**Introduction:** A recent meta-analysis suggested that patients with non–small-cell lung cancer (NSCLC) whose primary tumors have a higher standardized uptake value (SUV) derived from 18F-fluorodeoxyglucose positron emission tomography (PET) have a worse prognosis in comparison with those with tumors with lower values. However, previous analyses have had methodological weaknesses. Furthermore, the prognostic significance over the full range of SUV values in patients treated nonsurgically remains unclear. The aim of this retrospective study was to investigate the relationship between survival and maximum SUV (SUVmax) analyzed as a continuous variable, in patients with NSCLC, staged using PET/computed tomography (CT) and treated with radiotherapy with or without chemotherapy.

**Methods:** Eligible patients had a histological diagnosis of NSCLC, were treated with radical radiotherapy with or without chemotherapy as their primary treatment, and had pretreatment PET/CT scans. SUVmax, defined as the maximum pixel SUV value retrieved from the primary tumor, was analyzed primarily as a continuous variable for overall survival.

**Results:** Eighty-eight patients met eligibility criteria: stage I, 19; stage II, 10; and stage III, 59. Median SUVmax was 15.0 (range, 2.5–56). Higher stage was associated with higher SUVmax values \((p = 0.048)\). In univariate analysis, there was no evidence of a prognostic effect of SUVmax (hazard ratio per doubling = 0.83; 95% confidence interval, 0.62–1.11; \(p = 0.22\)). Analyzing SUVmax as a dichotomous variable (median cut point = 15.0), the hazard ratio (high: low) for risk of death was 0.71, with \(p = 0.18\) (95% confidence interval, 0.44–1.15).

**Conclusions:** In this cohort of patients, increasing SUVmax derived from 18F-fluorodeoxyglucose–PET/CT was associated with increasing tumor, node, metastasis (TNM) stage. We found no evidence of an association of increasing SUVmax with a shorter survival. Previous reports of an association between prognosis and SUVmax may partly be the result of methodological differences between this study and previous reports and an association between stage and SUVmax.

**Key Words:** Non–small-cell lung cancer, Positron emission tomography, Standardized uptake value, Prognosis.

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**Introduction:** In patients with non–small-cell lung cancer (NSCLC), the most important tumor-related prognostic factor is the tumor, node, metastasis (TNM) stage. The current noninvasive standard for tumor staging is hybrid positron emission tomography/computed tomography (PET/CT) using 18F-fluorodeoxyglucose (FDG). PET/CT has been shown to provide more precise anatomical and functional interpretations than PET or CT imaging alone.

In addition to its efficacy in assessing nodal and metastatic disease, FDG-PET/CT is thought to have a potential role as a prognostic factor. FDG uptake is commonly expressed as the standardized uptake value (SUV), a semiquantitative value defined as the tissue concentration of FDG in the region of interest divided by the injected dose normalized by body weight.

An update of the systematic review and meta-analysis of previous published studies, in which many patients were treated surgically and staged with FDG-PET, has suggested that the maximum SUV \((\text{SUV}_{\text{max}})\) of the primary tumor derived from 18F-FDG-PET scanning is potentially a prognostic indicator for outcome in patients with NSCLC. Nonetheless, this was not a consistent finding across all studies, which consisted mainly of patients with early-stage...
disease (stage IIB or less). Furthermore, most studies examined the effect of $SUV_{\text{max}}$ as a dichotomous variable, using a cutoff value equal in most cases to either the median or a so-called best cut point determined from the data, which will therefore vary from one study population to another.

Given the superiority of hybrid FDG-PET/CT in providing more accurate staging, in this study we assessed the survival outcomes of medically or surgically inoperable NSCLC patients treated with radical radiotherapy (RT) or chemoradiation at our institution. The aim was to determine whether primary tumor $SUV_{\text{max}}$, derived from the initial pretreatment FDG-PET/CT and evaluated as a continuous variable, provides prognostic information for overall survival (OS) independently of tumor stage.

