INTRODUCTION:

Positron emission tomography (PET) is a rapidly developing technology that is able to detect biochemical reactions, e.g., metabolism, or abnormal distribution of cell receptors within body tissues. A radioactive tracer is used during the procedure. Unlike other nuclear medicine examinations, PET can measure metabolic activity of the cells of body tissues, providing information about the functionality and structure of the particular organ or tissue examined. PET may also detect biochemical changes that help to evaluate malignant tumors and other lesions.

The degree of radioactive tracer uptake may indicate increased metabolism in the cells of body tissues or an abnormal distribution of cell receptors. Cancer cells may show increased radioactive tracer relative to tissue not involved with tumor. Radioactive tracer uptake is often higher in fast-growing tumors; PET is often not as useful or beneficial for slow-growing tumors.

Radioactive tracer uptake may occur in various types of active inflammation and is not specific for cancer. Thus it is not used for the initial diagnosis of cancer, but is useful in staging and monitoring cancer cell viability and for the diagnosis and detection of recurrence of cancer. PET is also useful for monitoring the response to treatment of various cancers.

Initial Clinical Reviewers (ICRs) and Physician Clinical Reviewers (PCRs) must be able to apply criteria based on individual needs and based on an assessment of the local delivery system.

IMPORTANT NOTE:

The appropriateness of an ordered PET/CT study is fully dependent on the answer to the question of which radiopharmaceutical will be used for the PET/CT.
• **The following are noncovered** for all other indications including (but not limited to):
  
  ♦ **Breast Cancer** – Initial Treatment Strategy (formerly diagnosis and initial staging) of axillary lymph nodes.
  
  ♦ **Melanoma** – Initial Treatment Strategy (formerly Evaluation) of regional lymph nodes.
  
  ♦ **Prostate Cancer** – Initial Treatment Strategy (formerly Diagnosis and initial staging.)
  
  ♦ **Infection and/or Inflammation** - PET for chronic osteomyelitis, infection of hip arthroplasty, and fever of unknown origin.

**INDICATIONS FOR AN ONCOLOGICAL FDG PET SCAN:**

**Initial Treatment Strategy**

All solid tumors, including myeloma, with biopsy proven cancer or strongly suspected based on other diagnostic testing:

Including

- CLL – chronic lymphocytic leukemia (PET/CT is generally not useful in CLL/SLL but may be necessary to direct nodal tissue sampling when high-grade histologic transformation is suspected)
- SPN – solitary (or clearly dominant) indeterminate pulmonary nodule ≥ to 8mm in size without existing tissue diagnosis (note: patient may have other non-suspicious nodules in the lung, such as granulomas and hamartomas.)

Excluding

- ALL - acute lymphoblastic leukemia
- AML – acute myelogenous leukemia
- BCC – basal cell carcinoma (of the skin)
- Prostate cancer

- To determine the anatomic extent of tumor when the recommended anti-tumor treatment reasonably depends on the extent of the tumor, **or**
- To determine if patient is an appropriate candidate for an invasive diagnostic or therapeutic procedure, **or**
- To determine the optimal anatomic location for an invasive procedure.

**Subsequent Treatment Strategy**

Restaging or monitoring response to active treatment, and/or a single evaluation after completion/cessation of therapy not to be performed within 4 weeks of completion of therapy (ideally FDG PET is delayed 2-3 months after surgical therapy, 2-3 months after radiation therapy if locoregional assessment is the imaging goal), and/or evaluation for suspicion of recurrence due to new or changing signs/symptoms. (Asymptomatic surveillance is not approvable.)

- Breast cancer (female and males)
• Cervical cancer
• Colorectal cancer (including colon, rectal, appendiceal or anal cancer)
• Esophageal cancer
• Head and neck cancer (not including Brain cancer/tumor; thyroid noted below)
• Lung cancer - Non-small cell
• Lymphoma
• Melanoma
• Myeloma
• Ovarian cancer

Subsequent PET Scans may be performed only if other imaging (ie. US, CT, MRI, NM) is inconclusive in determining a treatment plan or unable to be performed:

• Brain cancer: (with metastasis to non-head areas) Refer to Brain PET Scan Guidelines to image the brain
• Lung cancer -Small cell
• Neuroendocrine cancer (e.g. carcinoid, pheochromocytoma, etc)
• Pancreatic cancer
• Prostate cancer
• Soft tissue sarcoma
• Testicular cancer
• Tumors of unknown origin
• Other malignancies where the tumor has been shown to be FDG avid on prior PET/CT imaging, and other imaging (ie: US, CT, MRI, NM) is inconclusive in determining a treatment plan or unable to be performed

**Thyroid cancer:**

• Subsequent treatment strategy for recurrence or distant metastasis for thyroid cancer of Papillary, Follicular, or Hurthle cell origin AND patient has the following:
  o A thyroidectomy and radioiodine ablation initially, *and*
  o Current serum thyroglobulin > 10ng/mL, *and*
  o Current whole body I-131 scan is negative.
  o Medullary thyroid cancer when calcitonin levels are elevated post-operatively.

