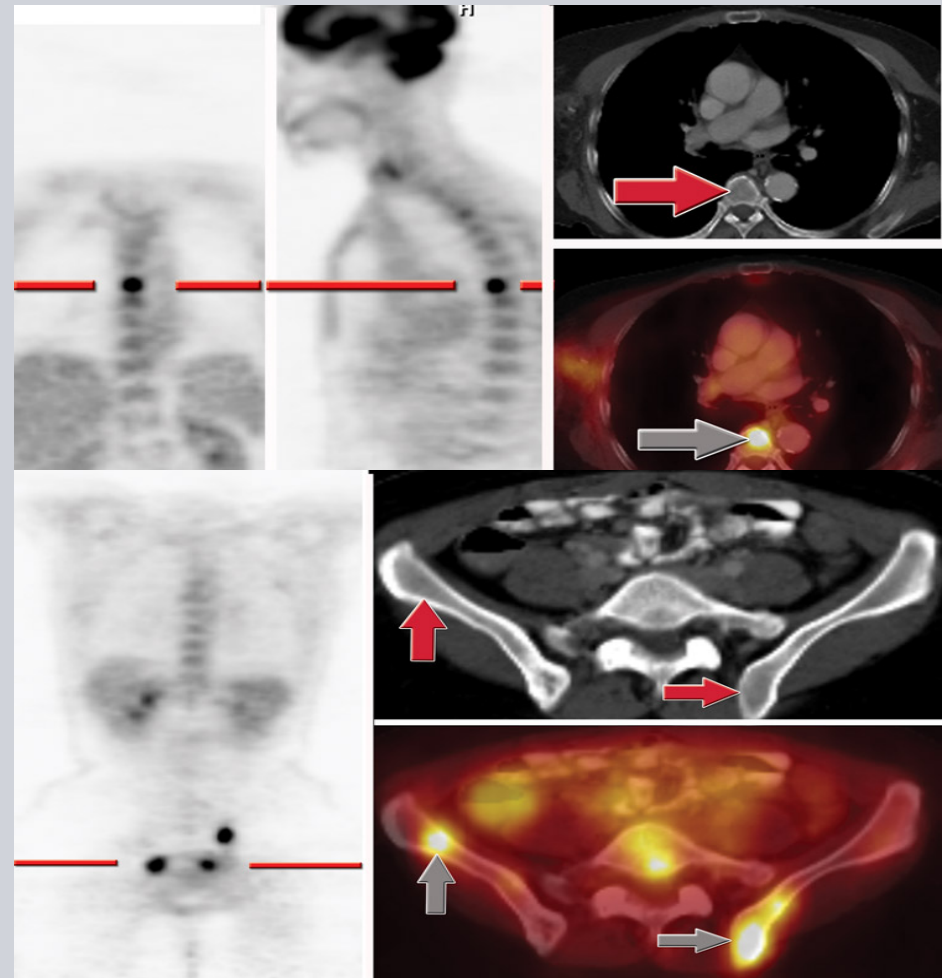


- Post transplant lymphoma - Small focal FDG uptake in jejunal loop - normal on CT? Intestinal disease
- Follow up PET•CT- Increased FDG uptake with jejunal thickening – Intestinal lymphoma

Source: Data courtesy of Todd Blodgett, MD

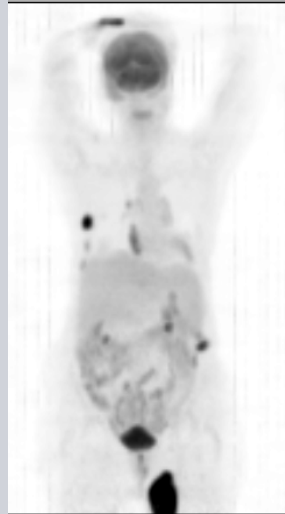
FDG PET can detect disease

- Burkitt's Lymphoma-
 - Asymptomatic patient for follow-up PET•CT assessment
 - Solitary disease in vertebral body
 - CT normal
- Non-Hodgkin's Lymphoma-
 - Asymptomatic patient for follow-up PET•CT assessment
 - Multiple lesions in pelvis involving marrow
 - CT nonspecific

