Original Article

Identifying lung cancer in Emergency Department patients outside national lung cancer screening guidelines

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Background: Lung cancer has become the second most common cancer and the leading cause of cancer death in the United States. We aim to determine factors associated with newly diagnosed lung cancer at the Emergency Department (ED) and identify specific patient populations eligible for lung cancer diagnostic screening.

Methods: This is a single-center retrospective observational study. We included all patients aged between 50 and 80 years old, who presented to the ED seeking healthcare between January 1, 2019, and December 31, 2023. Patients' socio-demographics, clinical information, and whether they were eligible for lung cancer screening determined by the United States Preventive Services Task Force (USPSTF) guideline were analyzed and compared between patients who had newly diagnosed lung cancer at ED and those without. Factors associated with newly diagnosed lung cancer patients were determined by multivariable logistic regressions with inverse probability weighting (IPW) to account for observed selection bias of lung cancer screening eligibility.

Results: Out of 75,516 patients in this study, 18,641 (25%) patients had documented smoking histories. Among these, only 8,051 (10.66%) were eligible for lung cancer screening, while 18,348 patients received lung computer tomography (CT). Among all patients whose CTs were performed, 123 individuals were identified as having been newly diagnosed with lung cancer. Multivariable logistic regressions showed that the adjusted odds ratio (AOR) for eligible lung cancer diagnostic screening was 3.07 [95% confidence interval (CI): 2.08–4.53, P<0.001] without IPW and 3.49 (95% CI: 2.24–5.42, P<0.001) with IPW. Other factors associated with newly diagnosed lung cancer in ED were older age, female, and patients who spoke neither English nor Spanish.

Conclusions: To optimize the identification of suitable patients for lung cancer diagnostic screening in the ED, it may be beneficial to modify the eligibility criteria beyond those currently outlined by the USPSTF guidelines. Integrating additional factors such as advanced age, female sex, and a preference for non-English languages could improve the screening's effectiveness by capturing at-risk populations that might otherwise be overlooked.

Keywords: Lung cancer; screening eligibility; Emergency Department (ED)

Submitted Aug 27, 2024. Accepted for publication Dec 27, 2024. Published online Feb 25, 2025.
doi: 10.21037/jtd-24-1399
View this article at: https://dx.doi.org/10.21037/jtd-24-1399

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Introduction

In recent years, the prevalence of lung cancer has increased globally, leading to a rise in mortality rate (1). As of the 2024 statistics from American Cancer Society (ACS), lung cancer has become the second most common cancer and the leading cause of cancer death, accounting for about 1 in 5 of all cancer death in the United States (2). Therefore, it is worthwhile to implement interventions for lung cancer prevention, promote lung cancer screening to detect the early stages of lung cancer, and encourage effective treatment.

In terms of lung cancer screening, current guidelines recommend low-dose chest computerized tomography (LDCT) for a targeted population. Such targeted population has been determined by United States Preventive Services Task Force (USPSTF) and ACS, and defined as individuals aged 50 to 80 years with a 20 pack-year smoking history, either currently smoking or having quit within the last 15 years (3). However, recent studies indicate that using USPSTF/ACS guideline to determine individuals eligible for LDCT may not be accurate enough to identify people at risk of lung cancer, therefore other lung cancer screening prediction models have been reported with various performance accuracy (4,5).

On the other hand, screening procedures are typically conducted during primary care physician clinic visits or annual check-ups. However, certain individuals lacking primary care physicians or seldom undergoing annual check-ups may miss opportunities for lung cancer screening. These individuals are often identified as vulnerable populations, including those without primary care physicians, individuals with infrequent clinical visits, poor communication with healthcare providers, or those with poor social and behavioral risks of health (such as alcohol abuse, intimate partner violence, poor social connection, etc.) (6-8). Many of them rely on the Emergency Department (ED) as their primary medical home for acute episodic care (9). Unfortunately, given the relatively low prevalence of lung cancer and the significant number of patients meeting the criteria for lung cancer screening, it is impractical to conduct LDCT scans for all targeted patients at the ED. Initiating lung cancer screening at the ED may be feasible for highly selected patients deemed to be at the highest risk of lung cancer.

However, at present, it remains uncertain which patient population is considered at the highest risk of developing lung cancer and would benefit from ED lung cancer screening. Previous studies have indicated that patient racial and ethnic factors, socioeconomic conditions, and social determinants of health could impact patients' access to lung cancer screening, designating them as high-risk vulnerable populations (10,11). For instance, previous studies reported that Black individuals had the highest lung cancer incidence and mortality among all races and ethnicities, whereas, such individuals had significantly lower odds of receiving lung cancer screening (12-14). Other studies addressed patients with lower household incomes, lacking healthcare insurance coverages, or lacking primary care physicians, tended to have lower lung cancer screening rates (15-17). These potential vulnerable populations also tended to visit EDs for non-emergent situations (9,18). This evidence suggests the potential benefit of performing lung cancer screening at EDs among such vulnerable populations.

