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Proportion of Non-Small Cell Lung Cancer Patients That Would Have Been Eligible for Lung Cancer Screening

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Abstract

BACKGROUND—Lung cancer screening is recommended for current smokers (CS) and former smokers (FS) who meet specific age and smoking criteria. We used existing criteria to estimate the proportion of non-small cell lung cancer (NSCLC) patients that would have been screening-eligible.

METHODS—We identified 2,030 NSCLC patients at our institution from 1994–2014 and recorded their cigarette smoking status and history. Using criteria from the United States Preventative Services Task Force (USPSTF) and from other organizations, we ascertained the proportions of screening-eligible patients. Associations among smoking status, sex, race/ethnicity, and insurance type were assessed using Chi-Square test.

RESULTS—In our cohort, 31.0% (n=630) were CS, 43.0% (n=873) were FS, and 26.0% (n=527) were never smokers. There were 698 patients (34.4%) who met all USPSTF screening criteria. Among 1,503 CS and FS, 77.5% (n=1,165) were between age 55–80 years and 67.9% (n=1,021) had smoked ≥30 pack-years. Among FS, 50.4% (n=440) had quit within 15 years of diagnosis. Median pack-years smoked was 40 (interquartile range 20–55 pack-years). CS were more likely to meet screening criteria than FS (67.5% vs. 31.3%, p<.0001). Significant differences were found among individuals meeting criteria by sex, race/ethnicity, and insurance type.

CONCLUSION—Only a third of patients diagnosed with NSCLC were eligible for lung cancer screening based on USPSTF criteria. FS were less likely to meet all screening criteria due to only

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half meeting the quit-time criterion. Additional evidence is needed to evaluate the utility of restricting screening among FS to those who quit within 15 years.

Keywords

screening criteria; age; current and former smoker; quit time; smoking cessation

Introduction

Lung cancer results in more cancer deaths than any other malignancy in the United States and worldwide. Lung cancer mortality is high since more than half of patients present with incurable distant disease.¹ Following results from the National Lung Screening Trial (NLST), which demonstrated a 20% lung cancer mortality reduction with three annual low-dose computed tomography (LDCT) screens of the chest², several major health organizations including the United States Preventative Services Task Force (USPSTF) have published guidelines recommending lung cancer screening with LDCT in high-risk current and former smokers (Table 1).^{3–9} Screening eligibility is determined from age, smoking history, and years since smoking cessation for former smokers, and is based on criteria established in the NLST.

Although lung cancer risk decreases with increased smoking cessation time,^{10, 11} the relationship between quit-time and lung cancer risk is complex and dependent on the total amount of tobacco exposure and the number of years smoked before quitting. It is unclear what proportion of lung cancer cases nationwide would have been eligible for screening using existing criteria. Moreover, the proportion of lung cancers that would have been eligible for screening may be different in distinct subgroups such as women and ethnic minorities with different smoking rates and sensitivities to lung cancer development with tobacco exposure. For instance, moderate and heavy smoking has been linked with higher lung cancer risk in women than in men.¹² This information is important to understand the expected impact of lung cancer screening with existing criteria on the burden of lung cancer and to propose new studies to better screen and identify lung cancers.

The aims of this study are to compare the various screening criteria put forth by major health organizations and to apply each set of criteria to our cohort of non-small cell lung cancer (NSCLC) patients to ascertain the proportion that would have been eligible for screening at diagnosis. We sought to identify differences in those meeting screening criteria among patients with different demographics and clinical characteristics. In addition, we considered the additional number of patients eligible for screening if certain criteria were expanded, for instance if the “time to quit” criterion was expanded or dropped since excess lung cancer risk has been shown to persist beyond 15 years after smoking cessation.^{13, 14}

Methods

Data

A retrospective analysis was performed using patient data collected from the electronic medical record (EMR) and from our institutional cancer registry. Smoking status and history

were obtained from the cancer registry and from text mining of the EMR using key words including “pack” and “quit.” Smoking history was cross-validated by manual EMR review. Patient demographics, insurance status, and clinical characteristics were obtained from the cancer registry. The study was approved by the City of Hope Institutional Review Board.

