Value of true whole-body FDG-PET/CT scanning protocol in oncology and optimization of its use based on primary malignancy

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The authors declare no conflicts of interest
Background

- PET/CT more accurate than either PET or CT for staging/restaging \(^1\)
- True Whole-Body (WB) PET/CT involves imaging from the vertex to the toes including the arms \(^2\)
- Limited WB PET/CT fields of view (FOV) exclude portions of the head, upper and lower extremities \(^2\)
- True WB PET/CT FOV detects more disease than limited WB PET/CT FOVs \(^2\)
- Currently several limited WB PET/CT FOV are used for staging/restaging \(^2\)
- Rationale for using limited WB FOV compared to true WB FOV:
  - decrease in scanning time
  - decreased radiation dose to patient and,
  - little perceived clinical benefit from additional imaging

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Purpose

Some PET/CT FOV:
- Top left – true whole body
- Top middle – vertex to mid-thighs
- Top right – vertex to upper thighs
- Bottom left – skull base to toes
- Bottom middle – skull base to mid-thighs
- Bottom right – skull base to upper thighs

AIM:
- To assess the frequency of findings suspicious for malignancy that occur outside limited whole body fields of view
- Assess how often these change clinical stage?
- Change clinical management (change in treatment, surgery, radiation, palliative care etc.)

MATERIALS AND METHODS:
- Retrospective review of 804 consecutive WB PET/CT studies performed on 556 subjects for known or suspected malignancy
- Suspicious metabolic foci were identified based on:
  - SUV>2.5
  - Not a normal variant
- Evaluated studies for new/additional sites of disease:
  - superior to the skull base
  - distal to the lesser trochanter but proximal to the knee (proximal lower extremity)
  - distal to the knee (distal lower extremity)
  - distal to the humeral neck but proximal to the elbow (proximal upper extremity)
  - distal to the elbow (distal upper extremity)
Results

- 556 patients (804 PET/CT studies)
- 137 patients had at least one follow-up examination (mean 1.45 examinations per patient)
- Solitary pulmonary nodule most common indication for PET/CT

**Table 1: Most frequent indications for PET/CT**

<table>
<thead>
<tr>
<th>Diagnosis</th>
<th>No. of Patients</th>
<th>Frequency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solitary Pulmonary Nodule</td>
<td>125</td>
<td>22.5</td>
</tr>
<tr>
<td>Lung cancer&lt;sup&gt;a,b&lt;/sup&gt;</td>
<td>70</td>
<td>12.6</td>
</tr>
<tr>
<td>Head and neck cancer&lt;sup&gt;c,d&lt;/sup&gt;</td>
<td>50</td>
<td>9.0</td>
</tr>
<tr>
<td>Lymphoma&lt;sup&gt;b,c,f&lt;/sup&gt;</td>
<td>50</td>
<td>9.0</td>
</tr>
<tr>
<td>Colorectal cancer</td>
<td>30</td>
<td>5.4</td>
</tr>
<tr>
<td>Hepatocellular cancer</td>
<td>30</td>
<td>5.4</td>
</tr>
<tr>
<td>Esophageal cancer</td>
<td>30</td>
<td>5.4</td>
</tr>
<tr>
<td>Bladder cancer</td>
<td>17</td>
<td>3.1</td>
</tr>
<tr>
<td>Melanoma&lt;sup&gt;f&lt;/sup&gt;</td>
<td>14</td>
<td>2.5</td>
</tr>
<tr>
<td>Multiple myeloma&lt;sup&gt;g&lt;/sup&gt;</td>
<td>13</td>
<td>2.3</td>
</tr>
<tr>
<td>Renal cell cancer</td>
<td>9</td>
<td>1.6</td>
</tr>
<tr>
<td>Anal cancer</td>
<td>8</td>
<td>1.4</td>
</tr>
<tr>
<td>Breast cancer</td>
<td>6</td>
<td>1.1</td>
</tr>
<tr>
<td>Prostate cancer</td>
<td>6</td>
<td>1.1</td>
</tr>
<tr>
<td>Sarcoma&lt;sup&gt;d,h&lt;/sup&gt;</td>
<td>5</td>
<td>0.1</td>
</tr>
<tr>
<td>Testicular cancer</td>
<td>3</td>
<td>0.1</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>466</strong></td>
<td><strong>83.8</strong></td>
</tr>
</tbody>
</table>
## Results