Secondary objectives were to (1) assess the effect of $SUV_{\text{max}}$ on progression-free survival (PFS), (2) examine for any correlations between SUV variables and baseline patient and tumor variables, and assess whether there are any interactions between the above variables in their relationship to outcome. A further secondary objective was to examine the methodological validity of the “best cut point” method, using our data.

**METHODS**

**Study Design**

This was a retrospective cohort study of patients with NSCLC receiving radical RT at the Peter MacCallum Cancer Centre (Peter Mac) between January 2000 and December 2006.

**Patient Selection**

Before data collection, the study protocol was approved by the ethics committee of the Peter Mac. Eligible patients were identified via the Peter Mac PET Centre and RT databases if they met the following criteria: histological diagnosis of NSCLC, received radical RT (60 Gy in 30 fractions) with or without concurrent chemotherapy as their primary treatment, were at least 18 years or older at commencement of treatment, and had pretherapeutic imaging with an integrated PET/CT scanner (GE Discovery LS PET/CT scanner, Milwaukee, WI). Hence, patients who had stand-alone PET imaging instead of PET/CT scanning before treatment were excluded from this study. Other exclusion criteria were a history of other malignancies within the last 5 years (with the exception of in situ carcinoma and nonmelanoma skin cancer), prior treatment for NSCLC including surgery, and evidence of metastasis before treatment.

**Data Collection**

Patient demographics and potential prognostic factors were collected from the review of the hospital’s electronic medical records. This included tumor histology and differentiation, NSCLC stage according to TNM classification of malignant tumors (6th edition), Eastern Cooperative Oncology Group (ECOG) performance status, weight loss over the 3 months before diagnosis, smoking status, lung function, and Simplified Co-morbidity Score.5

RT treatment details and chemotherapy regimen, if applicable, and relevant parameters from PET/CT scanning details were recorded.

**FDG-PET/CT Imaging Technique and Interpretation**

An integrated PET/CT scanner (GE Discovery LS PET/CT scanner) was used for all patients in this study. Patients were required to fast 4 to 6 hours before PET/CT imaging. FDG-PET/CT scans encompassing the lower neck to the proximal thighs were performed on the combined PET/CT scanner. Image acquisition started at approximately 1 hour after FDG injection. Contemporaneous noncontrast CT scans were performed for the purposes of attenuation correction and anatomical correlation.

**SUV Methodology**

$SUV_{\text{max}}$ was derived using an SUV threshold isocontour based volume of interest around the primary tumor. The operator defined a volume manually around the entire tumor but excluding nearby benign structures with FDG avidity. The operator had discretion for selecting the SUV contour for the tumor, but usually a value of 4. In-house software (MARVN 2.16) was used to manually draw the region of interest placed over the entire primary lung tumor and to calculate SUV. An ellipsoidal volume of interest was placed over a representative region of the liver from which the patient’s mean liver SUV was recorded. This was used as a quality assurance parameter to ensure concordance of $SUV_{\text{max}}$ measurements. The percentage of FDG uptake by the primary lung tumor (% dose) was also recorded.

**Endpoint Definitions**

**Time-to-event endpoints**

Patients were followed to the end of 2008, and dates of disease progression and death recorded. After 2008, follow-up was incomplete and so a close out date was used to minimize reporting bias.

The start date for all time-to-event outcomes was the date of commencement of RT. OS was defined as time to death from any cause. PFS was defined as time to progression or death. All times were censored at the end of 2008 and by the date of last follow-up in patients lost to follow-up.

**Statistical Analysis**

The primary aim was to assess whether $SUV_{\text{max}}$ was related to OS after adjusting for T stage. Secondary aims were to assess the relationship between $SUV_{\text{max}}$ and PFS.

Baseline patient and tumor characteristic distributions were tabulated and their association with $SUV_{\text{max}}$ examined using Wilcoxon or Kruskal-Wallis tests for categorical variables and Spearman rank correlation coefficients for continuous variables. $SUV_{\text{max}}$, $SUV_{\text{mean}}$, and percentage dose were transformed to normalize their distribution using logarithms to base 2; this allows the interpretation of hazard ratios (HRs) in terms of doublings.