Cohort selection

The initial study population had 2,886 patients diagnosed with lung cancer at our institution between 1994–2014. Following exclusion of 589 patients with small cell, carcinoid, and lymphoma histologies, 47 patients with previous lung cancer, 2 pediatric patients, and 4 patients with unknown race/ethnicity, 2,244 patients with NSCLC remained. We also excluded patients missing smoking status (n=48), pack-years or quit-time (n=166). The final cohort of 2,030 (90.5%) patients had complete smoking history. Pack-years were determined by multiplying average number of cigarette packs smoked daily by number of years smoked. Discrepancies in reported pack-years were resolved by taking the average. Never smokers (NS) were identified as having smoked fewer than 100 cigarettes in their lifetime. Current smokers (CS) reported either active smoking or cessation within 6 months of NSCLC diagnosis. Patients who reported abstaining at least 6 months prior to diagnosis or onset of lung cancer symptoms were considered former smokers (FS). Quit-time was computed as number of years from quit date to diagnosis date.

Variables

Insurance status was categorized into Medicare, Medicaid, managed care (health maintenance organizations, preferred provider organizations, and military insurance), or a group with no insurance or unknown insurance status. Histologies were identified using codes from International Classification of Diseases for Oncology 3rd edition and grouped as adenocarcinoma (8140–8574), squamous cell carcinoma (8070–8074), large cell carcinoma (8012–8013), and other NSCLC. Staging was derived from the American Joint Commission on Cancer, 7th edition and reported according to age and surgery type.

The proportions of smokers meeting individual and all lung cancer screening criteria were determined using USPSTF criteria. Additionally, we calculated the proportions of all NSCLC patients that met each set of criteria published by other health organizations recommending screening (Table 1). The percentage of patients meeting quit-time criterion was calculated from FS only. Patients eligible for screening based on National Comprehensive Cancer Network (NCCN) criteria⁶ and American Association for Thoracic Surgery (AATS) criteria⁷ either met respective primary criteria or specific secondary criteria defined as reduced age and pack-year minimum with the additional risk factor of personal cancer history, which was known for all patients from the cancer registry. Other lung cancer risk factors including family history, pulmonary disease or exposure history were incompletely reported in the EMR. For instance, family history or occupational exposure data were only available in 80% and 20% of patients, respectively. Consequently, only personal cancer history was used for determining secondary screening criteria. Lung cancer screening eligibility was further analyzed by stratifying race/ethnicity, sex, smoking status, and insurance type.

Statistical Analysis

Frequencies and percentages were reported for categorical data and Chi-square tests were used to check for association. Means and standard deviations or medians and interquartile ranges (IQR) were reported for continuous data as appropriate. Analysis of variance (ANOVA) was used to test differences by smoking status for age at diagnosis as a continuous variable and Wilcoxon rank test was used to test the difference between pack-years smoked by CS and FS. All tests performed with two-sided p-values <0.05 were considered statistically significant. Analyses were performed using SAS (SAS Institute, Inc, Cary, NC) software version 9.4. The EulerAPE was used to create an area-proportional Venn diagram¹⁵ (<http://www.eulardiagrams.org/eulerAPE/>) demonstrating the proportions of patients meeting one, two, or three USPSTF screening criteria. In order to create the Venn diagram, all CS were assigned a quit-time of “0” and included with FS when determining those meeting quit-time criterion, which would normally only apply to FS.

Results

Of 2,030 NSCLC patients in our cohort, 630 (31.0%) were CS, 873 (43.0%) FS, and 527 (26.0%) NS. Table 2 compares patient and tumor characteristics by smoking status. Women were more likely than men to be NS ($p<0.0001$). This finding was especially prominent in Asian and Hispanic women among whom 159 (83.7%) and 68 (63.6%) were NS, respectively, compared to 55 (27.5%) Asian men and 15 (19.0%) Hispanic men who were NS. Figure 1 displays the distribution of smoking status by race/ethnicity and sex.