Implementing lung cancer diagnostic screening at the ED targeting specific vulnerable populations may help improve early lung cancer detection and facilitate ongoing patient treatment. However, such findings are lacking in the literature. It is suggested that ED can act as a novel site to targeted patients for cancer screening education (19). However, a previous study showed extremely low cancer screening rates at ED, especially lung cancer screening (20). To further determine the value of ED lung cancer diagnostic screening, it is necessary to understand the status of newly diagnosed lung cancer at ED and potential

Highlight box

Key findings

- Factors such as older age, female sex, and non-English language preference could enhance the effectiveness of diagnostic screening by identifying at-risk populations for lung cancer at Emergency Department (ED).

What is known and what is new?

- We have already known that lung cancer screening criteria have been used for determining individuals at risk of lung cancer. However, we are still uncertain whether such screening criteria can be used among patients only present at ED for seeking their primary care.

What is the implication, and what should change now?

- Our findings showed that using current lung cancer screening criteria may not be sufficient for ED lung cancer screening. Incorporating additional factors such as older age, female sex, and non-English language preference could enhance the effectiveness of diagnostic screening by identifying at-risk populations that may otherwise be overlooked.

risks associated with these patients before initiating ED lung cancer screening. Therefore, in this study, our aim is to (I) determine factors associated with newly diagnosed lung cancer at the ED, and (II) identify specific patient populations vulnerable to lung cancer screening. Only under such circumstances can interventions be implemented more efficiently at ED with reasonable healthcare costs. We present this article in accordance with the STROBE reporting checklist (21) (available at https://jtd.amegroups.com/article/view/10.21037/jtd-24-1399/rc).

Methods

Study design and setting

This is a single-centered retrospective observational study. The study hospital serves as an urban tertiary referral center, addressing the regional healthcare needs of a population exceeding two million. It holds designations as a level one trauma center, a certified chest pain center, and a certified comprehensive stroke care center. The healthcare network of the study hospital extends to over 25 clinics across the region. The ED of the hospital manages an annual volume of approximately 120,000 visits. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the University of North Texas Health Science Center Regional Institutional Review Board (IRB#2093993-1) and individual consent for this retrospective analysis was waived.

Data extraction

Data was extracted by two individuals from the Department of Information Technology (IT), both of whom possess extensive training and experience in electronic medical record data management. For manual validation, we randomly selected 20 patients on three separate occasions, resulting in a total of 60 patients. After completing the manual validations and confirming their accuracy, the entire dataset was retrieved electronically.

Inclusion and exclusion criteria

To determine the status of lung cancer screening and newly diagnosed lung cancer at ED, we included all patients aged between 50 and 80 years old, who presented at the ED seeking healthcare between January 1, 2019, and December 31, 2023. Due to patients with multiple ED visits, we reported both the total ED encounters of included patients and the number of unique patients included in this study. For analysis purposes (such as patient demographics, number of clinic visits or ED visits that occurred during the study period), if multiple encounters occurred, we reported patient characteristics with the latest encounters during the study period. Furthermore, to determine the prevalence of newly diagnosed lung cancer at ED, we only included patients who performed computer tomography (CT) examinations of chest during the ED stay. Similarly, if patients had multiple chest CTs performed from various ED visits during the study period, if CT did not report lung cancer, we only included patient information from the latest ED visit. However, if CT reported lung cancer, we truncated this patient and used patient information of such ED visits. Patients with newly diagnosed lung cancer refer to individuals who had no prior documentation of lung cancer in the electronic health record (EHR) before the indexed ED visit, during which a chest CT scan was performed and revealed lung cancer. Based on the current lung cancer screening eligibility guideline from USPSTF, we excluded patients who were younger than 50 years old or elder than 80 years old.

Outcome measurement

The study outcome is newly diagnosed lung cancer at ED. Lung cancer was interpreted by CT of chest performed at ED. CT of chest included CT chest with or without contrast, and CT angiography of the chest. Lung cancer can be interpreted as primary or metastatic lesions in the chest, we only included patients who had primary lung cancer. Lung cancers were further validated if those patients had performed biopsy or surgical procedure with pathology reports. Patients were excluded if their pathology reports indicated no malignancy or other cancer metastasized to the lung (e.g., colon cancer, breast cancer metastasized to the lung). For patients who refused any biopsy or other surgical procedures without any pathology reports, we included these patients in our initial analyses since a significant number of patients either chose palliative care or lost follow up thereby no sample harvested for pathology examinations.