Survival curves were calculated using the Kaplan–Meier method and compared using the log-rank test. The median...
potential follow-up time for the study was calculated using the reverse Kaplan–Meier method. The assessment of the relationship of baseline variables to OS and PFS was undertaken using Cox regression for continuous variables or when assessing multiple variables simultaneously. The log-rank test was used to assess the relationship of single categorical variables to outcome. A Cox regression model with an interaction term was used to assess whether the prognostic effect of SUVmax differed according to the level of another factor (T stage, ECOG performance status, and histology). The relationship of SUVmax to the relative hazard rate (mortality rate) as a continuous function was estimated graphically using a cubic spline fitted to martingale residuals from a Cox model.

The best cut point method in the context of these data determines the cutoff value for dichotomizing SUVmax as that value for which the p value comparing high and low SUVmax groups with respect to OS is a minimum. We examined all possible cut point values between the 10th and 90th percentiles of SUVmax to allow sufficient numbers of events in each group. We used two methods to obtain an adjusted p value to correct for the method by which the nominal p value was obtained: a formula given by Altman et al.6 and a permutation test. The Altman formula in our case is given by:

$$p_{corr} = -1.63p_{max}(1 + 2.351\log(p_{max}))$$

where $p_{max}$ is the minimum p value obtained (the nominal p value) and $p_{corr}$ is the true (adjusted) p value. All analyses were undertaken using the R Statistical Package.

RESULTS

There were 88 patients who met eligibility criteria for analysis. Table 1 summarizes baseline characteristics and their relationship to SUVmax for the 88 PET/CT patients. The range of SUVmax was from 2.5 to 56; median = 15.0. Higher T stage was correlated with higher SUVmax ($p = 0.048$). There was a trend of higher nodal status and clinical stage to higher SUVmax ($p = 0.52$ and $p = 0.3$, respectively). Median SUVmax values were 10.7 (T1), 14.0 (T2), 15.6 (T3), and 16.0 (T4). Squamous cell carcinoma histology was associated with higher values of SUVmax ($p = 0.002$): median values of SUVmax were squamous cell carcinoma 16.4, adenocarcinoma 11.1, and other histologies 12.6.

Analyses of Outcomes

Of the 88 patients, there were 69 deaths (53 cancer-related), and 58 patients had documented disease progression (30 locoregionally and 45 in metastatic sites). Seventy-two patients had either progressive disease or died (or both). Only one patient was lost to follow-up (after 3 months). The median potential follow-up time was 53 months and ranged from 26 to 81 months in the 87 patients not lost to follow-up.

There was no statistically significant relationship between log (SUVmax) and OS ($p = 0.21$; HR = 0.83; Table 2). A similar result was obtained when assessing SUVmax adjusting for T stage ($p = 0.12$; HR [per doubling of SUVmax] = 0.78; Table 2).

Figure 2 shows the risk of death as a continuous function across the range of SUVmax values observed, with no indication of worsening outcome (in fact observed risk of dying decreases).

When comparing high and low SUVmax, dichotomized at the median (15.0), HR (high: low) = 0.72; 95% confidence interval = 0.44 to 1.14; $p = 0.18$ (Fig. 1A). A HR of 1.14 represents less than 5% difference in OS rates at the overall median survival time, indicating that there is no prognostic effect of increasing SUVmax resulting in an adverse outcome. SUVmax grouped using quartile cut points (10.5, 15.0, 19.0) indicated relative hazard rates of 1.15, 1.21, 0.87, and 0.82 for increasing SUVmax groups, respectively ($p = 0.21$; Fig. 1B).

Tests for interaction indicated no evidence for a prognostic effect of SUVmax differing by subgroup of T stage ($p = 0.79$), ECOG performance status ($p = 0.66$), or histology ($p = 0.39$). Analyses of other continuous SUV variables (mean, percentage dose uptake in tumor) on OS and PFS produced very similar results (Table 2).