CS reported smoking a median of 46 pack-years (IQR, 30–60 pack-years) compared with a median of 30 pack-years (IQR, 16–50 pack-years) reported by FS ($p<0.0001$). Among FS, median quit-time was 15 years (IQR, 8–27 years) before diagnosis. There were 442 patients (21.8%) with previous malignancies and 51.8% were FS. More than half of 1,101 (54.2%) Medicare-insured patients were FS while Medicaid patients were more likely to be CS than FS or NS ($p<0.0001$). 79.9% ($n=421$) of all NS had adenocarcinoma compared to 52.5% ($n=331$) of CS 64.5% ($n=563$) of FS ($p<0.0001$). Most patients were diagnosed with advanced disease and 55.2% ($n=291$) of NS had stage IV disease compared to 38.3% ($n=241$) of CS and 38.0% ($n=332$) of FS ($p<0.0001$).

There were 310 (80.9%) stage I patients who underwent surgery and 73 (19.1%) who did not (Supplemental Table 1). Reasons for not having surgery included patient refusal or contraindication due to high perioperative risk.. Lobectomy ($n=519$, 71.9%) was most commonly performed in all patients regardless of stage, followed by sub-lobar resection ($n=123$, 17.0%) and pneumonectomy ($n=56$, 7.8%). Of all lobectomies, only 7.7% ($n=40$) were done in elderly patients 80 years or older compared to 15.4% ($n=19$) of all sublobar resections performed in the same age group. Elderly patients were more likely to undergo sub-lobar resection ($n=19$, 31.1%) compared to patients 79 years and younger ($n=104$, 15.7%), $p=0.0039$.

There were 698 patients (34.4%) who met all USPSTF screening criteria.. The proportion of patients with incident NSCLC who would have met USPSTF screening criteria is portrayed in an area-proportional Venn diagram (Figure 2). The proportions of patients by smoking

status that failed to meet one or more criteria are also shown. The 1,070 patients who met quit-time criteria included 440 FS who had quit within 15 years of diagnosis and all 630 CS with designated quit-time of "0." CS were more likely than FS to meet USPSTF pack-year criterion (83.2% vs 56.9%, $p<0.0001$) and all screening criteria (67.5% vs. 31.3%, $p<0.0001$). Approximately half of FS ($n=440$) quit smoking within 15 years of NSCLC diagnosis. Women who had ever smoked were less likely to meet the 30-pack-year criterion than men who smoked (65.0% vs. 70.3%, $p=0.033$). Among smokers, Hispanics and Whites were more likely to meet all USPSTF screening criteria than Blacks and Asians (48.5% and 48.2% vs. 40.0% and 36.4%, respectively. ($p<0.019$). Approximately half of smokers with Medicare were eligible for lung cancer screening ($n=433$, 50.6%).

Other organizations with published lung cancer screening guidelines include the Centers for Medicare and Medicaid Services (CMS),⁴ NCCN,⁶ AATS,⁷ and organizations using NLST-derived criteria such as American Cancer Society (ACS),⁵ American College of Chest Physicians (ACCP), American Society of Clinical Oncology (ASCO),³ and American Lung Association (ALA).⁹ Among all NSCLC patients in our cohort, 698 (34.4%) were eligible for screening by USPSTF criteria, 661 (32.6%) by CMS criteria, 731 (36.0%) by NCCN criteria, 848 (41.8%) by AATS criteria, and 581 (28.6%) by NLST-derived criteria (Table 4). CS and men were more likely than FS and women to meet any set of screening criteria ($p<0.0001$ for both). NSCLC patients who were Asian or had managed care insurance, were least likely to fulfill screening criteria from any organization when compared to patients who were of a different race/ethnicity, or had alternative insurance, ($p<0.0001$ for all comparisons). Notably, only 5.8% ($n=11$) of Asian women and 13.1% ($n=14$) of Hispanic women met all screening criteria compared to 26.5% ($n=53$) of Asian men and 45.6% ($n=36$) of Hispanic men or 36.6% ($n=256$) of white women and 29.2% ($n=14$) of black women ($p<0.0001$ for all comparisons). Fourteen (35%) black men met all USPSTF lung cancer screening criteria while 300 (45.0%) white men were screening-eligible.