**Surveillance/Remission**

Surveillance/remission PET scan testing to assess for possible changes in status with no signs or symptoms of active cancer changes and not on any active treatment. Unless otherwise specified above, PET scan is not indicated for surveillance/remission.
INDICATIONS FOR AN ONCOLOGICAL GALLIUM 68 DOTATATE PET/CT SCAN:

Initial Treatment Strategy or Subsequent Treatment Strategy

For the following neuroendocrine tumors:
- Gastrointestinal tract, pancreas, lung, thymus (carcinoid tumors)
- Pheochromocytoma, paraganglioma
- Large or small cell carcinoma other than lung
- Neuroendocrine tumors of unknown primary

OR syndromes:
- Multiple endocrine neoplasia 1 (MEN-1)
- Multiple endocrine neoplasia 2 (MEN-2)

Neuroendocrine tumors should be biopsy proven (required in unknown primary cases) or very strongly suspected based on other diagnostic testing WITH recent Chest/Abdominal (for example, if lung or thymus) or Abdominal/pelvic (for example, if GI tract, pancreatic, MEN-1, MEN-2) multiphasic CT or MRI having been performed and reasonably deemed insufficient for the following:

- To determine the anatomic extent of tumor when the recommended anti-tumor treatment reasonably depends on the extent of the tumor, or
- To determine if patient is an appropriate candidate for an invasive diagnostic or therapeutic procedure, or
- To determine the optimal anatomic location for an invasive procedure.
- Restaging or monitoring response to active treatment, and/or evaluation for suspicion of recurrence due to new or changing signs/symptoms. (Asymptomatic surveillance is not approvable.)

NOTE: Gallium-68 DOTATATE PET/CT scans should be performed only if other imaging (CT, MRI) is inconclusive/insufficient AND the patient has not already been evaluated with Somatostatin Receptor SPECT scanning (another form of somatostatin receptor imaging performed on standard nuclear cameras), or that scanning was negative or equivocal.

Surveillance/Remission

Both somatostatin receptor imaging (Gallium-68 DOTATATE PET) and FDG PET/CT are NOT recommended for routine surveillance.
ADDITIONAL INFORMATION RELATED TO PET SCANS:

**Initial Treatment Strategy** - “Initial Anti-tumor Treatment Strategy” or “Initial Treatment Strategy” is replacing “diagnosis and initial staging”.

**Subsequent Treatment Strategy** - “Subsequent Anti-tumor Treatment Strategy” or “Subsequent Treatment Strategy” is replacing “restaging and monitoring response to treatment”.

**PET in the setting of immunotherapy** - Be aware that cancer immunotherapy with cytokines, immune-modulating antibodies, and cancer vaccines, is changing the landscape of imaging evaluation of cancer treatment response. Early experience with these therapies has demonstrated a delayed imaging response to therapy as compared to traditional chemotherapy. Transient enlargement and intensification of radiotracer activity in tumors, nodal and metastatic disease is well documented. This “pseudoprogression” may necessitate additional PET/CT surveillance. Literature currently supports repeat interval PET/CT after such a transient worsening on imaging so as to determine whether the changes seen are true progression or merely brisk immune response.

**PET/CT or PET with CT Attenuation Correction** – In contrast to the simple PET scan which requires a complex process of evaluation of body habitus to adjust for tissue density, modern scanners have the capacity to obtain a preliminary, general assessment of a patient’s habitus through the use of CT technology. Automatic adjustments to the PET data (based on tissue attenuation) are made. This is one study, not a combination study. This is interchangeably referred to as a PET/CT or PET/CT fusion examination. These provide the anatomical detail of a CT with PET’s ability to measure tissue metabolic activity. The ability to view both the morphology and metabolic activity simultaneously helps to evaluate tumors with speed and clarity. PET alone is normally not the standard of care and is significantly less accurate than PET/CT. The combination of PET and computed tomography (PET/CT) has advantages over PET alone because areas of tracer uptake are better localized and the image acquisition time is reduced.