Best Cut Point Method

The data were analyzed according to the “best cut point method” for the analysis of OS by SUVmax. Figure 3 shows the nominal p value and HR at each examined cut point plotted against the cut point value. The smallest p value (0.020) occurred at 12.6 (95th percentile of SUVmax, corresponding to a HR of 0.58. Using the formula given by Altman et al. to obtain a corrected p value gave $p_{corr} = 0.28$. The alternative permutation test method gave $p_{perm} = 0.23$ (SE = 0.004).

DISCUSSION

This study has demonstrated that in patients treated with radical RT for inoperable NSCLC, higher SUVmax derived from a staging FDG-PET/CT scan does not significantly correlate with poorer survival. Our data did demonstrate that increasing SUVmax was associated with increasing stage and squamous histology. After adjusting for these factors, there was still no clear and consistent adverse prognostic effect of higher SUV.

To our knowledge, this is the only published study investigating the prognostic potential of SUVmax using integrated PET/CT (rather than PET only) before commencing treatment in a cohort of patients with NSCLC treated nonsurgically, either with radical RT or chemoradiation. Due to technical factors, including superior attenuation correction, PET/CT provides a more accurate value for SUV than stand-alone PET. The aim of this study was to assess whether SUVmax had independent prognostic value after adjusting for tumor stage in this group of patients. We analyzed the effect of SUVmax as both a dichotomous and a continuous variable because if an effect exists it cannot be assumed that the effect is consistent across the full range of values.

This study therefore does not support the result of the meta-analysis. There are several reasons that could contribute to these findings.

FDG uptake is a surrogate for increased glucose metabolism, which has been thought to represent tumor cell activity. However, the exact mechanism of FDG activity and distribution within malignant tumors is not fully understood. FDG is not only taken up in malignant tumor cells but may reflect other metabolic processes within the heterogeneous
cellular components of the tumor, such as tumor hypoxia, inflammation, or necrosis, which are unrelated to tumor aggressiveness.  

Furthermore, the conclusions drawn from the results of the meta-analysis should be treated with caution, as the patient groups included in the studies included in the meta-analysis were highly selected both by stage and by treatment. Studies in patients with more advanced disease or those treated by nonsurgical means alone were underrepresented. The small proportion of patients with locoregionally advanced disease could have influenced the results. For example, in the study by Hoang et al. of patients with more advanced disease (some treated with RT), FDG SUV\textsubscript{max} was found not to have a significant relationship with survival.

There has been a recent study investigating the role of SUV values obtained following therapy in patients with NSCLC treated with chemoradiation, and initial findings are suggestive of an association between higher post-treatment SUV values and worse survival. Interestingly, as part of their exploratory analysis of pretreatment SUV values, no association with survival was found.

Although there have been previous studies with patients managed surgically that have shown reduced OS and disease-free survival in patients with higher SUV\textsubscript{max} values, there is still uncertainty regarding the clinical utility of PET in patients managed nonsurgically.

