Practical Aspects of ACR
PET Accreditation

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Houston

Objectives

- ACR PET Phantom
- Activation of ACR Phantom
- Image acquisition and processing

Accreditation Program Objective

To provide a solid foundation for continuous quality improvement through a peer review and education process for clinical facilities committed to image quality

Quality Patient Care

Accreditation Attests to a Site’s High Standard of Clinical Practice

- Personnel: physicians, technologists, physicists
- Policies and procedures
- Scanning equipment
ACR Accreditation
PET Physicist Qualifications

- Board Certification (recommended):
  Nuclear Medicine Physics or Radiologic Physics
- Training (required):
  40 hrs of on-site practical experience providing PET physics support
- Continuing Education (recommended):
  150 hours every 3 years with 15 hours in PET

ACR Accreditation
Two Part Submission

- Initial site application (online)
- Clinical review
  - Phantom images that reflect the performance of the equipment during routine clinical studies
  - Clinical images
    Quality Patient Care

Scanner Performance

- ACR Phantom testing for clinical image quality is required for ACR accreditation and renewal
- Phantom testing recommended quarterly
- Clinical performance, not NEMA acceptance testing

Image Submission

- Clinical images and techniques
- PET phantom images
  - Equipment quality assurance
  - FDG worksheet
  - SUV analysis worksheet

Quality Patient Care
Hot-Cylinder Cover Plate

Fillable thin-walled cylinders (8, 12, 16, and 25 mm in diameter), a Teflon cylinder and two 25 mm cylinders, one for air and one for "cold" water.
ACR PET Phantom
Hot Cylinders & Cold Rods

Typical Images
2.5:1 Ratio (10 mCi)
Clinical Protocol

HR+
High Count, 12E/7T

PET Phantom Review
1 cm slices
1 - 5 Grading Scale

Uniformity

Contrast – Hot Cylinders
8, 12, 16, 25 mm

Resolution – Cold Rods
4.8, 6.4, 7.9, 9.5, 11.1, and 12.7 mm
PET Phantom Review

1 - 5 Grading Scale

- 5 – Excellent, best image quality.
- 4 – Good, minor variations in quality.
- 3 – Satisfactory, some variations in image quality, but not likely to affect interpretations of clinical studies.
- 2 – Marginal, may affect interpretation of clinical studies.
- 1 – Failure, probably will affect interpretation of clinical studies. Scanner should not be used for clinical studies.

Images are reviewed by 2 reviewers (3 if tie)

**Contrast - marginal passing:**
16 mm vial is resolved with acceptable contrast: larger vial resolved with high contrast.

**Resolution - marginal passing:**
11.1 mm rods are resolved with low contrast: larger rods are resolved with high contrast.

**Uniformity - marginal passing:**
Strong artifacts are seen in a small number of slices.

Siemens ACCEL

GE Discovery: LightSpeed 4
16 mCi, 6 min per bed, 1 cm slices

Rods: 4.8, 6.4, 7.9, 9.5, 11.1, and 12.7 mm
PET Contrast:
$^{11}$C Spheres/$^{18}$F Background
HR+ (resolution ~ 6 mm at 10 cm), 3D (FBP)

Typical brain scan (10 mCi): 0.5 µCi/ml, 35 min acquisition
$^{18}$F (1.2 µCi/ml) and $^{11}$C spheres (ratio to background = 2.6)
Sphere diameters (volumes): 31.3 (16.0), 24.8 (8.0), 15.6 (2.0), 19.7 (4.0),
12.4 (1.0), 9.85 (0.5 ml) mm.

PET Statistics: Resolution

Activity: 1.6 µCi/ml FDG
Scanner: HR+, 3D Single slice
Rods (mm):
4.8, 6.4, 7.9, 9.5, 11.1, 12.7

Required Supplies

1,000 ml bag of saline solution
Two tuberculin syringes and FDG doses
1) Activation Dose A - added to 1,000 ml bag.
2) Activation Dose B - added to phantom, background activity

Three 60 ml syringes
1) Test Dose A (60 ml) - vial activity from saline bag
2) Test Dose B (60 ml) - background from phantom
3) Vial doses from saline bag (40 ml)
Required Supplies

Dose Dilution

<table>
<thead>
<tr>
<th>Patient Dose</th>
<th>Dose A mCi</th>
<th>Dose B mCi</th>
</tr>
</thead>
<tbody>
<tr>
<td>4 mCi</td>
<td>0.140</td>
<td>0.330</td>
</tr>
<tr>
<td>6 mCi</td>
<td>0.210</td>
<td>0.495</td>
</tr>
<tr>
<td>8 mCi</td>
<td>0.280</td>
<td>0.660</td>
</tr>
<tr>
<td>10 mCi</td>
<td>0.350</td>
<td>0.825</td>
</tr>
<tr>
<td>12 mCi</td>
<td>0.420</td>
<td>0.990</td>
</tr>
<tr>
<td>14 mCi</td>
<td>0.490</td>
<td>1.154</td>
</tr>
<tr>
<td>16 mCi</td>
<td>0.560</td>
<td>1.319</td>
</tr>
<tr>
<td>18 mCi</td>
<td>0.630</td>
<td>1.484</td>
</tr>
<tr>
<td>20 mCi</td>
<td>0.700</td>
<td>1.649</td>
</tr>
</tbody>
</table>