**PET and Breast Cancer** - PET provides important qualitative and quantitative metabolic information that is important in the initial staging and re-staging of breast cancer.

**PET and Cervical Cancer** – Studies have shown that PET may be useful for the pre-treatment detection of retroperitoneal nodal metastasis in cervical cancer.

**PET and Colorectal Cancer** – PET is useful in the detection of recurrent disease, the localization of recurrence in patients with a rise of carcinoembryonic antigen (CEA), the assessment of residual masses after treatment, and in staging patients before surgery.

**PET and Esophageal Cancer** – The most common use of PET in esophageal cancer is to detect distant metastases and distant lymph node disease. It may also be used to assess therapy response and evaluate for esophageal tumor recurrence after treatment. PET findings do not specify each separate type of lesion. It is very helpful in detecting distant spread from invasive thymic carcinomas.
**PET and Head and Neck Cancer** – PET is used to evaluate cancer/tumor in the head and neck region, e.g., face, orbit, temporal, neck and is useful to rule out head and/or neck cancer/tumor as the “primary” when there is evidence of tumor elsewhere in the body and clinical examination or conventional imaging has failed to localize the lesion. It is also used to distinguish a benign tumor from a malignant tumor.

**PET and Lung Cancer** – The most common cause of death from cancer in western countries is lung cancer. PET is helpful in the evaluation of patients diagnosed with early-stage non-small lung cancer. It is valuable in picking up otherwise occult metastasis. PET identifies areas of hypermetabolism such as neoplasia or inflammation and reveals occult metastases. The detection of hidden or unsuspected metastasis prevents unnecessary surgery or treatments.

**PET and Lymphoma** – PET is used in the early assessment of response to chemotherapy in Hodgkin lymphoma (HL) as well as in aggressive non-Hodgkin lymphoma (NHL). Soon after the initiation of therapy, changes in radioactive tracer uptake may occur and these changes precede changes in tumor volume. This information may be used to guide treatment for patients with HL and NHL. However, PET/CT scan at early/interim restaging can lead to increased false positives and should be carefully considered in select cases.

**PET and Melanoma** – PET is not used in the diagnosis of melanoma. It may be used in the evaluation of stage III melanoma for detection of distant metastases and to identify candidates for further treatment or surgery.

**PET and Pancreatic Cancer** – In difficult cases, the presence of diffuse uptake of radioactive tracer by the pancreas or concomitant extra pancreatic uptake by the salivary glands on PET/CT can be used to aid in differentiation of autoimmune pancreatitis and pancreatic cancer.

**PET and Solitary Pulmonary Nodule** – PET may be used in the evaluation of patients with a single solitary nodule. It measures glucose metabolism which is different between benign and malignant nodules. FDG-PET is accurate in evaluation of the nodule. However, it may provide false positive results in patients who have inflammatory disease or active infections.

**PET and Thyroid Cancer** – The differentiated thyroid carcinoma (DTC) represents the most common type of thyroid cancer. It can be cured with surgical treatment and adjunctive therapy, but tumor recurrence is associated with significant morbidity and mortality. PET is used to evaluate DTC patients with negative radioiodine scans and elevated thyroglobulin (Tg) levels to detect recurrent or metastatic DTC. When thyroid carcinoma is differentiated it tends to retain the ability to accumulate iodine and iodine-based imaging is therefore the most appropriate imaging exam. When thyroid carcinoma becomes dedifferentiated, it tends to lose the ability to accumulate iodine and instead begins to act like other aggressive carcinomas.

**PET in pediatric age group** – While radiation dose and stochastic effects of radiation are of greater concern in the pediatric age group as compared to the adult age group, there are no
PET/CT-specific radiation safety precautions. Prudence with all forms of imaging requiring ionizing radiation is recommended.

**Gallium 68 DOTATATE PET/CT** - Because most neuroendocrine tumors express high-affinity receptors for somatostatin, radiolabeled somatostatin receptor scintigraphy or Gallium 68 DOTATATE PET/CT may be used in the initial evaluation of patients with neuroendocrine tumors, when workup utilizing CT or MRI is reasonably deemed insufficient. However, somatostatin receptor scintigraphy is not routinely recommended for surveillance after definitive resection, but may be indicated to assess disease location and disease burden for comparison in cases of subsequent possible recurrence. (NCCN).
REFERENCES