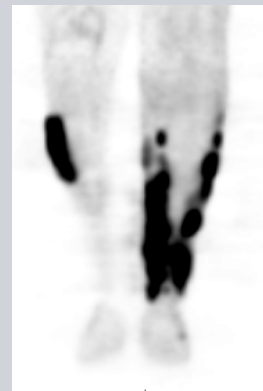


Data courtesy of Todd Blodgett, MD

81 year old female recently diagnosed with lymphoma. At initial staging noted to have disease in right lower anterior chest sub-cutaneous tissue



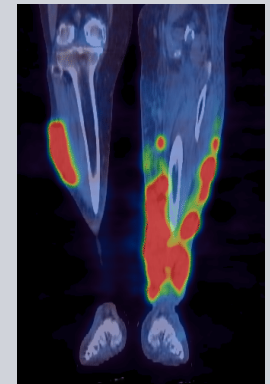
- Bulky disease confirmed in the left and right lower extremity corresponding to the disease defined histologically at biopsy



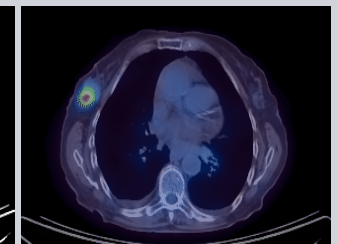
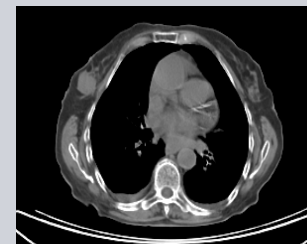
Dedicated PET