Variables

One key variable was the eligibility of ED lung cancer screening. The eligibility of Lung cancer screening was followed by the most recent USPSTF guideline. It indicates

lung cancer screening using low-dose CT should be performed annually among adults aged 50 to 80 years, who have a 20-pack-year smoking history and currently smoke or have quit within the past 15 years. Patients who were eligible for lung cancer screening were considered high risk, patients who did not meet screening criteria were considered no high risk, whereas ones who did not document number of pack-year smoking history were considered unknown eligibility statuses of lung cancer screening. We used triage smoking history data to determine whether individual patients were eligible for lung cancer screening. Our smoking history data include (I) smoke status (current smoker, former smoker, never smoker, and unknown), (II) smoke package, (III) smoke years, and (IV) type of smoke (cigarette, cigar, chew, pipes, and snuff). Other variables included patients' demographics, socioeconomic, and clinical information. Demographic variables included patients' age (i.e., ranging from 50 and 80 years old), sex (male and female), race and ethnicity (Non-Hispanic White, Non-Hispanic-Black, Hispanic/Latino, and others), marital status (single, married, and others), and preferred language speaking (English, Spanish, and other languages). Socioeconomic variables included patient insurance status (having insurance coverage and no insurance coverage) and having social/behavior risks of health (including six items: alcohol use, depression, intimate partner violence, physical activity, social connection, and stress), patients having issues with any of these six items were considered positive, whereas ones without any issues were considered negative. Healthcare access and clinical variables included whether patients had their primary care physicians (yes, no) and whether patients had chronic conditions (yes, no). Chronic conditions include hypertension, diabetes, coronary artery disease, asthma, chronic obstructive pulmonary disease (COPD), stroke, chronic kidney disease, human immunodeficiency virus (HIV)/acquired immunodeficiency syndrome (AIDS), tumor, liver cirrhosis, and depression.

Statistical analysis

Group differences in newly diagnosed lung cancer at ED were analyzed using appropriate statistical tests discovered below. The Student's *t*-test was performed for mean comparisons of continuous variables. The Wilcoxon rank-sum test was used for median comparison of continuous variables. Pearson Chi square tests were used for categorical variable comparisons. A multivariable logistic regression analysis was performed to determine the associations between independent variables and newly diagnosed lung cancer at ED, especially focusing on patients who were eligible for lung cancer screening. Furthermore, to avoid potential confounding factors associated with newly diagnosed lung cancer at ED, while setting lung cancer screening eligibility as the primary variable of interest, inverse probability weighting (IPW) logistic regression was performed. Briefly, (I) propensity scores were estimated based on the eligibility of lung cancer screening, (II) weights were calculated as the inverse of these propensity scores; and (III) weighted analysis was performed using these weights to adjust for confounding. By applying IPW, we aim to reduce bias and obtain a more accurate estimate of the association between the treatment (i.e., eligibility of lung cancer screening) and the outcome (i.e., newly diagnosed lung cancer at ED). Additionally, different sex, age, and language interactions were performed to determine the risk of newly diagnosed lung cancer if patients were older, female who spoke neither English nor Spanish. A figure was also generated to determine the odds ratio by age. Adjusted odds ratios (AOR) with their 95% confidence interval (CI) were reported. STATA 17 (College Station, TX, USA) was used for all statistical analyses in this study.

Sensitivity analysis

A sensitivity analysis was conducted by excluding patients with primary lung cancer that was not pathology-confirmed or those whose pathology reports were missing. A multivariable logistic regression was performed to determine the independent variables associated with the newly diagnosed lung cancer at ED. Furthermore, given the small number of newly diagnosed lung cancer cases, misclassification bias might exist. To address this, a misclassification bias analysis was performed to compare the observed and corrected prevalence of newly diagnosed lung cancer in the ED across varying sensitivities and specificities. Lastly, as this study included patient visits during the COVID-19 pandemic, it was assumed that the number of lung CT scans performed during or after the pandemic might have increased compared to the pre-COVID period. To assess this, a comparative analysis was conducted to evaluate the percentage of lung CT scans performed during the pre-COVID and COVID/post-COVID phases.

