PET/CT in the Management of Colorectal Cancer

R. Petter Tonseth BSc., MD, FRCPC
Radiologist / Nuclear Medicine Physician
BCCA Centre of Excellence for Functional Cancer Imaging
2012 Fall Update in Surgical Oncology:
Malignancies of the Lower GI Tract
October 20, 2012

pete.tonseth@becancer.bc.ca
Disclosures

- None
Objectives

- Briefly review the fundamentals of Positron Emission Tomography
- Review the indications for PET/CT in colorectal carcinoma
- Review the sensitivity/specificity of PET/CT in CRC
- Review the current availability and usage of PET/CT in BC
- Questions
Objectives

- Briefly review the fundamentals of Positron Emission Tomography
- Review the indications for PET/CT in colorectal carcinoma
- Review the sensitivity/specificity of PET/CT in CRC
- Review the current availability and usage of PET/CT in BC
- Questions
Fundamentals of PET imaging

- $\text{H}_2 (\text{O-18}) + \text{H-1} + \text{energy} \rightarrow \text{H}_2 (\text{F-18})$

- $\text{H}_2 (\text{F-18}) + \text{glucose} \rightarrow \text{FDG}$
Fundamentals of PET imaging

- FDG dispensed
- Injected into patient
- 1 hour uptake
- $\beta$ decay with positron emission
- Annihilation with an electron
- Release of 511keV photons at $\approx 180^\circ$
Fundamentals of PET imaging

- Patient positioned
- Coincidence detection
- Image reconstruction
- Patients are in the department for $\approx 2h$

Phelps M E PNAS 2000;97:9226-9233
Objectives

- Briefly review the fundamentals of Positron Emission Tomography
- Review the indications for PET/CT in colorectal carcinoma
- Review the sensitivity/specificity/accuracy of PET/CT in CRC
- Review the current availability and usage of PET/CT in BC
- Questions
<table>
<thead>
<tr>
<th>Cancer Indication</th>
<th>Canada¹</th>
<th>United States²</th>
<th>Europe</th>
<th>Australia</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brain - primary</td>
<td>CTA</td>
<td>YES</td>
<td></td>
<td>YES</td>
</tr>
<tr>
<td>Breast</td>
<td>YES</td>
<td>YES</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cervix</td>
<td>CTA</td>
<td>YES</td>
<td></td>
<td>YES</td>
</tr>
<tr>
<td>Colorectal</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Esophagus</td>
<td>CTA</td>
<td>YES</td>
<td></td>
<td>YES</td>
</tr>
<tr>
<td>Head and Neck</td>
<td>CTA</td>
<td>YES</td>
<td></td>
<td>YES</td>
</tr>
<tr>
<td>Lung</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>Lymphoma</td>
<td>CTA</td>
<td>YES</td>
<td></td>
<td>YES</td>
</tr>
<tr>
<td>Melanoma</td>
<td>CTA</td>
<td>YES</td>
<td></td>
<td>YES</td>
</tr>
<tr>
<td>Ovary</td>
<td>CTA</td>
<td>YES</td>
<td></td>
<td>YES</td>
</tr>
<tr>
<td>Stomach</td>
<td>CTA</td>
<td>YES</td>
<td></td>
<td>YES</td>
</tr>
<tr>
<td>Testicular</td>
<td>CTA</td>
<td>YES</td>
<td></td>
<td>YES</td>
</tr>
<tr>
<td>Thyroid</td>
<td>CTA</td>
<td>YES</td>
<td></td>
<td>YES</td>
</tr>
</tbody>
</table>

Table adapted from Demeter et al., 2009
¹YES – based on approved indications for five Health Canada approved FDG products circa January 2008
²Since 2006, the CMS will cover PET scanning for almost any malignancy if the appropriate paperwork is submitted
Funded indications for PET/CT in Colorectal Carcinoma:

BCCA

Colorectal Carcinoma

- Determination of stage in patients with potentially resectable recurrence (including rising CEA)

http://www.bccancer.bc.ca/PPI/PET/indications.htm
Other cancers given specific clinical indications, as approved by the BC Cancer Agency, on an individual basis.