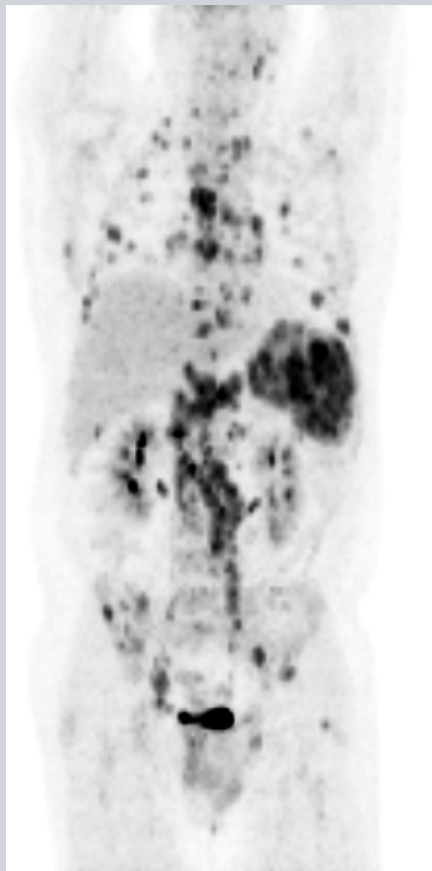
CT



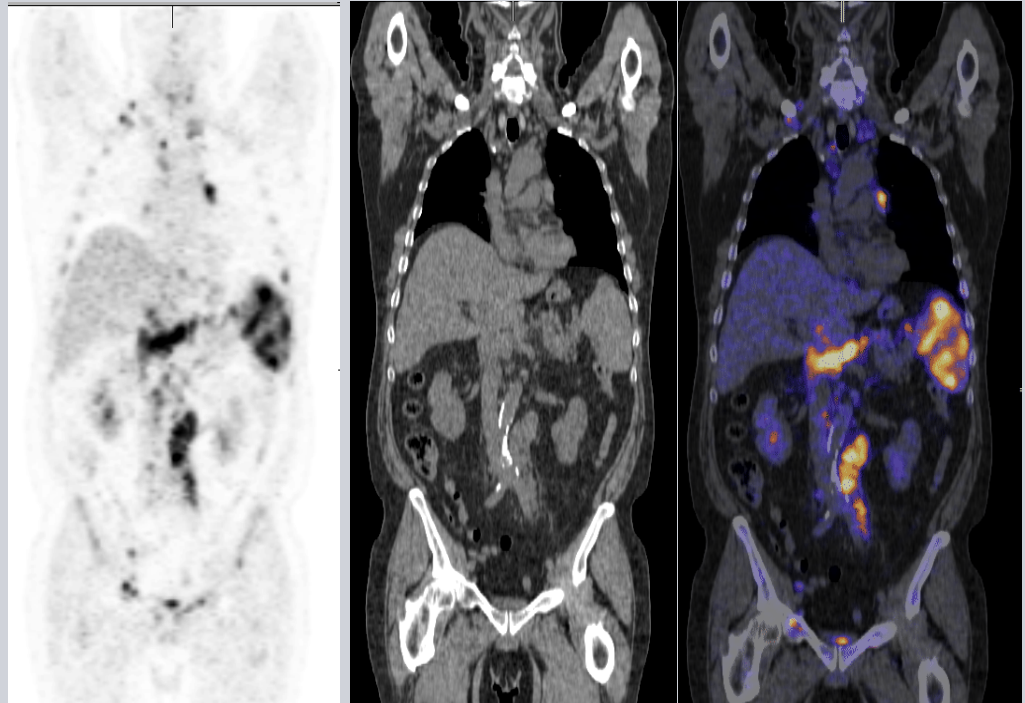
Coregistration



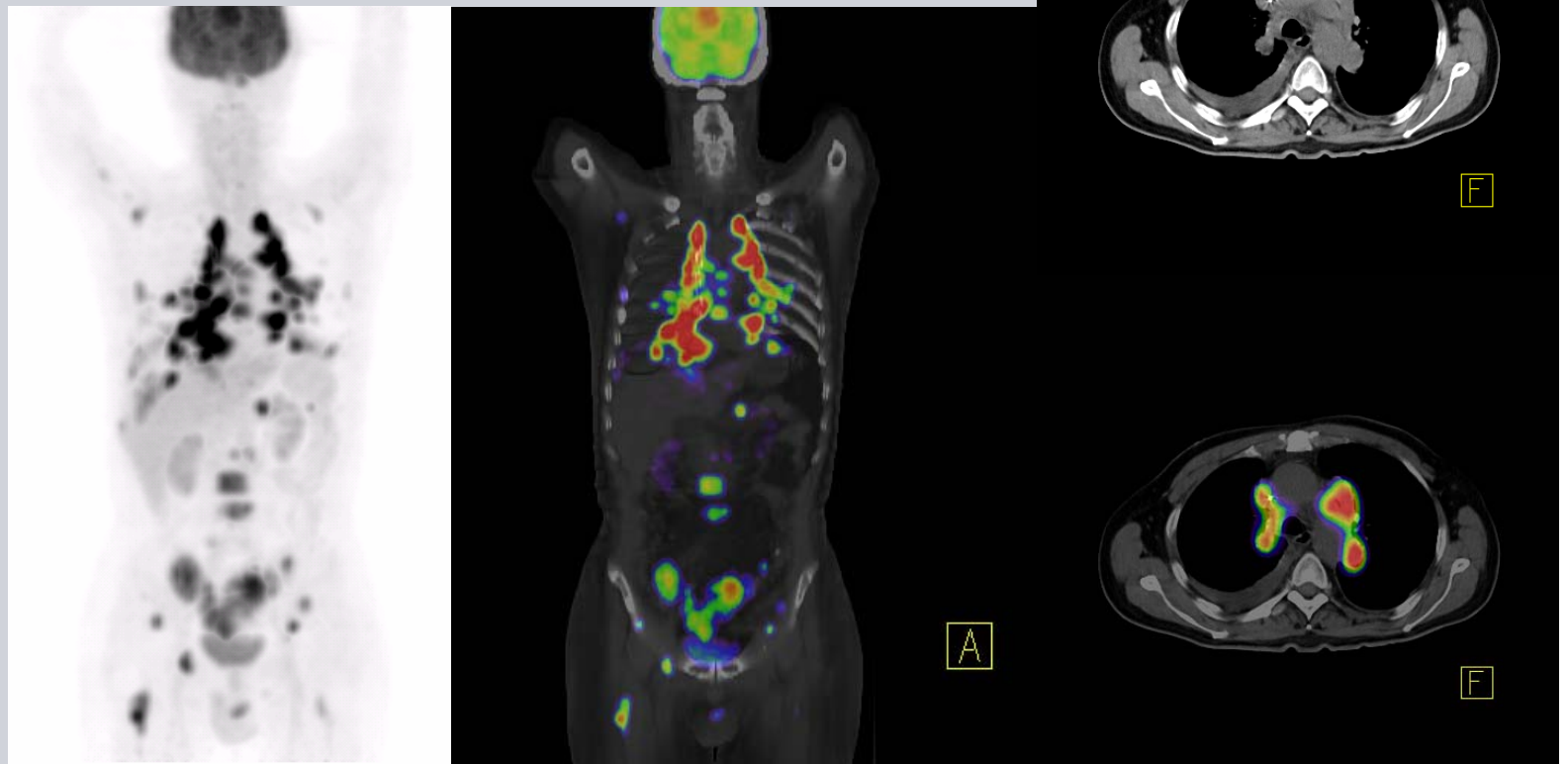
67 year old male with recent diagnosis of lymphoma established via biopsy of the left anterior neck presented for initial staging examination.