Reporting guideline

Strengthening of the reporting of observational studies

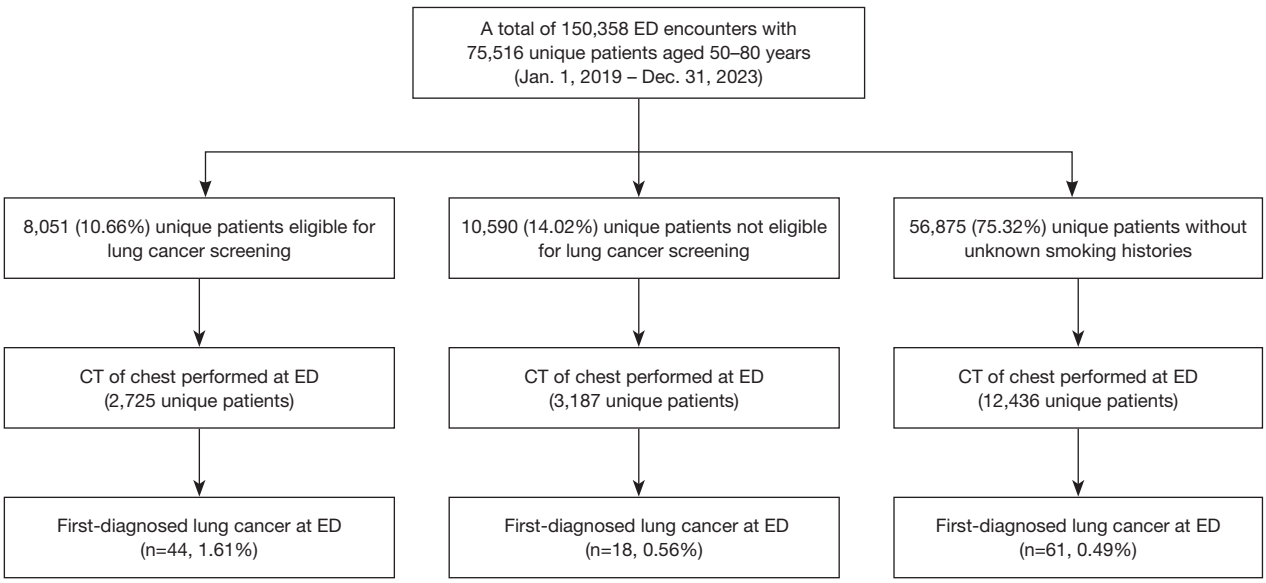

Figure 1 Status of lung cancer screening at study ED. ED, Emergency Department; CT, computer tomography.

in epidemiology (STROBE) reporting guidelines were followed in this study (21).

Results

From 2019 to 2023, there were 75,516 unique patients aged 50–80 years presented at the study hospital's ED at least once, resulting in a total of 150,358 ED encounters. However, only approximately one in four patients had documented smoking histories and 8,051 (10.66%) were eligible for lung cancer screening. Additionally, among patients who underwent a chest CT at the ED, we identified 123 individuals as having been newly diagnosed with lung cancer. Patients who were eligible for lung cancer screening exhibited the highest prevalence of newly diagnosed lung cancer when compared to those who were not eligible for lung cancer screening or who had unknown smoking histories (*Figure 1*). These findings provide insight into the status of lung cancer screening at the study ED.

We compared the general characteristics of patients who underwent a chest CT at the ED between those who had newly diagnosed lung cancer in the ED and those without such a diagnosis (*Table 1*). We confirmed the importance of providing smoking history to determine the eligibility of lung cancer screening. Patients who were eligible for lung cancer screening tended to have higher prevalence of newly diagnosed lung cancer at ED when compared with ones either not eligible for lung cancer screening or unknown of their smoking histories (P<0.001, *Table 1*). Additionally, patients diagnosed with lung cancer tended to be older, preferred speaking languages other than English or Spanish, and had multimorbidity. Interestingly, Hispanic patients appeared to have a lower incidence of lung cancer diagnosed in the ED (*Table 1*). These findings indicate the importance of further investigating age, language preference, social/behavior risks, and chronic conditions, in addition to the smoking history, as predictors of patients at a higher risk of being diagnosed with lung cancer in the ED.

To further determine factors associated with the newly diagnosed lung cancer in the ED, we conducted a multivariate logistic regression analysis (*Table 2*). The AOR for patients who were eligible for lung cancer screening was 3.07 with a 95% CI of 2.08–4.53 (P<0.001). This indicates that patients who were eligible for lung cancer screening had over three times higher odds of diagnosing lung cancer in the ED compared to those who were not eligible for lung cancer screening or whose smoking histories were unknown, confirming the necessity of providing smoking history screening in the ED. The AOR for speaking other languages was 2.42 (95% CI: 1.11–5.28, P=0.01) indicating such patients were also having high likelihood of sustaining newly diagnosed lung cancer at ED. Additionally, other factors associated with newly diagnosed lung cancer at ED include age, race and ethnicity, having primary care physicians, and patients with multimorbidity (*Table 2*).