Nearly all organizations restrict lung cancer screening among FS to those who have quit within 15 years. Only about half of FS with NSCLC met this quit time criteria (Table 4). AATS primary screening guidelines uniquely do not include a quit-time criterion. Additionally, NCCN and AATS secondary screening guidelines selectively exclude the quit-time maximum in FS with personal history of cancer and consequently had the largest proportions of FS meeting all screening criteria (38.0% and 48.0%, respectively). With their expanded criteria, NCCN and AATS included significantly more screening-eligible patients who were FS, white, and Medicare-insured, than CMS and organizations using NLST-derived criteria ($p<0.05$ for all comparisons). However, only AATS criteria yielded statistically significant higher proportions of screening-eligible patients with the same previous characteristics when compared to USPSTF ($p<0.0001$ for other comparisons).

If the quit-time criterion was dropped by the USPSTF, an additional 134 FS would have met screening criteria, increasing the proportion of eligible NSCLC patients from 698 (34.4%) to 832 (41.0%), $p<0.0001$. If only age was used as screening criteria (as with screening for other malignancies), 57.4% ($n=1,165$) of our cohort would have been screening-eligible. If either age criterion was expanded to 50–80 years or pack-year minimum was decreased to 20, then 488 (77.5%) or 458 (72.7%) CS, respectively, would be screening-eligible. In

contrast, to ensure that at least 70% of FS with NSCLC met screening criteria, then age range would have to expand to 50–85 years, pack-year minimum would have to decrease to 15, and quit-time maximum would have to increase to 35. In that case, 87% of CS would have met screening criteria. If the quit-time criterion was eliminated and age and pack-years were expanded as mentioned, then 655 (75.0%) FS with NSCLC would have met all screening criteria.

Discussion

Since the publication of NLST results demonstrating the mortality benefit of lung cancer screening with LDCT, the USPSTF and other organizations have published guidelines recommending screening. The screening criteria endorsed by these organizations were based on NLST inclusion criteria, which were designed to adequately power that study. Ideal criteria for lung cancer screening would maximize the number of lung cancer deaths prevented while minimizing harm and providing cost-effective screening. We found that only 34% of lung cancer patients in our institutional cohort would have been eligible for lung cancer screening when using the patients' age and tobacco exposure history at the time of lung cancer diagnosis.

Our data complements the findings of two population studies that similarly applied screening criteria to patients diagnosed with lung cancer. Wang et al. applied USPSTF criteria to all incident primary lung cancer cases in a county population (n= 1351) and found that the relative proportion of patients eligible for screening declined over time to 43.3% from 2005–2011.¹⁶ Using models and estimates of lung cancer cases and smoking histories derived from the Surveillance, Epidemiology and End Results (SEER) database, the United States Census, and the National Health Interview Survey, Pinsky and Berg calculated that 26.7% of lung cancer patients would meet NLST screening guidelines. This increased to 68% with the expansion of age range to 50–79 years.¹⁷ Our study similarly explored the inclusion of more screening-eligible patients with expansion of screening criteria. We also uniquely compared various institutional screening guidelines including some use of secondary criteria as well as how screening criteria differently affected current and former smokers.

FS were less likely to meet all criteria compared to CS. This was in part due to a lower median pack-year history of smoking among FS compared with CS, and in part due to the fact that half of FS quit smoking more than 15 years prior to their lung cancer diagnosis. Asian and Hispanic women and those with private insurance or adenocarcinoma were significantly less likely to meet screening criteria. These findings can be explained by lower rates of smoking and higher proportions of NS in these patient populations. These findings have important implications because of the high prevalence of lung cancer in these patients. Evaluation of the appropriate screening criteria in diverse populations with high lung cancer rates and relatively low tobacco exposure rates is important.