It is recognized in clinical practice that there may be clinical scenarios that do not meet specific guidelines but where expert medical opinion indicates the procedure could have a major impact on patient management. PET scan referrals in these cases will be reviewed on an individual basis and if approved by consensus, the patient will be offered participation in the study.

http://www.bccancer.bc.ca/PPI/PET/indications.htm
Funded indications for PET/CT in Colorectal Carcinoma: Ontario

Colorectal Carcinoma

- determining management and prognosis if conventional imaging is equivocal for the presence of metastatic disease
- to determine the site of recurrence in the setting of rising CEA when a conventional workup fails to unequivocally identify metastatic disease
- in the preoperative management assessment of colorectal cancer liver metastases prior to surgical resection

www.cancercare.on.ca
Funded indications for PET/CT in Colorectal Carcinoma: USA

- Colorectal carcinoma

Preoperative evaluation of patients with potentially resectable metastatic disease

Determining location of tumours when rising CEA level suggests recurrence
Funded indications for PET/CT in Colorectal Carcinoma: Australia

- Colorectal carcinoma

Prior to resection of primary or limited metastatic disease

Suspected recurrence or residual on structural imaging after definitive therapy

www.msac.gov.au/.../MSAC35a_PET_CRC_print250608new.pdf
Current UK Indications for PET/CT in Colorectal Carcinoma

Colorectal carcinoma

- Staging of patients with synchronous metastases at presentation suitable for resection or patients with equivocal findings on other imaging; for example, pulmonary or liver lesions.
- Restaging of patients with recurrence being considered for radical treatment and/or metastatectomy.
- Detection of recurrence in patients with rising tumour markers and/or clinical suspicion of recurrence with normal or equivocal findings on other imaging.

57 yo female, colon CA with potentially resectable hepatic mets on CT
Colorectal Carcinoma

- 57 yo female, colon CA with potentially resectable hepatic mets on CT
Colorectal Carcinoma

- 57 yo female, colon CA with potentially resectable hepatic mets on CT
Colorectal Carcinoma

- Rectal CA, staging Abd/Pel CT July 4, diversion ileostomy July 20, Chest CT Aug. 24 to complete staging, PET/CT Sept. 6
Colorectal Carcinoma

- Rectal CA, staging Abd/Pel CT July 4, diversion ileostomy July 20, Chest CT Aug. 24 to complete staging

PET/CT Sept. 6
Colorectal Carcinoma

- 81 yo female, limited colon CA resected in 2011 with 0/31 nodes positive, ? isolated hepatic metastasis
Colorectal Carcinoma

81 yo female, limited colon CA resected in 2011 with 0/31 nodes positive, ? isolated hepatic metastasis
Colorectal Carcinoma

- 55 yo male, T3 N0 rectal carcinoma with pulmonary nodules on CT
  Aug 2011
  August 2012
55 yo male, T3 N0 rectal carcinoma with pulmonary nodules on CT, PET/CT shows no apparent activity
Colorectal Carcinoma

- 55 yo male, T3 N0 rectal carcinoma with pulmonary nodules on CT, PET/CT shows no apparent activity

respiratory motion artifact
PET/CT **not** recommended in:

- Diagnosis or staging of clinical stage I-III colorectal cancers
- The routine surveillance in patients with colorectal cancer treated with curative surgery at high risk for recurrence

[www.cancercare.on.ca](http://www.cancercare.on.ca)
PET/CT not recommended in:

- The measurement of treatment response in locally advanced rectal cancer before and after preoperative chemotherapy

www.cancercare.on.ca
Monitoring and Predicting Response to Therapy with 18F-FDG PET in Colorectal Cancer: A Systematic Review

Lioe-Fee de Geus-Oei1, Dennis Vriens1, Hanneke W.M. van Laarhoven2, Winette T.A. van der Graaf2, and Wim J.G. Oyen1

- therapy response assessment with 18F-FDG PET remains a very worthwhile research topic.