Furthermore, to reduce bias and obtain a more

Table 1 General information of the study patients

Variables	Newly diagnosed lung cancer at ED (n=123)	No new lung cancer diagnosed at ED (n=18,225)	P value
Eligibility of lung cancer screen, n (%)			<0.001
Eligible	44 (1.61)	2,681 (98.39)	
Not eligible or unknown	79 (0.51)	15,544 (99.49)	
Age, years			
Mean (SD)	65 (7)	61 (8)	<0.001
Median (IQR)	64 (60–69)	61 (55–66)	<0.001
Sex, n (%)			0.38
Male	64 (0.62)	10,205 (99.38)	
Female	59 (0.73)	8,020 (99.27)	
Race and ethnicity, n (%)			<0.001
Non-Hispanic White	59 (0.79)	7,367 (99.21)	
Non-Hispanic Black	42 (0.79)	5,271 (99.21)	
Hispanic/Latino	10 (0.22)	4,551 (99.78)	
Others	12 (1.15)	1,036 (98.85)	
Marital status, n (%)			0.60
Single	49 (0.74)	6,596 (99.26)	
Married	33 (0.59)	5,572 (99.41)	
Others	41 (0.67)	6,057 (99.33)	
Preferred language speaking, n (%)			0.001
English/Spanish	110 (0.63)	17,410 (99.37)	
Other languages	13 (1.57)	815 (98.43)	
Insurance coverage, n (%)			0.51
Yes	106 (0.69)	15,309 (99.31)	
No	17 (0.58)	2,916 (99.42)	
Primary care physician, n (%)			0.03
No/unknown	65 (0.82)	7,883 (99.18)	
Yes	58 (0.56)	10,342 (99.44)	
Social/behavior risks, n (%)			0.07
Positive	47 (0.55)	8,471 (99.45)	
Negative	76 (0.77)	9,754 (99.23)	
Multimorbidity, n (%)			0.01
No	9 (0.32)	2,823 (99.68)	
Yes	114 (0.73)	15,402 (99.27)	

Based on a total of 18,348 unique patients who had CT of chest performed at ED. Patients were divided into two groups (new lung cancer versus no new lung cancer diagnosed from CT of chest performed at ED). Student's *t*-test was used for two group mean age comparisons and Wilcoxon rank-sum test was used for two group median age comparisons. Pearson Chi square test was used for two group comparisons of categorical data. ED, Emergency Department; SD, standard deviation; IQR, interquartile range; CT, computer tomography.

Table 2 Multivariable logistic regression analysis of factors associated with newly diagnosed lung cancer at ED

Variables	AOR	95% CI	P value
Eligibility of lung cancer screen			
Noneligible or unknown	ref.		
Eligible	3.07	2.08–4.53	<0.001
Age	1.05	1.02–1.07	<0.001
Sex			
Male	ref.		
Female	1.37	0.95–1.97	0.10
Race and ethnicity			
Hispanic/Latino	ref.		
Non-Hispanic White	2.73	1.38–5.42	0.004
Non-Hispanic Black	3.05	1.50–6.17	0.002
Others	2.94	1.08–7.99	0.04
Marital status			
Single	ref.		
Married	0.87	0.55–1.39	0.56
Others	0.79	0.52–1.22	0.29
Preferred language speaking			
English/Spanish			
Other languages	2.42	1.11–5.28	0.01
Insurance coverage			
No	ref.		
Yes	0.83	0.48–1.44	0.51
Primary care physician			
Yes	ref.		
No/unknown	0.60	0.40–0.89	0.01
Social/behavior risks			
Positive	ref.		
Negative	0.79	0.53–1.19	0.26
Multimorbidity			
No (ref)	ref.		
Yes	2.06	1.01–4.20	0.046

Based on a total of 18,348 unique patients who had CT of chest performed at ED. A multivariable logistic regression analysis was performed to determine the factors associated with newly diagnosed lung cancer at ED. ED, Emergency Department; AOR, adjusted odds ratio, CI, confidence interval; CT, computer tomography.

accurate estimate of the association of the treatment (i.e., eligibility of performing lung cancer screening) on the outcome (i.e., newly diagnosed lung cancer at ED), IPW logistic regression was performed. The analysis revealed that the eligibility of performing lung cancer screening (AOR =3.49, 95% CI: 2.24–5.42, P<0.001) was significantly associated with the newly diagnosed lung cancer at ED. Additionally, three independent variables were also found to be significantly associated with the outcome: age (AOR =1.05, 95% CI: 1.02–1.09, P=0.002), female (AOR =1.79, 95% CI: 1.05–3.04, P=0.03) and patients who spoke other than English or Spanish (AOR =3.14, 95% CI: 1.62–6.11, P=0.001). These findings indicate that not only is the treatment (i.e., eligibility of performing lung cancer screening) acting as a significant factor, but patients' age, female, and patients' speaking other languages also play crucial roles in determining the newly diagnosed lung cancer at ED (*Table 3*).

