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Original Research

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# Facility-Level Analysis of PET Scanning for Staging Among US Veterans With Non-small Cell Lung Cancer

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***Background:*** **PET scanning has been shown in randomized trials to reduce the frequency of surgery without cure among patients with potentially resectable non-small cell lung cancer (NSCLC). We examined whether more frequent use of PET scanning at the facility level improves survival among patients with NSCLC in real-world practice.**

***Methods:*** **In this prospective cohort study of 622 US veterans with newly diagnosed NSCLC, we compared groups defined by the frequency of PET scan use measured at the facility level and categorized as low (< 25%), medium (25%-60%), or high (> 60%).**

***Results:*** **The median age of the sample was 69 years. Ninety-eight percent were men, 36% were Hispanic or nonwhite, and 54% had moderate or severe comorbidities. At low-, medium-, and high-use facilities, PET scan was performed in 13%, 40%, and 72% of patients, respectively ($P < .0001$). Baseline characteristics were similar across groups, including clinical stage based on CT scanning. More frequent use of PET scanning was associated with more frequent invasive staging ($P < .001$) and nonsignificant improvements in downstaging ($P = .13$) and surgery without cure ($P = .12$). After a median of 352 days of follow-up, 22% of the sample was still alive, including 22% at low- and medium-use facilities and 20% at high-use facilities. After adjustment and compared with patients at low-use facilities, the hazard of death was greater for patients at high-use facilities (adjusted hazard ratio [HR], 1.35; 95% CI, 1.05-1.74) but not different for patients at medium-use facilities (adjusted HR, 1.14; 95% CI, 0.88-1.46).**

***Conclusions:*** **In this study of veterans with NSCLC, markedly greater use of PET scanning at the facility level was associated with more frequent use of invasive staging and possible improvements in downstaging and surgery without cure, but greater use of PET scanning was not associated with better survival.**

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**Abbreviations:** CanCORS = Cancer Care Outcomes Research and Surveillance; NSCLC = non-small cell lung cancer; VHA = Veterans Health Administration

PET scanning is more accurate than CT scanning for identifying malignant mediastinal lymph nodes in patients with non-small cell lung cancer (NSCLC).[1] Guidelines developed by the American College of Chest Physicians and the National Comprehensive Cancer Network recommend that PET scan be used to help stage lung cancer in patients who are candidates for curative treatment.[2,3] Three randomized controlled trials in patients with potentially resectable NSCLC found that compared with conventional staging, PET scan-based staging reduced the frequency of thoracotomy without cure.[4-6] However, in the majority of patients with NSCLC who have unresectable disease or are medically inoperable, PET scan-based staging strategies have not been evaluated in randomized trials, and few studies have examined use of PET scanning and outcomes in real-world populations. The overuse of tests and procedures has important implications for both patient safety and health-care cost control, and the use of imaging tests for cancer staging is one of the top 25 priorities of the Institute of Medicine for comparative effectiveness research.[7] In this prospective observational study, we examined the effectiveness of PET scanning by comparing survival and other outcomes among veterans with NSCLC who received care at Veterans Health Administration (VHA)

hospitals that differed considerably in how frequently they used PET scanning.

## Materials and Methods

To examine the association between use of PET scanning and outcomes among patients with NSCLC, we used data from the Cancer Care Outcomes Research and Surveillance (CanCORS) study, a prospective observational study of practices and outcomes for patients with lung and colorectal cancer.[8] All patients or an appropriate surrogate provided informed consent. Human subjects committees at Stanford University and all participating sites approved the study. This article was approved by the CanCORS Publications Committee. Additional details about the methods can be found in e-Appendix 1.

### *Patients*

CanCORS used rapid case ascertainment to prospectively enroll incident lung cancer cases in four large, geographically defined regions, five integrated health-care systems, and 13 health-care facilities of the VHA (e-Appendix 1, e-Table 1). Eligible patients were given a diagnosis of lung cancer between September 1, 2003, and October 14, 2005. For this analysis, we included all CanCORS participants with NSCLC who were enrolled at a VHA facility and whose VHA medical records were available. We did not have access to non-VHA records.

### *Variables*

The CanCORS baseline patient survey included items about age, sex, race, ethnicity, insurance coverage, annual household income, and level of education. Professional chart abstractors collected information about comorbidities,[9,10] tumor size, histology, and stage. Independently, we collected additional information about symptoms, signs, imaging tests, procedures, consultations, and outcomes by reviewing the electronic medical records of all VHA CanCORS participants. We collected facility-level information by performing a survey of lung cancer practices that was completed by the VHA CanCORS principal investigator at each site.

To characterize patients by the extent of disease at the earliest possible time in the course of their evaluation, we reviewed electronic transcripts of CT scan reports for evidence of hilar (N1), mediastinal (N2 or N3), or distant (M1) tumor involvement and subsequently classified patients as having N0M0, N1M0, N2/3M0, or M1 disease on the basis of CT scan findings. We used identical methods to classify patients on the basis of PET scan reports.

The main exposure variable of interest was the frequency at which the PET scan was obtained prior to treatment at the facility level. Noting that PET scan use varied widely across VHA facilities during the study period, we classified facilities by frequency of PET scanning as low (< 25%), medium (25%-60%), or high (> 60%) (e-Appendix 1, e-Table 1) use.

The primary outcome was survival measured from the date of initial suspicion until the date of death or censoring. Other outcomes were use of noninvasive imaging tests; invasive staging procedures; other tests and consultations; and frequency of upstaging, downstaging, and surgery without cure. We determined upstaging and downstaging by comparing stage by CT scan with stage by PET scan or final stage. Similar to the definitions used in two randomized trials, we defined surgery without cure as identification of unresectable disease at the time of surgery or recurrence or death within 1 year of the operation.[4,6]

### *Statistical Analysis*

For bivariate comparisons, we performed $\chi^2$ tests for categorical variables and Kruskal-Wallis tests for continuous variables. We examined survival by using the Kaplan-Meier method. To adjust for residual differences between groups and identify patient and tumor characteristics that were independently associated with survival, we performed Cox proportional hazards analysis that included all candidate predictor variables, adjusting for stage by CT scan rather than for final stage because more accurate staging is the mechanism by which PET scan is expected to improve survival and because adjusting for this mediating factor would obscure a true association between PET scanning and survival, if one existed. We tested for subgroup effects by entering interaction terms for all variables of interest into multivariate models and by performing selected stratified analyses. We performed sensitivity analyses by developing additional logistic regression models that (1) measured survival from the date of diagnosis instead of the date on which lung cancer was initially suspected, (2) categorized the frequency of PET scanning as low (< 25%) vs medium or high (≥ 25%), and (3) included 165 patients with unknown histology.

## Results

Of 926 potentially eligible VHA CanCORS participants with lung cancer, we excluded 289 with small cell or unknown histology and 15 with recurrent lung cancer or missing records (Fig 1). The resulting sample included 622 VA CanCORS participants with NSCLC.

### *Patient, Tumor, and Facility Characteristics*

The median age of the sample participants was 69 years (Table 1). Almost all participants were men, and 36% were of Hispanic ethnicity or nonwhite race.

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