- Diffuse uptake was detected with both supra- and infra-diaphragmatic uptake as well as splenic involvement and bone marrow disease.

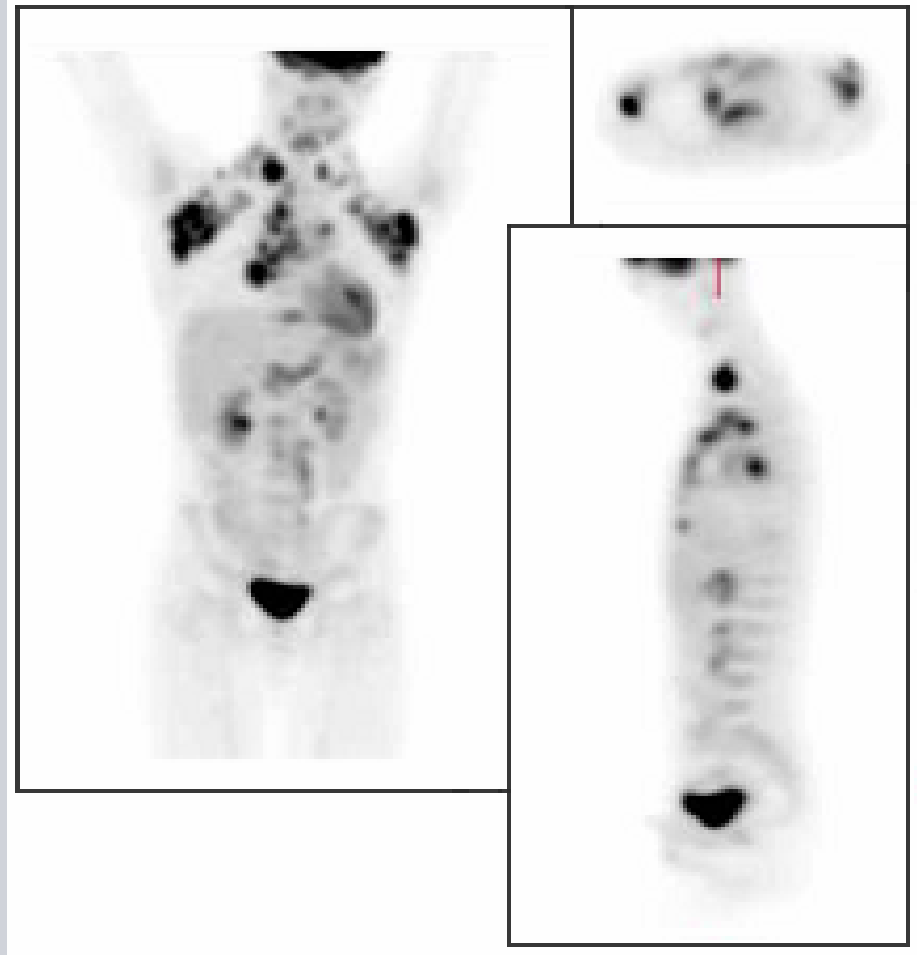


- Staging disseminated Hodgkin's Lymphoma
- FDG PET identifies small lesions that appear normal by CT



Lymphoma: Initial Staging

- 13 year old female with NHL
- Baseline PET exam performed to confirm extent of disease prior to initiating therapy.
- PET demonstrates additional disease below the diaphragm (involvement of abdominal lymph nodes)



Images courtesy of G. Warnock, MD, EPIC Imaging, Portland, OR

FDG PET in the detection of
extra nodal disease in
lymphoma

FDG PET vs CIM: Detection of extranodal disease

- Patients presenting with extranodal disease have poorer prognosis

(Moog et al, *Radiology* 1998; 206: 475)

