Evaluation of Incidence and Economic Impact of Incidental Findings on $^{18}$F-FDG PET/CT Imaging

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Disclosure

- No conflict of interest
Background

- Incidental findings (IFs)—findings that are unrelated to the clinical indication for the imaging examination performed—are increasingly recognized as a systemic problem plaguing the health system and compromising patient care.¹

- There is a paucity of data regarding the prevalence of IFs on PET/CT and the economic impact of follow-up of IFs initially identified on PET/CT.²,³

Objectives

To determine:

- Incidence of IFs reported on PET/CT imaging
- Associations of IFs with patient characteristics (age, sex, BMI, diabetes)
- Rate of radiologists’ recommendations for imaging follow-up
- Actual rate of follow-up imaging of IFs
- Additional cost related to follow-up imaging of IFs
Methods

Retrospective review of PET/CT imaging studies at our institution between October 2013 and August 2014

Inclusion Criteria:
(1) Whole body or near-whole body PET/CT studies
(2) Patients who consented to inclusion in our institutional PET/CT Registry

Exclusion Criteria:
(1) Anatomically limited studies
(2) Patients with a previous PET/CT study within the study period
(3) Patients residing outside of the Saskatoon Health Region
## Methods

### Patient Characteristics

**Patient Characteristics (N = 153)**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age, years Mean (SD)</td>
<td>59.1 (17.9)</td>
</tr>
<tr>
<td>Range</td>
<td>2.2, 89.7</td>
</tr>
<tr>
<td>Sex, n (%) Male</td>
<td>93 (60.8)</td>
</tr>
<tr>
<td>Female</td>
<td>60 (39.2)</td>
</tr>
<tr>
<td>Indication for imaging, n (%)</td>
<td>Oncological 148 (96.7)</td>
</tr>
<tr>
<td>Non-oncological</td>
<td>5 (3.3)</td>
</tr>
</tbody>
</table>
**Methods**

**Definition – Incidental Finding**

- A significant non-physiologic area of $^{18}$F-FDG uptake or an abnormality on the CT component of the PET/CT scan considered unrelated to the clinical indication for imaging as provided by the referring physician.
- Findings were considered IFs if they had an atypical location, pattern, or intensity for metastasis as determined by the reporting nuclear medicine physician.¹

Not included in the definition of an IF¹,²
- Expected sites of direct extension or lymphangitic or hematogenous spread for a specific malignancy
- Tumor recurrence
- Normal physiologic or non-pathological anatomic variants
- Past surgical interventions
- Old injuries
- Normal line or pacemaker locations

**Other variables abstracted**
- Age
- Sex
- BMI
- Diabetes
- Recommendations for follow-up

Methods

Follow-Up Imaging and Cost Analysis
• Provincial PACS was queried to identify follow-up imaging studies up to one-year following the initial PET/CT study.
• Total direct cost of follow-up imaging of IFs (including hospital/technical costs and interpretation fees) was calculated using local health region data.

Statistical Methods
• Descriptive statistics (mean values, standard deviations, and mean differences for continuous variables; frequencies and proportions for categorical variables) were determined.
• Associations between patient characteristics and reporting of IFs were compared by t-test/ANOVA for continuous variables, and conclusions were unchanged with non-parametric (Mann-Whitney-U, Kruskal-Wallace) testing.
• Categorical variables were compared by odds ratios and chi-square testing.
• Analysis was completed using SPSS software, version 23 (Chicago, Ill).
Results

71.2%
Reports with at least one IF reported in body of report

35.3%
Reports with at least one IF reported in impression

1.5
Mean number of IFs reported in body of report

0.45
Mean number of IFs reported in impression

153 patients

109 patients with IFs reported

230 IFs reported in body of report

69 IFs reported in impression of report

44 patients with no IFs reported

Non-FDG-avid CT findings, FDG-avid findings with no CT correlate, and FDG-avid findings with CT correlate were identified in similar proportions
## Results – Associations with Patient Characteristics

Association between patient characteristics and the reporting of incidental findings in the impression section of the report

<table>
<thead>
<tr>
<th>IF reported</th>
<th>Odds ratio</th>
<th>p-value*</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Yes (n=54)</strong></td>
<td><strong>No (n=99)</strong></td>
<td></td>
</tr>
<tr>
<td>Age, year, mean (SD)</td>
<td>65.6 (14.2)</td>
<td>56.1 (19.1)</td>
</tr>
<tr>
<td>BMI, mean (SD)</td>
<td>27.0 (7.6)</td>
<td>28.1 (6.3)</td>
</tr>
<tr>
<td>Sex, n (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>37 (68.5)</td>
<td>56 (56.6)</td>
</tr>
<tr>
<td>Female</td>
<td>17 (31.5)</td>
<td>43 (43.4)</td>
</tr>
<tr>
<td>Diabetes, n (%)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>9 (16.7)</td>
<td>14 (14.1)</td>
</tr>
<tr>
<td>No</td>
<td>45 (83.3)</td>
<td>85 (85.9)</td>
</tr>
</tbody>
</table>