Although tobacco exposure is an important contributor to lung cancer risk and outcomes,^{18–20} data from this study raises questions regarding the rationale of the 15-year quit-time criterion used by the USPSTF and other organizations in their screening

guidelines. We observed that 50% of former smokers with lung cancer quit more than 15 years prior to their diagnosis. Eliminating this criterion increased the percentage of former smokers with lung cancer who would have been eligible for screening from 31% to 47%. While our data cannot conclusively estimate the impact of altering this criterion, they provide preliminary information that may be used to examine the utility of this criterion. Although studies have attempted to model the effects of smoking length, intensity, and cessation on lung cancer risk, the exact temporal relationship is unknown.^{21, 22} Models have estimated approximately 25–35% excess lung cancer risk after 15 years of cessation which declines to 10% after 25–35 years.^{23, 24} Data from case-control studies also suggest that excess lung cancer risk persists beyond 15 years of quitting.¹⁴ In addition, the cumulative risk of lung cancer death increases as age at smoking cessation increases regardless of quit-time length.¹³ Additional investigation is needed to identify whether the quit-year criterion improves effective utilization of lung cancer screening.

We also postulated that if USPSTF were to expand the age criteria to 50–85 years and pack-years were decreased to 15, then 87% of CS and 75% of FS would meet all USPSTF screening criteria. While we provide these estimates from our cohort, the primary objective of this study was not to suggest alternative criteria for screening. The effect of screening more patients may not change mortality benefit and could potentially decrease the cost-effectiveness of screening, especially if more FS and individuals from the youngest age group were to be screened, since estimates from the NLST have suggested lower cost-effectiveness in these participants compared to CS and individuals from the oldest age group.²⁵ Additionally, increasing the number screened may increase the potential for false positives, overdiagnosis, and procedure-related harms from subsequent work-up.²⁶ However, implementation of Lung Reporting and Data System (Lung-RADS), which uses a larger 6 mm nodule threshold (compared to 4 mm used by NLST) and standardizes reporting of LDCT screening results, may reduce false-positive rates and allow more patients to be cost-effectively screened.^{27, 28}

Other investigators have evaluated alternative screening criteria, though most have focused on restricting screening to a subset of high-risk participants in NLST. Tammemägi et. al proposed a more restrictive model based on data from the NLST and the Prostate, Lung, Colorectal, and Ovarian Cancer Screening Trial.²⁹ That model incorporated additional lung cancer risk factors including race/ethnicity, body mass index, chronic obstructive pulmonary disease, personal history of malignancy, and family history of lung cancer. In a follow-up study that compared the performance of this model with that of USPSTF screening criteria, the authors found that the model was more efficient in screening for lung cancer, and that only 8.5% of FS who have quit longer than 15 years met the model's screening criteria, suggesting that these patients may not need screening.³⁰ McMahon et. al also used multiple models calibrated to the NLST population to identify more “efficient” screening criteria which would prevent the greatest number of lung cancer deaths.³¹ Their results suggested screening smokers age 55–85 years with at least 27 pack-years of smoking history and 20-year quit-time maximum in FS. Other large screening cohorts such as the International Early Lung Action Program (I-ELCAP)³² and the Dutch-Belgian NELSON lung cancer screening trial³³ used entry criteria that were broader than NLST and may prove to be useful cohorts to

study the effect of broadening criteria and its effect on the efficiency and cost-effectiveness of screening for lung cancer.

There are several important limitations in our study. First, although our cohort was large and our dataset was complete, our results may not be generalizable to the national population. Our region has larger Asian and Hispanic populations as well as lower smoking prevalence than national average. In addition, although we only included patients with documented smoking status and history, there remains the potential for recall bias and inaccuracies inherent in self-reported smoking status and history. Next, we likely underestimated those meeting NCCN and AATS criteria due to incomplete documentation of lung cancer risk factors other than personal cancer history. This would result in underestimation of patients eligible for screening based on secondary criteria using other lung cancer risk factors. The use of other lung cancer risk factors to create a risk prediction model to replace NLST-like criteria has been already been described in a population setting and is beyond the scope of our study. Finally, although we identified the proportion of NSCLC patients who would have met screening criteria, we could not determine whether applying lung cancer screening to these eligible patients at any point before diagnosis would have benefited their disease or treatment course. It is impossible to predict at what point a patient's lung cancer would have been screen-detected and therefore estimates of age and tobacco exposure at time of screen detection are likely to be different from the age and tobacco exposure at time of clinical diagnosis of lung cancer.