**Figure 2**: Percentage of subjects with missed lesions by FOV

<table>
<thead>
<tr>
<th>Limited Whole Body Field of View</th>
<th>Number of subjects with missed lesions</th>
<th>Percentage of subjects with missed lesions (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertex to upper thighs, excluding upper extremity</td>
<td>38</td>
<td>6.8</td>
</tr>
<tr>
<td>Vertex to upper thighs, imaging proximal upper extremity</td>
<td>38</td>
<td>6.8</td>
</tr>
<tr>
<td>Vertex to upper thighs, imaging the entire upper extremity</td>
<td>33</td>
<td>5.9</td>
</tr>
<tr>
<td>Vertex to knees excluding upper extremity</td>
<td>18</td>
<td>3.2</td>
</tr>
<tr>
<td>Vertex to knees, imaging proximal upper extremity</td>
<td>17</td>
<td>3.1</td>
</tr>
<tr>
<td>Vertex to knees, imaging the entire upper extremity</td>
<td>6</td>
<td>1.1</td>
</tr>
<tr>
<td>Vertex to toes, excluding upper extremity</td>
<td>13</td>
<td>2.3</td>
</tr>
<tr>
<td>Vertex to toes, imaging proximal upper extremity</td>
<td>2</td>
<td>0.4</td>
</tr>
<tr>
<td>Skull base to upper thighs excluding upper extremity</td>
<td>47</td>
<td>8.5</td>
</tr>
<tr>
<td>Skull base to upper thighs, imaging proximal upper extremity</td>
<td>47</td>
<td>8.5</td>
</tr>
<tr>
<td>Skull base to upper thighs, imaging the entire upper extremity</td>
<td>42</td>
<td>7.6</td>
</tr>
<tr>
<td>Skull base to knees excluding upper extremity</td>
<td>28</td>
<td>5.0</td>
</tr>
<tr>
<td>Skull base to knees, imaging proximal upper extremity</td>
<td>27</td>
<td>4.9</td>
</tr>
<tr>
<td>Skull base to knees, imaging the entire upper extremity</td>
<td>19</td>
<td>3.4</td>
</tr>
<tr>
<td>Skull base to toes, excluding upper extremity</td>
<td>25</td>
<td>4.5</td>
</tr>
<tr>
<td>Skull base to toes, imaging proximal upper extremity</td>
<td>17</td>
<td>3.1</td>
</tr>
<tr>
<td>Skull base to toes, imaging the entire upper extremity</td>
<td>15</td>
<td>2.7</td>
</tr>
</tbody>
</table>

**Figure 3**: Percentage of subjects with missed lesions by body part

- **Proximal Upper**: 2.2% (12)
- **Proximal Lower**: 5.6% (31)
- **Distal Upper**: 0.4% (2)
- **Distal Lower**: 1.1% (5)
- **Scalp**: 1.4% (8)
- **Brain**: 1.3% (7)
- **Upper Extremity**: 2.3% (13)
- **Lower Extremity**: 5.9% (33)
Results

**Frequency**
- Most restricted limited WB FOV is from the skull base to the upper thighs excluding the upper extremities
- 8.5% (47/556) of subjects had suspicious findings outside the most limited FOV
- More proximal than distal lesions
  - 6.5% (36/556) of subjects had lesions in the proximal extremities compared to 1.4% (8/556) with lesions in the distal extremities
- More lower extremity than upper extremity lesions
  - 5.9% (33/556) of subjects had lesions in the lower extremities compared to 2.3% (13/556) of subjects with lesions in the upper extremities

**Effect on Clinical Staging:**
- Stage changed in one patient (0.2%) who was upstaged from IIIB disease to stage IV disease

**Effect on Clinical Management:**
- There were 7 patients (1.3%) where true WB PET/CT changed the clinical management with newly discovered or recurrent brain lesions detected
  - gadolinium contrast-enhanced brain MRI to evaluate metastases
  - whole brain radiation therapy/ gamma knife radiation therapy or
  - the decision to change management to palliative care
Conclusions

CONCLUSIONS:

- Findings suggest true WB PET/CT detects additional sites of malignancy in over 8% of subjects.
- Over 10% of patients with the following malignancies had findings outside the most restricted limited WB FOV:
  - Melanoma
  - Multiple myeloma
  - Sarcoma
  - Lymphoma
  - Stage IV
    - Renal cell
    - Bladder
    - Testicular
    - Prostate
    - Breast cancer
- Findings suggest that some malignancies have increased propensity to have metastases outside the most restricted limited WB FOV.
- True WB PET/CT should also be used when the primary/index lesion is outside of the other limited WB FOV.

LIMITATIONS

- Retrospective study
- Academic center
- Population 96% male, so not generalizable to all populations

DISCUSSION

- Benefit of knowing total extent of disease
- Pathological fractures
- Explain symptoms
- Prognosis (metabolic tumor volume)
- Cost and billing for different limited WB PET/CT FOV
- Additional time for true WB FOV 20 – 40 minutes longer