*Continuous variables compared by t-test. Conclusions unchanged with non-parametric (Mann-Whitney-U) testing.
Results – IFs by Age

Percentage of patients with incidental findings by number of IFs reported, within each age category

<table>
<thead>
<tr>
<th>Age (years)</th>
<th>0 IFs</th>
<th>1 IF</th>
<th>2 IFs</th>
<th>≥3 IFs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less than 45</td>
<td>45</td>
<td>31</td>
<td>54</td>
<td>66</td>
</tr>
<tr>
<td>45-59</td>
<td>31</td>
<td>54</td>
<td>66</td>
<td></td>
</tr>
<tr>
<td>60-74</td>
<td>54</td>
<td>66</td>
<td></td>
<td></td>
</tr>
<tr>
<td>75 and older</td>
<td>66</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Mean number of IFs in the impression section per patient: 0.10, 0.31, 0.54, 0.66

p = 0.006
Results – Radiologists’ Recommendations

- 153 patients
  - 109 patients with IFs reported
    - 230 IFs reported in body of report
      - 69 IFs reported in impression of report
        - 40 recommendations
          - 14 recommendations acted upon
  - 44 patients with no IFs reported

33% Patients for whom further imaging/tests/procedures were recommended

35% Radiologists’ recommendations actually carried out
## Results – Follow-Up Imaging

### Most frequent imaging studies recommended

<table>
<thead>
<tr>
<th>Imaging Study</th>
<th>n (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ultrasound</strong></td>
<td></td>
</tr>
<tr>
<td>Thyroid</td>
<td>6</td>
</tr>
<tr>
<td>Prostate</td>
<td>2</td>
</tr>
<tr>
<td>Renal</td>
<td>2</td>
</tr>
<tr>
<td>Other</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>12 (30)</td>
</tr>
<tr>
<td><strong>CT</strong></td>
<td></td>
</tr>
<tr>
<td>CT chest</td>
<td>5</td>
</tr>
<tr>
<td>Other</td>
<td>3.5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>8.5 (21)</td>
</tr>
<tr>
<td><strong>MR</strong></td>
<td></td>
</tr>
<tr>
<td>Adrenal</td>
<td>2</td>
</tr>
<tr>
<td>Other</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>7 (18)</td>
</tr>
<tr>
<td><strong>PET or PET/CT</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>7 (18)</td>
</tr>
<tr>
<td><strong>Bone scan</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>3.5 (9)</td>
</tr>
<tr>
<td><strong>Radiography/mammography</strong></td>
<td>2 (5)</td>
</tr>
</tbody>
</table>

### Costs

- **$472.76**
  
  Average direct cost of each imaging recommendation

- **$123.60**
  
  Per patient average direct cost for recommended follow-up imaging

- **$43.26**
  
  Per patient actual direct cost of follow-up imaging (Predictive value of costs of follow-up imaging)
Results – Case Examples

84-year-old female patient referred for assessment of a right lower lobe mass following two negative biopsies. Intensely FDG avid 1 cm nodule was identified in the medial right breast.

**Follow-up imaging**
- Mammography
- U/S-guided biopsy
  → Ductal carcinoma in situ
Results – Case Examples

74-year-old female patient referred for pre-biopsy assessment of a right lower lobe mass. Moderate hypermetabolism is associated with a 1.9 x 1.3 cm section of the distal body of the pancreas.

Follow-up imaging
- MR abdomen
- Tumour localization octreotide and SPECT CT
- MR pancreas and MRCP x 2
- PET/CT → resolved
83-year-old female for initial staging of a malignant gastric lesion. Intense focal increased tracer uptake involving the right side of the thyroid gland was incidentally noted.

Follow-up imaging
• Thyroid U/S
Limitations

- As the imaging report was used as the unit of analysis rather than the actual images, this study does not provide true incidence of IFs on PET/CT imaging (but it does provide the real-world incidence of IFs which are reported).
- At our centre the majority PET/CT studies are reported by nuclear medicine physicians; different training backgrounds (nuclear medicine or diagnostic radiology) of interpreters may effect the rate at which IFs are reported.
- Our provincial PACS system may not include all studies performed in private clinics, underestimating the actual rate of follow-up of IFs and underestimating the costs of follow-up imaging.
Conclusions

- IFs are identified in a significant proportion of PET/CT studies and are more frequent in older patients.
- Reporting of IFs may be influenced by patient demographics and/or co-morbidities.
- Recommendations for follow-up imaging are made for numerous IFs, with significant cost implications.
- Most recommendations for further imaging of IFs are not acted upon by clinicians.
Implications

- Variable recommendations for follow-up imaging of IFs and low rates of follow-up of IFs suggest the need for the development of national or international guidelines for appropriate follow-up of IFs identified on PET/CT.
- This study provides preliminary data to allow clinicians, as part of informed consent processes, to inform patients prior to PET/CT imaging of the probability of an IF being identified.
- This study provides clinicians and policy-makers with preliminary data to allow them to better assess the overall costs of PET/CT imaging.
- As Canada’s population ages it will be increasingly important to consider IFs in healthcare modelling.

Thank you!

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