Additional research is needed to improve upon current lung cancer screening guidelines. In particular, an evidence-based approach to evaluating the 15-year quit rule adopted by the USPSTF and other organizations is warranted. Moreover, investigating the optimal screening criteria for populations with high lung cancer prevalence but modest tobacco exposure, including women, Asians, and Hispanics, is needed.

Conclusion

In this institutional cohort, we applied existing lung cancer screening criteria to patients diagnosed with NSCLC and found that only a third of patients would have met all USPSTF lung cancer screening criteria at time of diagnosis. Additionally, FS were less than half as likely to meet all screening criteria compared to CS due to the 15-year quit criterion. By comparing the different lung cancer screening guidelines set forth by several major health organizations, we identified higher proportions of screening-eligible patients with the use of more sensitive guidelines such as those delineated by the NCCN and AATS, which selectively expand age criteria and exclude the quit-time requirement. Our data raise the concern that existing lung cancer screening criteria may be too restrictive by excluding patients who fall outside of current age and smoking history parameters, including certain populations at high risk for lung cancer. However, in order to better assess the utility of current lung cancer screening criteria, prospective evaluation in a true screening population is needed in combination with cost-benefit analysis to identify the most sensitive and specific criteria that will maximally reduce mortality at a minimal risk for harm.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Abbreviations

CS	Current smoker
FS	Former smoker

NS	Never smoker
NSCLC	Non-small cell lung cancer
USPSTF	United States Preventative Services Task Force
NLST	National Lung Screening Trial
LDCT	Low-dose computed tomography
EMR	Electronic medical record
NCCN	National Comprehensive Cancer Network
AATS	American Association for Thoracic Surgery
IQR	Interquartile range
ANOVA	Analysis of variance
CMS	Centers for Medicare and Medicaid Services
ACS	American Cancer Society
ACCP	American College of Chest Physicians
ASCO	American Society of Clinical Oncology
ALA	American Lung Association

Clinical Practice Points

Lung cancer screening decreases mortality by 20% according to the National Lung Screening Trial (NLST). Criteria for screening adopted by major health organizations include current and former smokers age 55–80 years, smoking history of at least 30 pack years, and a minimum quit time of 15 years for former smokers. However, the utility of individual and combined criteria is unclear.

We retrospectively applied current lung cancer screening criteria to an institutional cohort of 2,030 patients diagnosed with non-small cell lung cancer (NSCLC) from 1994–2014 and found that only 34% of patients in our cohort would have been screening-eligible at the time of diagnosis. Current smokers were twice more likely to meet all screening criteria than former smokers (67.5% vs. 31.3%, $p<0.0001$). When comparing screening criteria among major health organizations, those that selectively increased the age range and excluded quit-time criterion had significantly higher proportions of screening-eligible patients. If quit time criterion was routinely excluded from screening criteria, then 41% of our NSCLC cohort would meet all screening criteria, which is significantly higher than when using existing criteria ($p<0.0001$).

By apply existing lung cancer screening criteria to a cohort of NSCLC patients, we provide an alternative lens through which to view screening guidelines, which may be too stringent as they exclude a large proportion of patients with known lung cancer, especially former smokers. To effectively validate current lung cancer screening guidelines, there needs to be evidence-based research to prospectively evaluate individual and combined criteria in a true screening population.

Figure 1.

Distribution of male and female current, former, and never smokers (CS, FS, NS) among different race/ethnicity categories.

CS = current smoker; FS = former smoker; NS = never smoker

Figure 2.
Venn diagram of lung cancer patients meeting individual or combined screening criteria.
(Central Picture)

Figure 3.

Proportions of all NSCLC patients meeting lung cancer screening criteria from different organizations stratified by smoking status.