Phantom Doses

Two required doses (from Dilution Chart)

- **Activation Dose A** will be added to 1000 ml bag (or bottle) to diluted activity for the 4 test vials
- **Activation Dose B** will be added to the phantom as background activity.

Radiation Safety
Measurement of Doses

*Measure and record the activity of Activation Dose A and Activation Dose B (tuberculin syringes) with time on the work sheet.

*Scanning begins 1 hr after the Activation Dose A measurement time.
Add Activation Dose A to the 1000 ml bag or bottle and mix well. Then with the first 60 ml syringe withdraw 60 ml — this is Test Dose #1 (set aside).

Next, using the second 60 ml syringe withdraw 40 ml from the bag and fill the 4 appropriate chambers in the phantom top.
Phantom Background Activation

Thoroughly mix Activation Dose B into the main chamber of the PET phantom (a bubble of air will help ensure a well-mixed solution).

Vial Activation

Withdraw 40 ml from the saline bag using the second 60 ml syringe and fill the 4 appropriate chambers in the phantom top.
Measurement of Test Doses with Time

- Measure and record the activity of Test Dose #1 and Test Dose #2.
- Inject Test Dose #2 back into the phantom. Fill any remaining air-space in the phantom with water and mix again.
- Scan at the specified time. Dispose of syringes appropriately.

Phantom Dilution Worksheet
Enter dose and time below

<table>
<thead>
<tr>
<th>Dose Ratios</th>
<th>Dose</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Patient Dose:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FDG dose (A), mCi:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FDG dose (B), mCi:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test dose #1, µCi:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Test dose #2, µCi:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Actual start time of phantom scan:</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

When entering SUV parameters for the PET scanning protocol assume a 70 kg patient and use the Patient Dose (e.g. 10 mCi) from above with the measurement time entered for dose A.
### Phantom Dilution Worksheet

Enter dose and time below

<table>
<thead>
<tr>
<th></th>
<th>Dose</th>
<th>Time</th>
<th>Dose Ratios</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Patient Dose:</strong></td>
<td><strong>10 mCi</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>FDG dose (A), mCi:</strong></td>
<td><strong>0.38</strong></td>
<td><strong>2:21:10</strong></td>
<td><strong>PA 2.36</strong></td>
</tr>
<tr>
<td><strong>FDG dose (B), mCi:</strong></td>
<td><strong>0.83</strong></td>
<td><strong>2:21:49</strong></td>
<td><strong>2.18</strong></td>
</tr>
<tr>
<td>#1) 0.35 μCi X 60=21</td>
<td>17.10</td>
<td>2:34:54</td>
<td><strong>2.50</strong></td>
</tr>
<tr>
<td>#2) 0.14 μCi X 60=8.4</td>
<td>7.25</td>
<td>2:35:32</td>
<td><strong>2.36</strong></td>
</tr>
</tbody>
</table>

| Actual start time of phantom scan: | **3:21** |

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*Expected:

When entering SUV parameters for the PET scanning protocol assume a 70 kg patient and use the Patient Dose (e.g. 10 mCi) from above with the measurement time entered for dose A.

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### Phantom Scanning
PET Phantom Image Processing

- Clinical whole-body reconstruction protocol
- 1 cm transaxial slices of phantom

Pitfall: Merged PET/CT

Warning: merged images do not provide adequate information on PET component.
Clinical Importance

Based on the evaluation of Phantom Images, patient dose increased to 12 mCi.

Phantom Activation

Objectives

suv = activity in tissue / ml body wt (g)

Bckgr. SUV = 1.0
0.14 µCi/cc for 10 mCi patient dose

Cylinders: SUV = 2.5
0.35 µCi/cc for 10 mCi patient dose

(For scanner SUV setup)
New Reviewer Guidelines

SUV Analysis Worksheet

- **Pass or Fail Criteria**
  - Maximum SUV for 25 mm high Contrast Vial must be ≥ 2 and ≤ 3
  - 16 mm/25 mm ≥ 0.7 or greater, other ratios should decrease in a reasonably manner

- In the future, the scoring criteria will be adjusted

Current Program Status

- **Accredited Sites**
  - PET: > 650+
  - Nuclear Medicine: > 1200+

- WEB based review process
- WEB based image submission under development

Special thanks to

- Chitra Saxena, Manager, Kreitcrman PET Center
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