Positron-emission tomography (PET) and computed tomography (CT) fusion imaging is a rapidly evolving technique that is useful in the staging of non-small-cell lung cancer (NSCLC), Hodgkin's disease, ovarian cancer, gastrointestinal stromal tumors, gynecologic malignancies, colorectal malignancies, and breast cancer. In their article, Rusthoven et al[1] describe the role of PET-CT in head and neck malignancies and include a review of all currently available literature. According to the authors, PET-CT is useful for staging head and neck carcinomas and for target volume delineation during radiation treatment planning.

Staging Standard
PET-CT is quickly becoming the standard of care for staging malignancies at certain anatomic sites. A study by Antoch et al[2] compared PET-CT with whole-body magnetic resonance imaging (MRI). The overall tumor-node-metastasis (TNM) stage was correctly determined in 77% of patients with PET-CT and in 54% with MRI. Moreover, compared with MRI, PET-CT had a direct effect on disease management in 12 patients. In a landmark study by Lardinois et al published in the *New England Journal of Medicine*,[3] PET-CT was found to improve the accuracy of NSCLC staging over PET and CT alone; the combined modality provided additional staging information in 41% of patients. In head and neck tumors, PET-CT again appears to be superior to PET alone, and probably also to PET and CT when both are assessed side by side for detection of tumor invasion and staging accuracy.[4] Schoder et al[5] found that PET-CT was more accurate in depicting cancer than was PET alone, and PET-CT findings resulted in a change in treatment in 12 of 68 patients, further establishing the higher efficacy of PET-CT over PET alone in recurrent head and neck cancer. Therefore, PET-CT may become a "one-stop shop" for oncologic staging of head and neck cancers.[6] 

Advantages of PET-CT
A major advantage of PET-CT over PET alone is the notable reduction in scanning time. A PET scan is composed of an emission scan, depicting the distribution of fluorine-18 fluorodeoxyglucose (FDG) in the body, and a transmission scan that is used for attenuation correction. For PET, the transmission scan can take approximately 20 minutes, increasing the total scanning time to approximately 50 minutes.[7] In PET-CT, the CT data are used for attenuation correction, and a whole-body scan can be performed in under 2 minutes.[8] An additional advantage of PET-CT is that the intrinsic hardware provides high-quality images through coregistration of both image datasets in a relatively fast acquisition time.[6] The coregistration of datasets obtained by different techniques (ie, PET with CT or MRI) at different time points may lead to inaccurate anatomic and physiologic delineation of the tumor with respect to normal tissues. These inaccuracies may be caused by anatomic changes, neck repositioning, or head and neck swelling. Feasibility studies have found that the use of PET-CT for planning three-dimensional (3D) conformal radiation therapy improves the standardization of volume delineation compared with CT alone.[9,10] Rusthoven et al[1] report that since July 2002, PET-CT fusion imaging has been an integral planning component for intensity-modulated radiation therapy in patients with head and neck cancer. Changes in the TNM stage have ranged from 14% to 36% with PET-CT, and treatment volume and dose have been altered in 14% and 11% of patients, respectively.

Target Volumes
That said, the authors do not define the appropriate threshold by which physiologic disease is correlated with anatomic disease. The resolution for clinical PET is approximately 5.0 to 7.0 mm, and without pathologic correlation to help determine the true extent of gross and microscopic physiologic disease, the radiation treatment volumes could be altered drastically. Furthermore, partial volume and misregistration effects can extend a portion of the PET-defined target volume into air spaces (ie, the larynx or trachea), which may alter the treatment volume. Rusthoven et al[1] also note that
PET-CT is not as sensitive in diagnosing tumors < 2 cm in diameter and may result in false-positive findings in inflammatory tissue or lesions. Institutional variability in defining the threshold of malignant disease with physiologic imaging can have a profound effect on the contoured biologic tumor volume. By raising or lowering the threshold, the resultant sensitivity is altered, and the volume of contoured disease decreases or increases, respectively. This may ultimately result in the underdose or overdose of the actual tumor volume. Recently, Scarfone et al[11] found that the threshold of PET images was adjusted on a case-by-case basis to adequately visualize FDG-avid lesions relative to the background, with the resultant "average" threshold being approximately 50% of maximum image intensity. They further expressed concern about the use of PET-CT for radiation treatment planning by pointing out that the optimal threshold needed to standardize the settings has yet to be determined. For this reason, we have resisted the urge to modify treatment planning contours by incorporating PET-CT in radiation treatment planning for head and neck cancer at our institution. Future studies confirming gross and microscopic pathologic disease with PET-CT will help define the appropriate threshold settings to better delineate target volumes.

**Conclusions**

In the multidisciplinary management of patients with cancer, PET-CT is an exciting and rapidly evolving technique that is improving our ability to make better treatment decisions. The use of PET-CT for staging primary and recurrent head and neck lesions is "ready for prime time," but its application in head and neck cancer treatment planning should be viewed as investigational until we can better correlate our imaging findings with gross and microscopic pathologic findings and resolve the issues of variable FDG uptake by the tumor and nodal metastases as well as institutional threshold variability.

**Disclosures:** The authors have no significant financial interest or other relationship with the manufacturers of any products or providers of any service mentioned in this article.

**References:**


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