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Evidence-Based Series 7-18

A Quality Initiative of the
Program in Evidence-Based Care (PEBC), Cancer Care Ontario (CCO)

**Positron Emission Tomography in
Radiation Treatment Planning for Lung Cancer**

Y.C. Ung, A. Bezjak, N. Coakley, W.K. Evans, and the Lung Cancer Disease Site Group

Report Date: November 17, 2010

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Assessment & Review Protocol)

The full Evidence-based Series 7-18 is comprised of 3 sections
and is available on the CCO website on the PEBC Lung Cancer DSG page.

   Section 1:   Guideline Recommendations
   Section 2:   Evidentiary Base
   Section 3:   EBS Development Methods and External Review Process

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Evidence-Based Series 7-18

Positron Emission Tomography in Radiation Treatment Planning for Lung Cancer: Guideline Recommendations

Y.C. Ung, A. Bezjak, N. Coakley, W.K. Evans, and the Lung Cancer Disease Site Group

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QUESTION
What role should positron emission tomography (PET) play in radiation treatment planning for non-small cell lung cancer (NSCLC)? Specifically, does the combination of PET and computed axial tomography (CT) imaging provide data that is superior to CT imaging data alone for the purposes of radiation treatment (RT) planning?

TARGET POPULATION
Patients with lung cancer for whom thoracic RT is indicated.

INTENDED USERS
Radiation oncologists involved in RT planning.

RECOMMENDATIONS AND KEY EVIDENCE
Combination PET-CT imaging data may be used as part of research protocols in RT planning. Current evidence does not support the routine use of PET-CT imaging data in RT planning at this time outside of a research setting.
- The PET START trial, released in abstract form at the 2009 ASCO Annual Meeting (1), reported on the use of PET-CT compared to CT in treatment planning for patients with stage III non-small cell lung cancer (NSCLC). The primary outcome was the proportion of patients who did not receive combined modality therapy because their tumour was upstaged to stage 4 or their intrathoracic tumour was too extensive for radical RT. The primary outcome was achieved in 15% of the patients randomized to PET, as opposed to 2.7% in the CT arm (p=0.0002). Data on other outcomes, including overall survival, have not yet been reported.

- Twenty-eight non-randomized prospective and retrospective studies provided evidence on the impact of PET imaging data on RT planning (2-29).
- No studies provided data on the effect of PET-based changes in RT planning on patient outcomes such as overall survival, recurrence, or quality of life. Therefore, data on technical measures form the evidence base of this recommendation. These measures include changes in gross treatment volume (GTV) and changes in planning treatment volume (PTV)
- Eighteen studies including a total of 587 patients reported changes in GTV as a result of the inclusion of PET data in RT planning (2-12,20-22,27,29). See Table 3 and its accompanying text in Section 2 of this Evidence-based Series for details of these data.
- Eleven studies including a total of 283 patients reported changes in PTV as a result of the inclusion of PET data in RT planning. (5-7,9,12-17,21). See Table 4 and its accompanying text in Section 2 of this Evidence-based Series for details of these data.
- The limited data available suggest that the addition of PET to RT planning is more likely to decrease the dose to the esophagus rather than increase it. Two of five studies (3,7,8,18,22) providing data on esophageal exposures (V_{50-55}eso), reported statistically significant decreases (-10.4%, p<0.005, and -8.7%, p=0.004, respectively) (8,18), and one study reported a result with no significance test (22). Changes in total radiation dosages to the esophagus were more variable across the studies, although one study did report a statistically significant (p=0.004) decrease of 6.1 Gy (8).
- The available data regarding the effect of PET in RT planning on dose to lung tissue is mixed. While substantial numbers of patients experience a change in V_{20}lung (between 42% and 100% of patients across four studies (3,7,9,22), these changes involve both increases and decreases. However, three studies (8,12,18), did report statistically significant reductions in V_{20} lung. The data do suggest that PET does reduce lung dose, with four studies (8,9,12,18) reporting decreases (range of changes -5.1 to +1.5 Gy), and one of these reported a statistically significant decrease (8).
- Two studies evaluated the impact of PET on the total RT dose administered and treatment control probability: the total RT dose administered to patients increased by approximately 15 Gy because of PET, and the tumour control probability increased by 17.7% and 8.6% (p=0.026), respectively (8,18).
- In twelve studies (6,7,9-11,13,14,17,19,21,23,24) with a total of 656 patients, PET detected distant metastases in 8% to 25% of patients and resulted in a change from curative to palliative RT intent in 8% to 41% of patients.

QUALIFYING STATEMENTS
- There is only one randomized trial, the PET-START trial, to inform recommendations on this topic, and this trial has only been reported in abstract form. Should the results of this trial be similar when reported in a peer-reviewed publication with longer follow-up, the recommendation above may warrant review.
- There are no data available that demonstrate an impact of PET-based RT planning on either survival or local recurrence rates.
- The available evidence, besides the PET-START trial, consists of data from small, non-randomized studies that report on changes in treatment volume, changes in treatment intent, and changes in dose delivered to critical organs. These data, taken as a whole, suggest that the addition of PET increases accuracy in RT planning.
- The available data on change in treatment volume and other changes in response to the incorporation of PET into RT planning have not yet been confirmed to be beneficial, for example, through clinicopathological correlation and/or failure analysis patterns.

- Higher quality research, such as randomized trials, should be conducted to better evaluate the utility of PET in RT planning and to determine if the technology provides added value over existing imaging technologies for this purpose. Investigators publishing data related to the use of PET should evaluate and report on a wider range of outcome measures.
- PET may be useful in RT planning under very specific circumstances in the differentiation of malignant from non-malignant tissue, such as lung opacification that may be due to tumour and/or major atelectasis or pneumonitis secondary to airway obstruction. Clinicians should cautiously interpret results in situations where PET is known to produce false-positive results (e.g., presence of inflamed lymph nodes due to pneumonitis).
- When performing RT planning, clinicians should take into consideration the technical specifications of the PET scanner being used, as these may modify the utility of the device for RT planning purposes.

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