- FDG PET imaging may detect up to 57% more extranodal sites than CT

(Moog et al, *Radiology* 1998; 206: 475)

- Incidence of hepatic and splenic involvement

- Hodgkin's disease: hepatic 3.2% and splenic 23%

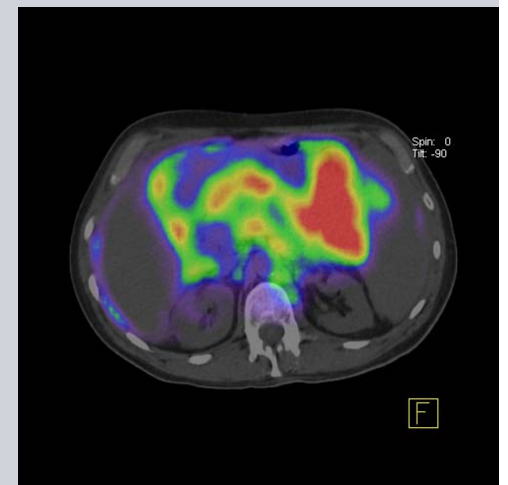
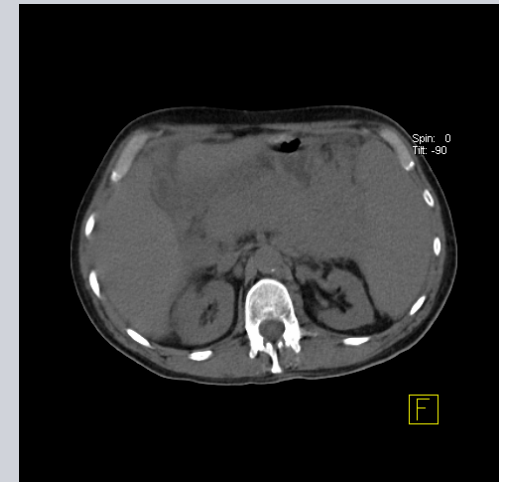
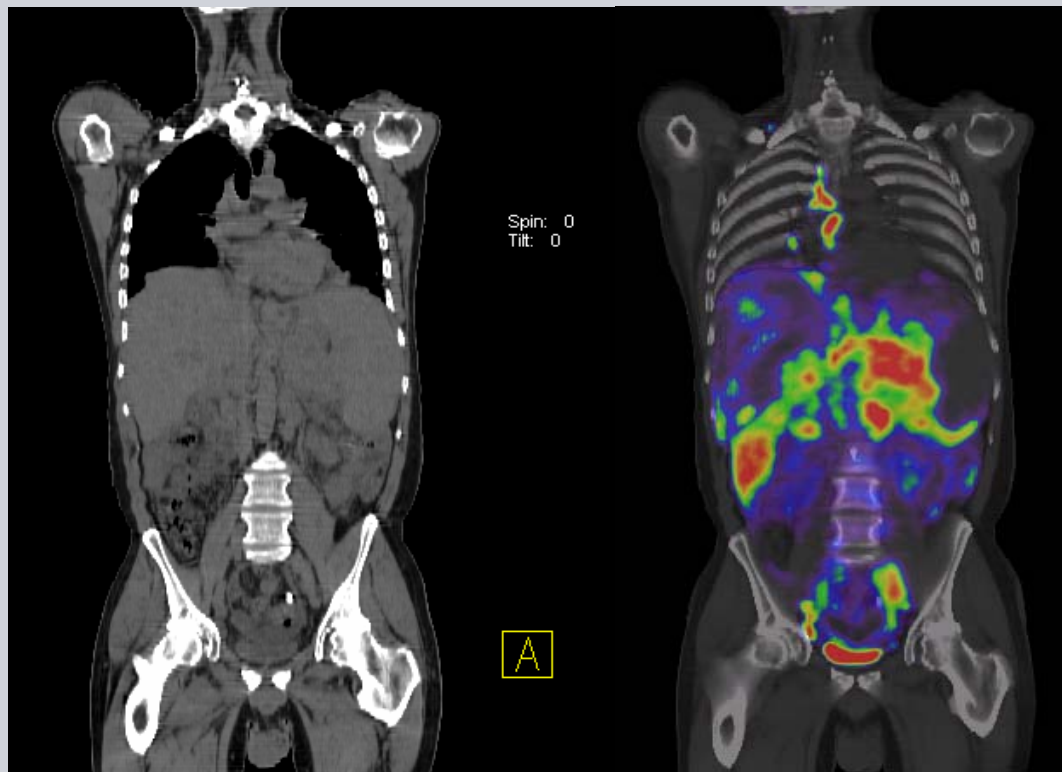
- Non-Hodgkin's disease: hepatic 15% and splenic 22%