Treatment response

**Prognostic Ability of 18F-FDG PET/CT in the Assessment of Colorectal Liver Metastases**

Vijayaragavan Muralidharan1, Marco Kwok1, Sze Ting Lee2,3, Lawrence Lau1, Andrew M. Scott*2,3, and Christopher Christophi

- **Maximum and mean standardized uptake value did not show any significant predictive ability.**

- **volumetric 18F-FDG PET parameters…. may enable better risk stratification of patients.**

Objectives

- Briefly review the fundamentals of Positron Emission Tomography
- Review the indications for PET/CT in colorectal carcinoma
- Review the sensitivity/specificity of PET/CT in CRC
- Review the current availability and usage of PET/CT in BC
- Questions
Detection of Recurrence in Patients With Rectal Cancer: PET/CT After Abdominoperineal or Anterior Resection

Even-Sapir, E., Parag, Y., Lerman, H.

“PET/CT was used to distinguish benign and malignant presacral abnormalities with a sensitivity, specificity, positive predictive value, and negative predictive value of 100%, 96%, 88%, and 100%, respectively.”

Radiology | vol. 232, 815 - 822, 2004
PET changes management and improves prognostic stratification in patients with recurrent colorectal cancer: results of a multicenter prospective study.

Scott AM, Gunawardana DH, Kelley B, Stuckey JG, Byrne AJ, Ramshaw JE, Fulham MJ.

Colorectal Carcinoma

Group A – structural lesion suggestive of recurrence
- Additional disease in 48.4%; change in management in 65.6%

Group B – resectable pulmonary or hepatic metastases
- Additional disease in 43.9%; change in management in 49%

Colorectal Carcinoma

The Value of FDG Positron Emission Tomography/Computerised Tomography (PET/CT) in Pre-Operative Staging of Colorectal Cancer: A Systematic Review and Economic Evaluation

Health Technology Assessment, No. 15.35, September 2011

J Brush, K Boyd, F Chappell, F Crawford, M Dozier, E Fenwick, J Glanville, H McIntosh, A Renehan, D Weller, and M Dunlop.
Colorectal Carcinoma

UK based, systematic review of published and unpublished articles
“colorectal”, “neoplasm”, “FDG/PET”

3933 titles/abstracts identified by search words; 3431 excluded

Of the remaining 502, only 30 met the inclusion criteria

Colorectal Carcinoma

- 2 studies looked at primary CRC – insufficient data to support

- 5 studies looked at detection of recurrent disease
  
  Sensitivity 91%    Specificity 91%

- 23 studies looked at detection of metastatic disease

  Sensitivity 91%    Specificity 76%

Objectives

- Briefly review the fundamentals of Positron Emission Tomography
- Review the indications for PET/CT in colorectal carcinoma
- Review the sensitivity/specificity/accuracy of PET/CT in CRC
- Review the current availability and usage of PET/CT in BC
- Questions
PET/CT in BC

- Two scanners located at BCCA
- 6000 scans per year
- 4100 Jan-Sept 2012
- 500 related to colorectal carcinoma
- Urgent scans can currently be completed within 2 weeks
PET/CT in BC

Colorectal Cancer PET/CT Scans by Health Authority
Current Indications for PET/CT in Colorectal Carcinoma

Colorectal Carcinoma

- Determination of stage in patients with potentially resectable recurrence (including rising CEA)

http://www.bccancer.bc.ca/PPI/PET/indications.htm

Colorectal carcinoma

- Staging of patients with synchronous metastases at presentation suitable for resection or patients with equivocal findings on other imaging; for example, pulmonary or liver lesions.
- Restaging of patients with recurrence being considered for radical treatment and/or metastatectomy.
- Detection of recurrence in patients with rising tumour markers and/or clinical suspicion of recurrence with normal or equivocal findings on other imaging.
Objectives

- Briefly review the fundamentals of Positron Emission Tomography
- Review the indications for PET/CT in colorectal carcinoma
- Review the sensitivity/specificity of PET/CT in CRC
- Review the current availability and usage of PET/CT in BC
- Questions
Thank you

R. Petter Tonseth BSc., MD, FRCPC
Radiologist / Nuclear Medicine Physician
BCCA Centre of Excellence for Functional Cancer Imaging
2012 Fall Update in Surgical Oncology:
Malignancies of the Lower GI Tract
October 20, 2012

pete.tonseth@becancer.bc.ca