† Including the American Cancer Society (ACS), American College of Chest Physicians (ACCP), American Society of Clinical Oncology (ASCO), American Lung Association (ALA). USPSTF = United States Preventative Services Task Force; CMS = Centers for Medicare and Medicaid Services; NCCN = National Comprehensive Cancer Network; NLST = National Lung Screening Trial; AATS = American Association for Thoracic Surgery; LCS = lung cancer screening

Table 1

Lung cancer screening criteria among major health organizations.

Lung cancer screening criterion	USPSTF ⁸	CMS ⁴	Primary	Secondary	NCCN ⁶	Primary	Secondary	AATS ⁷	Others ^{3,5,9} using NLST derived criteria [*]
Age (years)	55–80	55–77	55–74	50	50	55–79	50	50	55–74
Smoking History (pack-years)	30	30	30	20	20	30	20	20	30
Quit time (years)	15	15	15	none	none	none	none	none	15
Other criteria	-	-	-	Additional risk factor [‡]	Additional risk factor [‡]	-	Additional risk factor [‡] or Lung cancer survivors [§]	-	-

USPSTF = US Preventative Services Task Force; CMS = Center for Medicare and Medicaid Services; NCCN = National Comprehensive Cancer Network; NLST = National Lung Screening Trial; AATS = American Association for Thoracic Surgery.

* Organizations including the American Cancer Society (ACS), American College of Chest Physicians (ACCP), American Society of Clinical Oncology (ASCO), American Lung Association (ALA).

[‡] History of personal cancer, lung disease, family member with lung cancer, radon exposure, occupational exposure, COPD or pulmonary fibrosis.

[‡] Resulting in cumulative lung cancer risk 5% in 5 years (ie. COPD with FEV1 < 70%, environmental/occupational exposure, prior cancer/radiation therapy, genetic/family history).

[§] After 4 yrs negative surveillance.

Table 2

Patient demographics and clinical characteristics.

Variable (%)	Total	Current smoker	Former smoker	Never smoker	P
Count	2,030	630 (31.0)	873 (43.0)	527 (26.0)	
Age, mean (year $\pm$ SD)	65 $\pm$ 11	63 $\pm$ 10	69 $\pm$ 10	63 $\pm$ 13	<0.0001
<55	369 (18.2)	135 (36.6)	81 (22.0)	153 (41.5)	<0.0001
55–64	539 (26.6)	212 (39.3)	196 (36.4)	131 (24.3)	
65–80	950 (46.8)	268 (28.2)	489 (51.5)	193 (20.3)	
>80	172 (8.5)	15 (8.7)	107 (62.2)	50 (29.1)	
Sex					<0.0001
M	986 (48.6)	354 (35.9)	487 (49.4)	145 (14.7)	
F	1,044 (51.4)	276 (26.4)	386 (37.0)	382 (36.6)	
Race/ethnicity					<0.0001
White	1,366 (67.3)	485 (35.5)	669 (49.0)	212 (15.5)	
Asian	390 (19.2)	65 (16.7)	111 (28.5)	214 (54.9)	
Hispanic	186 (9.2)	45 (24.2)	58 (31.2)	83 (44.6)	
Black	88 (4.3)	35 (39.8)	35 (39.8)	18 (20.4)	
Median pack-years (IQR)	40 (20–55)	46 (30–60)	30 (16–50)	-	<0.0001
Personal history of cancer					0.0001
No	1,588 (78.2)	514 (32.4)	644 (40.6)	430 (27.1)	
Yes	442 (21.8)	116 (26.2)	229 (51.8)	97 (21.9)	
Insurance					<0.0001
Medicare	1,101 (54.2)	283 (25.7)	573 (52.0)	245 (22.3)	
Medicaid	178 (8.8)	89 (50.0)	38 (21.3)	51 (28.7)	
Managed care	623 (30.7)	211 (33.9)	208 (33.4)	204 (32.7)	
Uninsured/other	128 (6.3)	47 (36.7)	54 (42.2)	27 (21.1)	
Histology					<0.0001