(Moog et al, *Radiology* 1998; 206: 475)

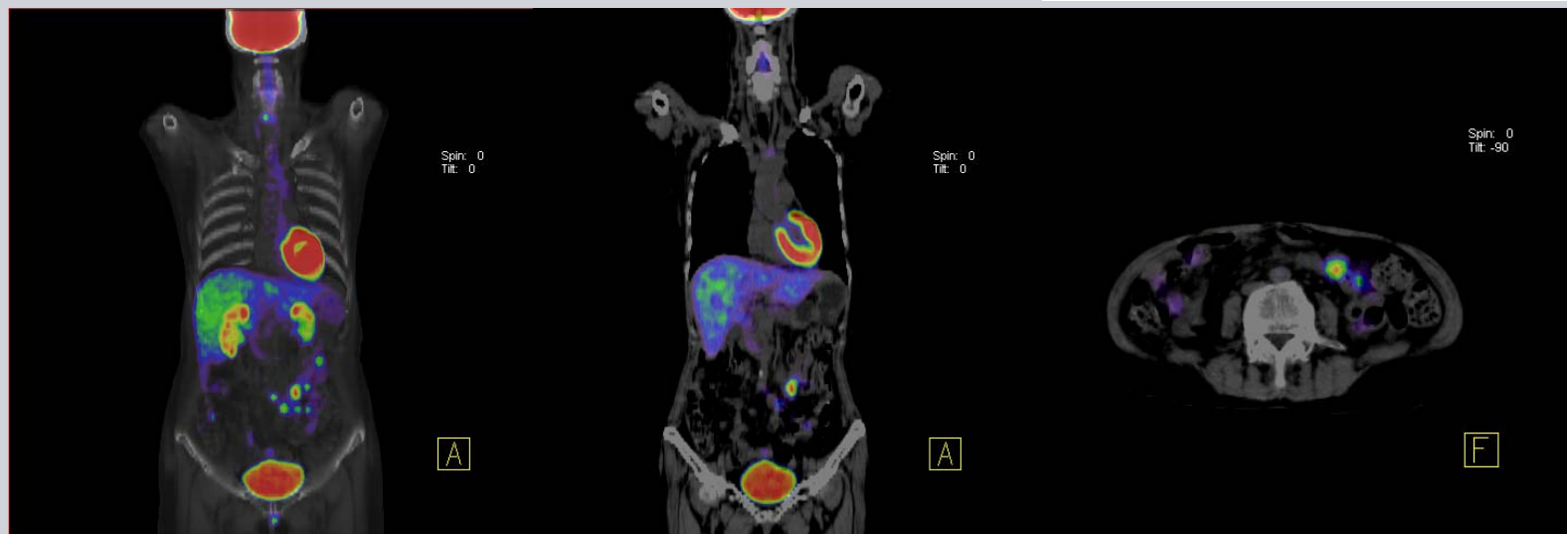
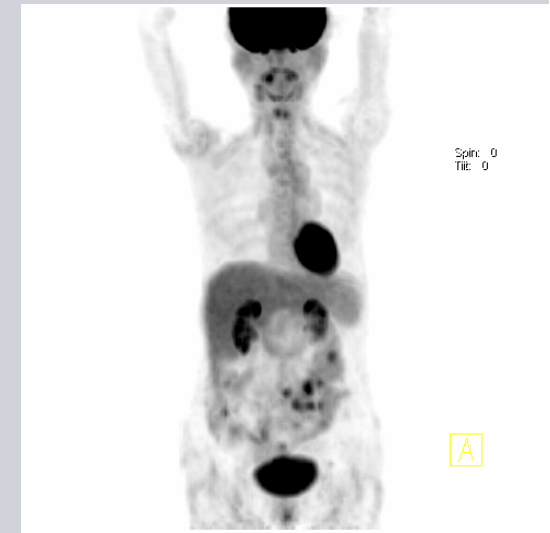
- CIM does not accurately portray liver, spleen and bone marrow involvement