We then performed an interaction analysis with the combination of sex, language, and age. *Table 4* shows AORs with their 95% CI when two or three factors were combined. Since age was treated as a continuous variable, a figure was generated to illustrate the AORs across different ages when the other two factors were fixed (e.g., female, speaking neither English nor Spanish). *Figure 2* demonstrates an increase in AORs with advancing age. The shaded area represents the 95% CI of the AORs.

Finally, a sensitivity analysis was conducted to determine factors associated with newly diagnosed lung cancer at ED with the exclusion of lung cancer patients without biopsy and pathologic reports. Our findings were consistent with the same factors identified and listed in *Table 2* except for patients who spoke other languages (Table S1). This was assumed that patients who spoke other languages preferred palliative or conservative treatment, thereby neither surgical procedures nor biopsies were performed. Meanwhile, we also calculated the observed prevalence of newly diagnosed lung cancer in the ED (0.67%) and estimated the corrected prevalence (ranging from 0.67% to 86.60%) under varying assumptions of sensitivity and specificity to account for potential misclassification. A supplemental table has been included to illustrate the corrected prevalence across these scenarios (Table S2). We observed that 19.25% of patients underwent lung CT scans during or after the COVID-19 pandemic (March 1, 2020, to October 31, 2023), compared to 13.02% during the pre-COVID period (January 1, 2019, to February 29, 2020). Despite this increase in imaging, the detection rate of newly diagnosed lung cancer did not

Table 3 Using IPW logistic regression to determine the association between the eligibility of lung cancer screening and newly diagnosed lung cancer at ED

Variables	AOR	95% CI	P value
Eligibility of lung cancer screen			
Noneligible or unknown	ref.		
Eligible	3.49	2.24–5.42	<0.001
Age	1.05	1.02–1.09	0.002
Sex			
Male	ref.		
Female	1.79	1.05–3.04	0.03
Race and ethnicity			
Hispanic/Latino	ref.		
Non-Hispanic White	2.13	0.71–6.42	0.18
Non-Hispanic Black	1.87	0.57–6.15	0.30
Others	2.40	0.74–7.76	0.15
Marital status			
Single	ref.		
Married	1.28	0.66–2.46	0.46
Others	0.80	0.43–1.48	0.47
Preferred language speaking			
English/Spanish	ref.		
Other languages	3.14	1.62–6.11	0.001
Insurance coverage			
No	ref.		
Yes	1.01	0.47–2.17	0.98
Primary care physician			
Yes			
No/unknown	0.69	0.38–1.24	0.21
Social/behavior risks			
Positive	ref.		
Negative	0.89	0.47–1.67	0.71
Multimorbidity			
No	ref.		
Yes	1.91	0.62–5.91	0.26

IPW was performed with lung cancer screening eligibility as the treatment. Multivariable logistic regression was then performed to determine the association between the treatment and newly diagnosed lung cancer at ED. Meanwhile, the association of all other independent variables and newly diagnosed lung cancer was also determined. IPW, inverse probability weighting; ED, Emergency Department; AOR, adjusted odds ratio; CI, confidence interval.

increase, with rates of 0.97% in the pre-COVID phase and 0.60% during the COVID/post-COVID phase.

Discussion

Early cancer prevention and detection play a crucial role in cancer management. Providing lung cancer screening can greatly enhance the likelihood of early cancer detection. Our study explores the possibility of implementing lung cancer screening in the ED. Currently, only one in four patients presenting at the ED have a documented detailed smoking history, which is essential for determining eligibility for lung cancer screening. Among individuals who underwent chest CT, patients who were eligible for lung cancer screening had a significantly higher prevalence of newly diagnosed lung cancer at the ED compared to patients whose smoking history was unknown or who were not eligible. Furthermore, we confirmed that only using USPSTF/ACS eligibility guideline to initiate lung cancer screening might not be enough. Certain populations, who were older, females, or spoke languages other than English or Spanish, tended to have much higher odds of sustaining a newly diagnosed lung cancer at the ED. Our study confirms the value of obtaining smoking history for lung cancer screening. In addition, we identify other risks that may contribute to modifying eligibility for performing lung cancer screening, particularly in the acute care setting. Additionally, the USPSTF eligibility guidelines target asymptomatic individuals for lung cancer screening. In contrast, our study's screening population was derived from patients who underwent CT scans. These patients were typically presented with symptoms deemed by healthcare providers to warrant CT examination. As a result, the lung cancer screening approach suggested by our study is more aligned with diagnostic lung cancer screening rather than preventive lung cancer screening. These findings go beyond the national lung cancer screening guideline, providing evidence for the feasibility of initiating cancer diagnostic screening at the ED, and potentially leading to significant healthcare cost savings.

