Overview

The Brain Metabolism Study with F-18-fluorodeoxyglucose depicts the distribution of glucose metabolism in the brain in a tomographic fashion. The sole energy source of the brain is glucose, and the gray matter uses three to four times as much glucose on a per volume basis as the white matter.

Indications

- Differential diagnosis of dementia, and particularly Alzheimer’s disease.
- Preoperative lateralization of temporal lobe seizure foci.
- Detection of viable brain tumor post-surgery and/or radiation therapy.

Medicare PET Reimbursement Guidelines:

<table>
<thead>
<tr>
<th>Indication</th>
<th>CPT</th>
<th>Coverage Guidelines</th>
</tr>
</thead>
<tbody>
<tr>
<td>Refractory Seizures</td>
<td>78608</td>
<td>Presurgical evaluation to localize seizure focus of refractory seizure activity.</td>
</tr>
<tr>
<td>Alzheimer’s</td>
<td>78608</td>
<td>Differential diagnosis of fronto-temporal dementia (FTD) and Alzheimer’s disease (AD) under specific requirements (please refer to separate coverage criteria guide for AD)</td>
</tr>
<tr>
<td>Brain Tumor</td>
<td>78608</td>
<td></td>
</tr>
</tbody>
</table>

**NOTE:**

*Private payer coverage for PET often reflects that of Medicare but may vary. Providers should obtain coverage and pre-authorization guidelines for PET from their private payers.*

Examination Time

- Allow approximately 1.5 hours for the entire PET/CT brain study.
- Prior to Scan: Allow 30 minutes for interview, IV, BGL, followed by 30 - 45 minute uptake post injection.
- Image acquisition:
1. 78608 (Brain metabolism)
   a. 10 minutes on Siemens scanner / 8 - 25 minutes on GE scanner

Patient Preparation

- Prior to arriving for the study:
  > NPO for 6 hours.
  > No nicotine or caffeine for 12 hours.

- Patient to remain on any anti-seizure medications.

- Recent interventions, i.e. surgery, radiation therapy, biopsy, and chemotherapy:
  1. Record any interventions during the last 3 months (see clinical history sheet at the end of this section).
  2. Preferably, there should have been no interventions within the last 1-2 months.
  3. Record any head trauma.
  4. Record date of last seizure (if applicable).

- Place the patient in a dimly lit, quiet room. Provide the patient with an eye mask and ear plugs prior to injection.

- Check the blood glucose level.
  - Fasting blood sugar should be obtained on all patients. PET scan preferred blood sugar ≤ 200 mg/dl.
  - Normal range 70-110 mg/dl.
  - If blood sugar is low (i.e. < 50 mg/dl) consult the radiologist.
  - If the blood glucose is between 200 mg/dl and 225 mg/dl, try oral hydration and walking the patient to lower the blood sugar.
  - If the BGL is between 225 mg/dl and 250 mg/dl, consult the radiologist.
  - If the BGL is over 250 mg/dl, cancel the exam.

- Sedation may be needed for claustrophobia. Alprazolam (Xanax) at 1 mg is commonly used to treat panic disorders including claustrophobia. Sedation for brain studies must be given approximately 30 minutes post injection to prevent interference with distribution.

Equipment & Energy Windows

- Imaging system:
  - Siemens Biograph Horizon 16 PET-CT scanner.
  - United Imaging uMI 550

- Collimators:
  - 3D mode (septa out or absent) (*Siemens Biograph 16 only has 3D function*)
• 3D mode for United Imaging uMI 550
• Energy windows (may vary with manufacturer and machine design): 30% window centered at 511 keV.

Radiopharmaceutical, Dose, & Technique of Administration

• Radiopharmaceutical: F-18-fluorodeoxyglucose.

• Dosing:

<table>
<thead>
<tr>
<th></th>
<th>Siemens</th>
<th>GE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Adult</td>
<td>7 mCi (259 MBq)</td>
<td>10 mCi (370 MBq)</td>
</tr>
</tbody>
</table>

  Pediatric Patients – use North American Consensus Guidelines for Administered Radiopharmaceuticals in Children or Adolescents.