(Moog et al, *Radiology* 1998; 206: 475)

- Extranodal NHL
- Peritoneal & intestinal lymphoma detected by PET•CT

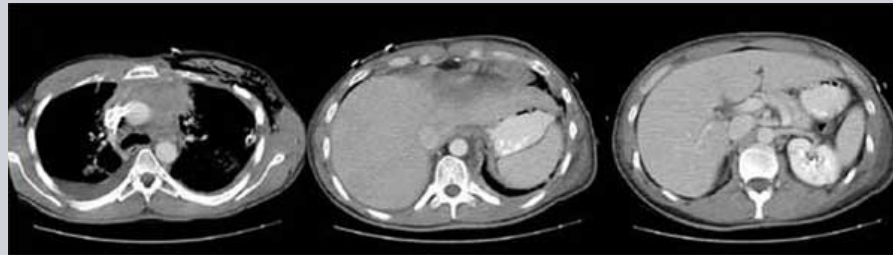


- Extranodal Non-Hodgkin's Lymphoma
- Intestinal lesions

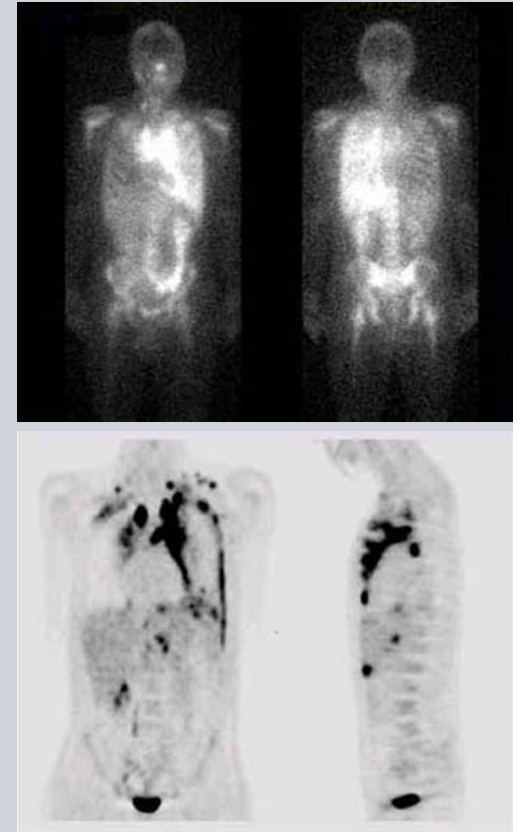


Lymphoma: NHL Pre-therapy baseline

- Baseline ^{67}Ga , bulky disease apparent



- Baseline FDG, improved sensitivity in detection of abdominal and small nodal disease