According to the American Lung Association statistics, the prevalence of lung cancer in 2019 was approximately 59 in 100,000 in men and 48 in 100,000 in women in the United States (22). The detection rate of lung cancer among individuals who were eligible for lung cancer screening varied due to different screening criteria used. The National Lung Screening Trial in US found 2.4% (649/26,722) detection rate among individuals eligible for lung cancer

Table 4 Interaction analysis of three variables associated with newly diagnosed lung cancer

Variables	AOR	95% CI	p
Female + speaking neither English nor Spanish	3.30	1.41–7.75	0.006
Female + elderly	5.39	2.44–11.92	<0.001
Speaking neither English nor Spanish + elderly	9.54	3.51–25.97	<0.001
Female + speaking neither English nor Spanish + elderly	13.03	4.56–37.28	<0.001

Adjusted odds ratios are calculated based on the results from multivariable logistic regression with 50-year-old male who spoke either English or Spanish as the reference group. Elderly refers to adults who were 80-year-old. AOR, adjusted odds ratio; CI, confidence interval.

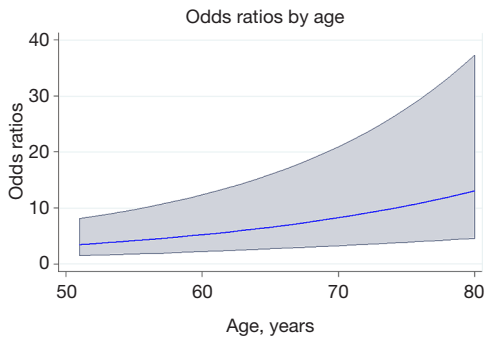

Figure 2 Adjusted odds ratios across different ages. The shaded area represents the 95% CI of the AORs. CI, confidence interval; AOR, adjusted odds ratio.

screening and the criteria included US adults of 55–74-year-old with 30 pack-year of smoking history (23). In Canada, a higher detection rate (2.85% at baseline and 0.89% seen on the follow-up scans) was found among individuals aged 50–74 with over 30 pack-year smoking history (24). In Europe, the detection rates were around 1.1–1.7% when CT scans were performed among individuals aged 50 or older with 20 pack-year smoking history (25,26). Our findings reported an overall lung cancer detection rate of 1.61% among ED individuals who met the screening eligibility. These rates are similar in comparison to the previous reports. Our results also revealed that approximately 25% of ED patients had a documented detailed smoking history capable of determining whether they were eligible for lung cancer screening. Such a low percentage could be a barrier for the initiation of ED lung cancer screening. Among patients who screened, non-Hispanic White yielded the highest lung cancer screening eligible rate and Hispanic/Latino patients tended to have lower eligible rate, such findings are also similar to the previous reports (27,28). Given the similar lung cancer detection rate and relatively lower rate of eligibility for screening in the study ED, our findings suggest the need to enhance triage smoking history screening for ED patients.

In addition to emphasizing the importance of obtaining an accurate smoking history during triage, lung cancer screening in the ED should incorporate shared decision-making discussions and smoking cessation counseling. These processes, however, are relatively time intensive. Given the emergent or urgent nature of ED visits, not all patients are suitable candidates for lung cancer screening in this setting. We recommend prioritizing lung cancer screening for ED patients who have sufficient time during their visit to engage in shared decision-making and smoking cessation counseling, and who have high risk for lung cancer, as identified by their triage presentation (e.g., hemoptysis, significant weight loss) or by employing automated tools designed to flag high-risk patients at triage. For patients who may not have adequate time for comprehensive screening during their ED stay, it may be feasible to provide education and counseling on lung cancer screening at discharge. This strategy could facilitate smoking cessation efforts and encourage patients to pursue lung cancer screening during follow-up visits with their primary care providers, thus creating an additional opportunity to address their screening needs (29,30). Previously reported studies have highlighted the risks associated with lung cancer (31,32). Advanced age is a well-established factor in cancer epidemiology. In our study, the Hispanic/Latino patient population exhibited a relatively lower rate of newly diagnosed lung cancer compared to other races and ethnicities. Our findings align with previous reports (31,33), and this difference may be attributed, in part, to the relatively younger age, fewer people eligible for lung cancer screening, and fewer chronic conditions among our Hispanic/Latino patients (refer to Table S3). Additionally, patients with multimorbidity tended to have

a higher prevalence of developing cancer. This might, partially, be explained as cancer and other chronic diseases share some common risk factors (32). For example, patients with COPD can develop lung cancer at a rate of 0.8–1.7% yearly (34). Patients whose preferred languages were neither English nor Spanish also tended to have a higher incidence of lung cancer diagnosed in the ED. This observation may be interpreted as these patients having fewer clinical and ED visits in the past (see Table S4). Therefore, such patients should be considered as the targeted population for initiating lung cancer screening at the ED.