### TABLE 1. Clinicopathological Characteristics of Study Cohort

| Variable          | Level   | n   | %   | SUV\textsubscript{max} Median (range) | p    |
|-------------------|---------|-----|-----|--------------------------------------|------|
| Sex               | Male    | 58  | 66  | 15.4 (2.5–56.1)                      | 0.33 |
|                   | Female  | 30  | 34  | 12.4 (2.9–45.6)                      |      |
| Age               | ≤70     | 44  | 50  | 14.2 (2.5–56.1)                      | 0.14 |
|                   | >70     | 44  | 50  | 15.5 (2.9–45.6)                      |      |
| ECOG PS\textsuperscript{a} | 0      | 21  | 25  | 14.8 (2.5–33.4)                      | 0.98 |
|                   | 1       | 52  | 62  | 15.7 (2.9–56.1)                      |      |
|                   | 2       | 11  | 13  | 14.4 (5.4–21)                        |      |
| SCS               | ≤8      | 35  | 40  | 14.8 (6.8–45.6)                      | 0.56 |
|                   | >8      | 53  | 60  | 15.1 (2.5–56.1)                      |      |
| Weight loss       | None    | 46  | 53  | 15.0 (2.5–45.6)                      | 0.44 |
|                   | <10%    | 30  | 35  | 15.1 (5.4–23.9)                      |      |
|                   | >10%    | 10  | 12  | 12.2 (2.9–56.1)                      |      |
| T stage           | 1       | 10  | 10  | 10.7 (2.5–45.6)                      | 0.054|
|                   | 2       | 43  | 49  | 14.0 (2.9–33.8)                      |      |
|                   | 3       | 15  | 17  | 15.6 (9.8–36.3)                      |      |
|                   | 4       | 21  | 24  | 16.0 (7.3–56.1)                      |      |
| N stage           | 0       | 27  | 31  | 14.2 (2.5–45.6)                      | 0.52 |
|                   | 1       | 12  | 14  | 16.5 (9.7–33.8)                      |      |
|                   | 2       | 43  | 49  | 14.6 (4.2–56.1)                      |      |
|                   | 3       | 6   | 7   | 15.7 (10.7–19.7)                     |      |
| Clinical stage    | 1       | 19  | 22  | 14.2 (2.5–45.6)                      | 0.3  |
|                   | 2       | 10  | 11  | 14.8 (9.7–36.3)                      |      |
|                   | 3       | 59  | 67  | 15.1 (4.2–56.1)                      |      |
| Histology         | Adenocarcinoma | 25  | 28  | 11.1 (2.5–45.6)                      | 0.002|
|                   | SCC     | 44  | 50  | 16.4 (5.4–51.7)                      |      |
|                   | Other   | 19  | 22  | 12.6 (6.7–56.1)                      |      |
| Differentiation   | Well    | 4   | 6   | 12.9 (4.2–25.9)                      | 0.74 |
|                   | Moderate| 12  | 18  | 15.1 (2.9–33.8)                      |      |
|                   | Poor, undifferentiated | 49  | 75  | 14.6 (5.4–56.1)                      |      |
| Chemotherapy      | No      | 20  | 23  | 12.0 (2.5–36.3)                      | 0.073|
|                   | Yes     | 67  | 77  | 15.3 (2.9–56.1)                      |      |
| Smoking           | ≤40     | 45  | 52  | 14.4 (2.5–51.7)                      | 0.86 |
|                   | >40     | 42  | 48  | 15.1 (5.4–56.1)                      |      |

\textsuperscript{a}ECOG PS.

\textsuperscript{b}p value for trend.

\textsuperscript{c}p value for any group differences.

SUV\textsubscript{max}, standardized uptake value maximum; ECOG PS, Eastern Cooperative Oncology Group performance status; SCS, Simplified Co-morbidity Score; SCC, squamous cell carcinoma.
these values were derived from pretreatment stand-alone PET scans (as opposed to PET/CT) scans. More recently, Cistaro et al.\textsuperscript{14} reported worse 2-year outcomes with presurgical SUV\textsubscript{max} values above the calculated best cutoff value using PET/CT scanners. These studies had small sample sizes, and most were limited to patients with early-stage, resectable disease.

### TABLE 2. Univariable and Multivariable Cox Regression Analyses of the Relationship of SUV as a Continuous Variable on OS and PFS

| Outcome          | Factor       | HR  | CI             | p   |
|------------------|--------------|-----|----------------|-----|
| OS               | log(SUV\textsubscript{max}) | 0.83 | 0.62–1.11      | 0.21|
| OS (multivariable analysis) | log(SUV\textsubscript{max}) | 0.78 | 0.57–1.06      | 0.12|
|                   | T stage      | 0.15 | 0.93–1.58      | 0.15|
| PFS              | log(SUV\textsubscript{max}) | 0.88 | 0.67–1.16      | 0.36|
| PFS (multivariable analysis) | log(SUV\textsubscript{max}) | 0.83 | 0.62–1.11      | 0.22|
|                   | T stage      | 1.19 | 0.92–1.53      | 0.18|

Of the 88 patients, 69 had died and 72 had progressed or died (or both). Multivariable analyses assess log(SUV\textsubscript{max}) adjusting for T stage.