  *ARA RAM licensure allows +/- 20% dose variance.*

• Technique of administration: Standard intravenous injection or through an existing intravenous line.

Patient Positioning & Imaging Field

• Patient position: Supine.

• Restrain the head: Position the patient’s head in the standard head holder.

• Imaging field of view: Cranium.

Acquisition Protocol

• Have the patient empty his/her bladder before image acquisition.

• Begin image acquisition approximately 45 minutes following injection of F-18-fluorodeoxyglucose.

• Imaging times:

  *Siemens Biograph Horizon 16*
  - Emission data acquisition: 10 minutes.

  *GE Discovery ST*
  - Emission data acquisition: 8 minutes with Dimension upgrade

• Have the patient empty his/her bladder after image acquisition.
CT parameter values vary with patient size and machine specific factors:

1. Milliampere-seconds (mAs) and Kilovolts peak (kVp) guidelines:
   a) pediatric patient ≤ 6 yrs old: 260 eff mAs, 120 kVp.
   b) pediatric patient > 6 yrs old: 300 eff mAs, 120 kVp.
   c) average adult: 450 eff mAs, 120 kVp.

2. The care dose is not utilized on Brain studies due to the bone density in the head.

Protocol Summary Diagram

Data Processing

- The PET images are reconstructed using iterative reconstruction. Siemens settings include: matrix 360, 8 iterations, 10 subsets, Gaussian filter, filter FWHM 2.0, zoom 2.0, T.O.F. Settings for the United uMI 550 include: 3D reconstruction, HYPER Iterative, TOF, PSF, 256 matrix, measured attenuation.

- A rotating maximum intensity projection (MIP) display and surface-rendered 3D displays facilitate lesion evaluation.

Optional Maneuvers

- Attenuation correction: May be done with calculated attenuation coefficients rather than measured attenuation coefficients.

Principle Radiation Emission Data - F-18

- Physical half-life = 109.8 minutes.

<table>
<thead>
<tr>
<th>Radiation</th>
<th>Mean % per disintegration</th>
<th>Mean energy (keV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positron</td>
<td>100</td>
<td>250</td>
</tr>
<tr>
<td>Gamma ±</td>
<td>200</td>
<td>511</td>
</tr>
</tbody>
</table>
Dosimetry - F-18-Fluorodeoxyglucose

<table>
<thead>
<tr>
<th>Organ</th>
<th>rads/15 mCi</th>
<th>mGy/555 MBq</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bladder</td>
<td>2.21</td>
<td>22.1</td>
</tr>
<tr>
<td>Heart</td>
<td>0.80</td>
<td>8.0</td>
</tr>
<tr>
<td>Spleen</td>
<td>0.80</td>
<td>8.0</td>
</tr>
<tr>
<td>Kidneys</td>
<td>0.42</td>
<td>4.2</td>
</tr>
<tr>
<td>Brain</td>
<td>0.41</td>
<td>4.1</td>
</tr>
<tr>
<td>Lungs</td>
<td>0.39</td>
<td>3.9</td>
</tr>
<tr>
<td>Liver</td>
<td>0.38</td>
<td>3.8</td>
</tr>
<tr>
<td>Testes</td>
<td>0.35</td>
<td>3.5</td>
</tr>
<tr>
<td>Ovaries</td>
<td>0.26</td>
<td>2.6</td>
</tr>
<tr>
<td>Total body</td>
<td>0.20</td>
<td>2.0</td>
</tr>
</tbody>
</table>

Dosimetry - Computed Tomography

- Actual effective doses will depend on the user-specific exam protocols and the specific CT scanner used. It is important that each facility develop appropriate exam protocols and monitor the resultant patient doses for each machine in use.

<table>
<thead>
<tr>
<th>Effective dose</th>
<th>rem</th>
<th>mSv</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diagnostic CT</td>
<td>0.15</td>
<td>1.5</td>
</tr>
<tr>
<td>Low dose CT</td>
<td>0.01</td>
<td>0.1</td>
</tr>
</tbody>
</table>