This study has several strengths. It boasts a large sample size, incorporating 5 years of ED data. Although the primary focus was not specifically on low-dose chest CT lung cancer screening, we included patients who underwent chest CTs at the ED, irrespective of the reasons for the CT. This approach provided us with a comprehensive overview of the overall status of newly diagnosed lung cancer at the study ED. Furthermore, beyond considerations for patients meeting lung cancer screening criteria, we also considered other variables with the potential to influence lung cancer screening, such as patient demographics (e.g., race and ethnicity), socioeconomic status (e.g., insurance), and psychosocial risks (e.g., social/behavior risks). All these factors were considered and analyzed together and along with the IPW logistic regression to determine the association with the outcome (i.e., newly diagnosed lung cancer) and mitigate confounding factors.

Inevitably, our study has its limitations. Firstly, being a retrospective observational study, the presence of missing, incomplete, and incorrect data cannot be entirely avoided, potentially introducing biases in data accuracy and results. Secondly, the determination of newly diagnosed lung cancer relied on CT interpretation, even though we validated the lung cancer diagnoses by reviewing patients' final pathological reports. However, a significant number of patients did not have pathology reports for various reasons, which could introduce further deviations in our findings. Thirdly, we only calculated the number of ED visits within the same healthcare system, and the clinical conditions of patients who sought follow-up care outside our systems remained largely unknown. Fourthly, although we included certain factors that could potentially influence lung cancer diagnoses in the ED, such as adherence to the USPSTF guideline for lung cancer screening eligibility, we were unable to exclude patients who were not recommended by USPSTF for screening under these guidelines. This limitation arose from the retrospective nature of the study, which prevented us from obtaining detailed information on individual factors, such as comorbid conditions that may limit life expectancy <5 years, not willing to accept treatment for lung cancer, or health conditions that may increase harm or hinder further evaluation, surgery, or treatment for lung cancer. Furthermore, there may be additional unconsidered that could introduce inaccuracies in the study findings. In this study, we adhered to the most recent USPSTF lung cancer screening guidelines. However, these guidelines are updated periodically and may change in the future. Therefore, future large-scale, multi-center studies incorporating more potential factors associated with ED lung cancer screening eligibility are warranted for further validation.

Lung cancer screening guidelines have been established and recommended by organizations such as the USPSTF and ACS. However, our study aims to modify the current guidelines to make them more suitable for use in an emergency setting, specifically targeting vulnerable patient populations who may only seek healthcare in the ED. Given the unique conditions in the ED, the eligible candidates for lung cancer diagnostic screening may be limited to those who require a chest examination, meet our study's criteria, and have time for shared decision-making and smoking cessation counseling. We hope that this robust and tailored approach to lung cancer diagnostic screening will help minimize healthcare disparities among certain vulnerable populations.

Conclusions

Currently, there is a lack of lung cancer diagnostic screening initiatives in the ED. Lung cancer diagnostic screening programs might consider modifying their eligibility criteria beyond the current USPSTF guidelines. Incorporating additional factors such as advanced age, female sex, and a preference for non-English languages could improve the screening's effectiveness by capturing at-risk populations that might otherwise be overlooked.

Acknowledgments

None.

Footnote

Reporting Checklist: The authors have completed the STROBE reporting checklist. Available at https://jtd.

amegroups.com/article/view/10.21037/jtd-24-1399/rc

Data Sharing Statement: Available at https://jtd.amegroups.com/article/view/10.21037/jtd-24-1399/dss

Peer Review File: Available at https://jtd.amegroups.com/article/view/10.21037/jtd-24-1399/prf

Funding: None.

Conflicts of Interest: All authors have completed the ICMJE uniform disclosure form (available at https://jtd.amegroups.com/article/view/10.21037/jtd-24-1399/coif). U.S. received funds from the National Institute on Minority Health and Health Disparities through the Texas Center for Health Disparities (NIMHD) 5S21MD012472-05, and the NIH/AIM-AHEAD Grant # 1OT2OD032581-01. The content is solely the responsibility of the authors and does not necessarily represent the official view of the NIH. The other authors have no conflicts of interest to declare.

Ethical Statement: The authors are accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved. The study was conducted in accordance with the Declaration of Helsinki (as revised in 2013). The study was approved by the University of North Texas Health Science Center Regional Institutional Review Board (IRB#2093993-1) and individual consent for this retrospective analysis was waived.

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Cite this article as: Wang H, Cheeti R, Murray M, Muirheid TA, McDowell J, Sambamoorthi U. Identifying lung cancer in Emergency Department patients outside national lung cancer screening guidelines. J Thorac Dis 2025;17(2):695-706. doi: 10.21037/jtd-24-1399