SUV\textsubscript{max}, standardized uptake value maximum; OS, overall survival; PFS, progression-free survival; HR, hazard ratio; CI, confidence interval.

### FIGURE 1. Kaplan–Meir survival curves by SUV\textsubscript{max}. A, Dichotomized according to median cut point = 15.0. B, Using quartile cut points. Q1, smallest 25% of SUV\textsubscript{max}; Q2, second smallest; Q3, third smallest; Q4, top 25% of SUV\textsubscript{max}. SUV\textsubscript{max}, standardized uptake value maximum; HR, hazard ratio; CI, confidence interval; RT, radiotherapy.

### FIGURE 2. Smoothed relationship between SUV\textsubscript{max} (ranked) and relative risk of progression or death. SUV\textsubscript{max}, standardized uptake value maximum.

### FIGURE 3. Obtaining the best cut point for analysis for overall survival of a dichotomized SUV\textsubscript{max}. HR, hazard ratio; SUV\textsubscript{max}, standardized uptake value maximum.

Some published reports suggest that there is a potential difference between absolute SUVs measured using PET and PET/CT.\textsuperscript{15,16} To ensure homogeneity in our study cohort, patients who had surgical management as part of their therapy or were staged with PET only were excluded from the study.
Our primary analysis used SUV\textsubscript{max} as a continuous variable. This is generally to be preferred to dichotomizing the variable as it is more powerful (information is not discarded) and is not subject to the arbitrariness of choice of cut point. This latter point is demonstrated in the example provided from our own data, where a cut point of SUV\textsubscript{max} = 12.6 divided patients into groups, which were (nominally) statistically significantly different, but the median SUV\textsubscript{max} of 15.0 was not.

In many previous publications that report a poor outcome with higher SUV values, the prognostic value of SUV was assessed by dichotomizing patients according to the “best cut point” method. As this method involves multiple tests based on a large number of potential cut points and choosing the one with smallest \( p \) value, the approach is associated with a large type I error rate—an inbuilt tendency to produce significance where no difference exists. A correction has to be made to the \( p \) value to make this a valid analysis, a practice that is commonly ignored. The analysis of our data using the best cut point method gave a “significant” nominal \( p \) value of 0.020, which after correction was reduced to a modest \( p = 0.23 \), consistent with the continuous variable analysis. The type I error rate using the uncorrected best cut point method in a study of the size of ours can be approximately 40%.

We acknowledge that there are limitations in our study, including the fact that this is a single institution retrospective study with relatively small numbers. It has been hypothesized that the impact of SUV\textsubscript{max} on prognosis may be stage dependent—that in patients with more advanced stages, the metabolic activity measured by SUV\textsubscript{max} on the primary tumor has lower prognostic value as it has been subsumed by the anatomic extent of the tumor.\(^4\) We did not observe evidence for such a dependency in our data for T stage (or for ECOG performance status or histology).

Alternatively, it is possible that the relationship between primary tumor FDG uptake and survival, if present, could be a biphasic rather than linear relationship, with a limited role on prognosis in more advanced stage disease. It is clear from our data that further prospective, methodologically sound studies with larger sample sizes are required before it is possible to draw sound conclusions about the prognostic significance of SUV\textsubscript{max} in NSCLC.