Variable (%)	Total	Current smoker	Former smoker	Never smoker	P
Adenocarcinoma	1,315 (64.8)	331 (25.2)	563 (42.8)	421 (32.0)	
Squamous cell carcinoma	433 (21.3)	200 (46.2)	192 (44.3)	41 (9.5)	
Large cell carcinoma	62 (3.1)	25 (40.3)	27 (43.5)	10 (16.1)	
Other	220 (10.8)	74 (33.6)	91 (41.4)	55 (25.0)	
Stage					<0.0001
I	383 (18.9)	124 (32.4)	185 (48.3)	74 (19.3)	
II	135 (6.7)	47 (34.8)	65 (48.2)	23 (17.0)	
IIIA	252 (12.4)	89 (35.3)	123 (48.8)	40 (15.9)	
IIIB	298 (14.7)	108 (36.2)	114 (38.3)	76 (25.5)	
IV	864 (42.6)	241 (27.9)	332 (38.4)	291 (33.7)	
Unknown/other	98 (4.8)	21 (21.4)	54 (55.1)	23 (23.5)	
Treatment					0.0017
Surgery	722 (35.6)	240 (33.2)	328 (45.4)	154 (21.3)	
Chemotherapy	1,267 (62.4)	376 (29.7)	510 (40.3)	381 (30.1)	
Radiation	864 (42.6)	305 (35.3)	367 (42.5)	192 (22.2)	

Table 3

Proportion of NSCLC patients who would have been eligible for screening according to criteria reported by various organizations and stratified by smoking status, sex, race/ethnicity, insurance type, histology, and stage.

Variable	(%) Other* (NLST derived)	CMS	USPSTF	NCCN	AATS
All screening criteria met [†]	581 (28.6)	661 (32.6)	698 (34.4)	731 (36.0)	848 (41.8)
Smoking status [‡]					
Current smoker (CS)	368 (58.4)	410 (65.1)	425 (67.5)	399 (63.3)	429 (68.1)
Former smoker (FS)	213 (24.4)	251 (28.8)	273 (31.3)	332 (38.0)	419 (48.0)
Sex [‡]					
Male	336 (34.1)	381 (38.6)	403 (40.9)	416 (42.2)	482 (48.9)
Female	245 (23.5)	280 (26.8)	295 (28.3)	315 (30.2)	366 (35.1)
Race/ethnicity [‡]					
White	469 (34.3)	535 (39.2)	556 (40.7)	600 (43.9)	688 (50.4)
Asian	44 (11.3)	54 (13.8)	64 (16.4)	53 (13.6)	70 (17.9)
Hispanic	42 (22.6)	44 (23.7)	50 (26.9)	48 (25.8)	55 (26.9)
Black	26 (29.5)	28 (31.8)	28 (31.8)	30 (34.1)	35 (39.8)
Insurance [‡]					
Medicare	325 (29.5)	400 (36.3)	433 (39.3)	452 (41.1)	538 (48.9)
Medicaid	57 (32.0)	57 (32.0)	58 (32.6)	61 (34.3)	63 (35.4)
Managed Care	147 (23.6)	150 (24.1)	152 (24.4)	165 (26.5)	185 (29.7)
Uninsured/other	52 (40.6)	54 (42.2)	55 (43.0)	53 (41.4)	62 (48.4)
Individual criterion met [§]					
Age	944 (62.8)	1083 (72.1)	1165 (77.5)	1067 (71.0)	1147 (76.3)
Smoking history	1021 (67.9)	1021 (67.9)	1021 (67.9)	1057 (70.3)	1057 (70.3)
Quit time (FS only)	440 (50.4)	440 (50.4)	440 (50.4)	492 (56.4)	--
None	102 (6.8)	74 (4.9)	55 (3.7)	68 (4.5)	126 (8.4)

USPSTF = United States Preventative Services Task Force; CMS = Centers for Medicare and Medicaid Services; NCCN = National Comprehensive Cancer Network; NLST = National Lung Screening Trial; AATS = American Association for Thoracic Surgery

* Organizations including the American Cancer Society (ACS), American College of Chest Physicians (ACCP), American Society of Clinical Oncology (ASCO), American Lung Association (ALA),
† Percentage of corresponding group of NSCLC cohort
‡ Percentage of current or former smokers, respectively
§ Percentage of current and former smokers