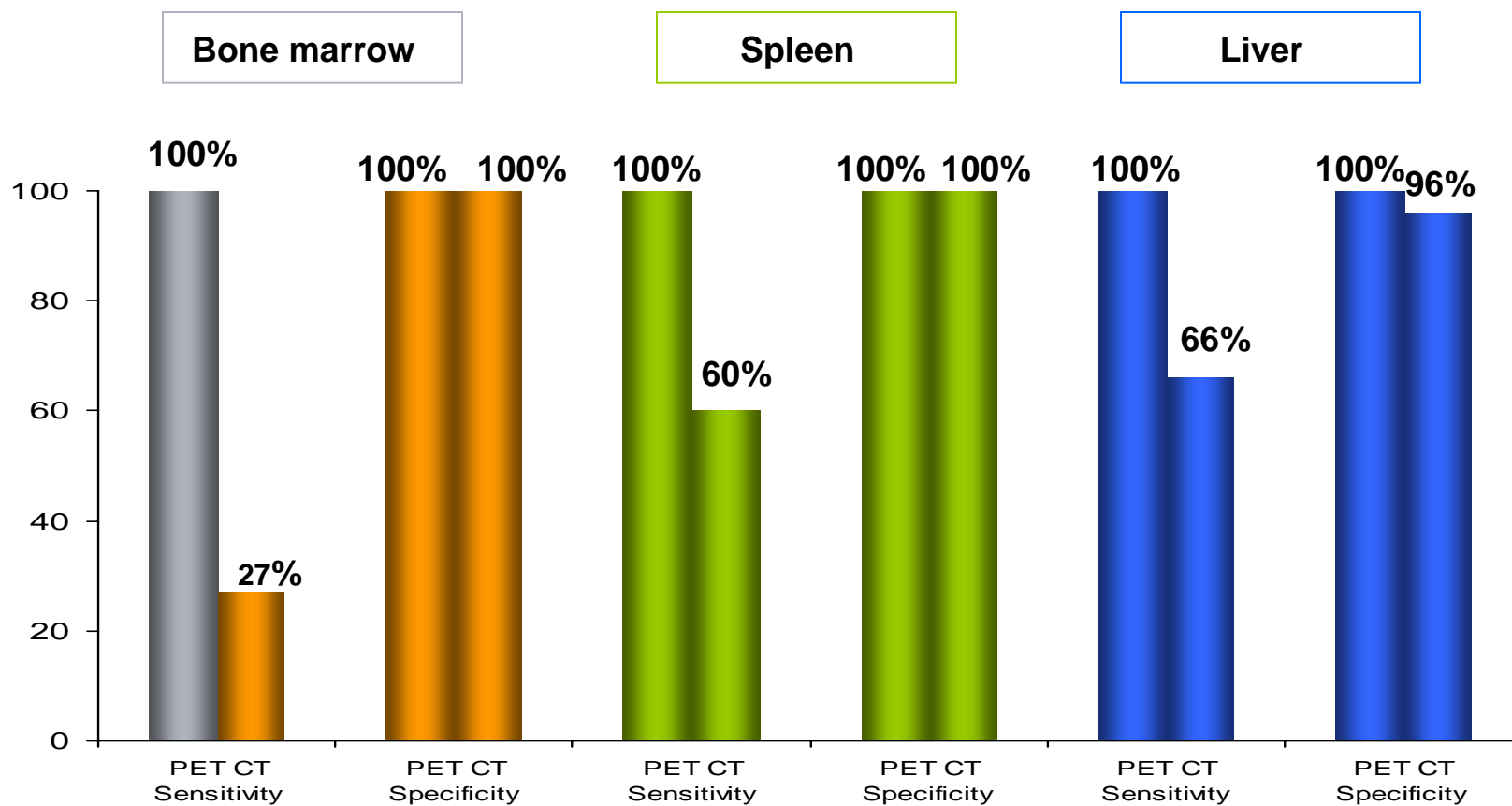
Images courtesy of H. Macapinlac, MDMD Anderson, Houston, TX

FDG PET vs CIM: Detection of bone marrow involvement

- Bone marrow involvement indicates stage IV disease
- Associated with poorer prognosis (Lee et al, Clin Nucl Med 2000; 25: 532)
 - Incidence of bone marrow involvement
 - Hodgkin's disease: 5-15%
 - Non-Hodgkin's disease: 19-83%
 - (Moog et al, Radiology 1998; 206:475 Moog et al, J Clin Oncol 1998; 16:603 Bangerter et al, Ann Oncol 1998; 9:1117)
- Detection of the presence of focal bone destruction with associated repair using CT/conventional bone scintigraphy
 - Infiltrative marrow involvement demonstrates no bone destruction
 - Patients generally asymptomatic (Moog et al, *Radiology* 1998; 206: 475)
- Bone marrow involvement may be mimicked by the presence of myeloid hyperplasia in the absence of neoplastic infiltration (Elstrom et al, Clinical Lymphoma 2004; 5:62)
- Advantage of whole body FDG PET, all organ systems may be assessed (Moog et al, J Nucl Med 1999; 40: 1407)

FDG PET vs. CIM: Detection of extranodal disease

81 consecutive patients with untreated lymphoma



Source: Moog et al, Radiology 1998; 206: 475

Conclusion...

FDG PET stages lymphoma with a high degree of accuracy

PET•CT is superior to any conventional imaging modality for staging and follow-up

Conclusion: Lymphoma Part I

This concludes Part I of the Lymphoma presentation. Please continue with Part II which will include:

FDG PET in restaging of lymphoma

FDG PET in detection of recurrent lymphoma

FDG PET in monitoring of therapy in lymphoma

FDG PET and prognosis in lymphoma

FDG PET after initiation of chemotherapy

FDG PET assessment after completion of therapy

FDG PET impact on lymphoma patient management

FDG PET in predicting clinical outcome in lymphoma