\textbf{REFERENCES}

1. Feld R, Abratt R, Graziano S, et al. Pretreatment minimal staging and prognostic factors for non-small cell lung cancer. *Lung Cancer* 1997;17(Suppl 1):S3–S10.
2. Dwamena BA, Sonnad SS, Angobaldo JO, Wahl RL. Metastases from non-small cell lung cancer: mediastinal staging in the 1990s—meta-analytic comparison of PET and CT. *Radiology* 1999;213:530–536.
3. Berghmans T, Dusart M, Paesmans M, et al; European Lung Cancer Working Party for the IASLC Lung Cancer Staging Project. Primary tumor standardized uptake value (SUV\textsubscript{max}) measured on fluorodeoxyglucose positron emission tomography (FDG-PET) is of prognostic value for survival in non-small cell lung cancer (NSCLC): a systematic review and meta-analysis (MA) by the European Lung Cancer Working Party for the IASLC Lung Cancer Staging Project. *J Thorac Oncol* 2008;3:6–12.
4. Paesmans M, Berghmans T, Dusart M, et al; European Lung Cancer Working Party, and on behalf of the IASLC Lung Cancer Staging Project. Primary tumor standardized uptake value measured on fluorodeoxyglucose positron emission tomography is of prognostic value for survival in non-small cell lung cancer: update of a systematic review and meta-analysis by the European Lung Cancer Working Party for the International Association for the Study of Lung Cancer Staging Project. *J Thorac Oncol* 2010;5:612–619.
5. Colinet B, Jacot W, Bertrand D, et al; oncoLR health network. A new simplified comorbidity score as a prognostic factor in non-small-cell lung cancer patients: description and comparison with the Charlson’s index. *Br J Cancer* 2005;93:1098–1105.
6. Altman DG, Lausen B, Sauerbrei W, Schumacher M. Dangers of using “optimal” cutpoints in the evaluation of prognostic factors. *J Natl Cancer Inst* 1994;86:829–835.
7. Gregory DL, Hicks RJ, Hogg A, et al. Effect of PET/CT on management of patients with non-small cell lung cancer; results of a prospective study with 5-year survival data. *J Nucl Med* 2012;53:1007–1015.
8. Duhaylongsod FG, Lowe VJ, Patz EF Jr, Vaughn AL, Coleman RE, Wolfe WG. Lung tumor growth correlates with glucose metabolism measured by fluorodeoxyglucose positron emission tomography. *Ann Thorac Surg* 1995;60:1348–1352.
9. Higashi K, Ueda Y, Yagishita M, et al. FDG PET measurement of the proliferative potential of non-small cell lung cancer. *J Nucl Med* 2000;41:85–92.
10. Christensen JD, Colby TV, Patz EF Jr. Correlation of [18F]-2-fluoro-deoxy-D-glucose positron emission tomography standard uptake values with the cellular composition of stage I nonsmall cell lung cancer. *Cancer* 2010;116:4095–4102.
11. Hoang JK, Hoagland LF, Coleman RE, Coan AD, Herndon JE 2nd, Patz EF Jr. Prognostic value of fluorine-18 fluorodeoxyglucose positron emission tomography imaging in patients with advanced-stage non-small-cell lungadenocarcinoma. *J Clin Oncol* 2008;26:1459–1464.
12. Machtay M, Duan F, Siegel BA, et al. Prediction of survival by [18F]fluorodeoxyglucose positron emission tomography in patients with locally advanced non-small-cell lung cancer undergoing definitive chemoradiation therapy; results of the ACRIN 6686/ROG trial 0235 trial. *J Clin Oncol* 2013;31:3823–3830.
13. Hanin FX, Lonneux M, Cornet J, et al. Prognostic value of FDG uptake in early-stage non-small-cell lung cancer. *Eur J Cardiothorac Surg* 2008;33:819–823.
14. Cistaro A, Quartuccio N, Mogiatiheh A, et al. Prediction of 2 years-survival in patients with stage I and II non-small cell lung cancer utilizing (18)F-FDG PET/CT SUV quantification. *Radiol Oncol* 2013;47:219–223.
15. Nakamoto Y, Osman M, Cohade C, et al. PET/CT: comparison of quantitative tracer uptake between germanium and CT transmission attenuation-corrected images. *J Nucl Med* 2002;43:1137–1143.
16. Souvatzoglou M, Ziegler SI, Martinez MJ, et al. Standardised uptake values from PET/CT images: comparison with conventional attenuation-corrected PET. *Eur J Nucl Med Mol Imaging* 2007;34:405–412.