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Epidemiology

Multidisciplinary approach to low-dose CT screening for lung cancer in a metropolitan community

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Abstract

Background: Lung cancer is the primary cause of cancer death in men and women in the USA, led by Kentucky. In 2015, the Centers for Medicare and Medicaid Services initiated annual lung cancer screening with a low-dose computed tomography (LDCT) scan. This observational cohort study evaluated the multidisciplinary approach to this screening in our metropolitan community.
Methods: We present the prospective findings of patients who underwent a screening lung LDCT scan over a 2-year period at our institution in Kentucky. Patients who fulfilled the screening criteria were identified during an office visit with their primary care provider.
Results: Of the 4170 patients who underwent a screening lung LDCT scan, a total of 838 (20.9%) patients had nodules >4 mm. Of the 70 patients diagnosed with lung cancer, Stage 1 non-small cell lung cancer was most commonly detected [38 cases (54.3%)]. A follow-up lung LDCT scan (n = 897), pulmonary function test (n = 157), positron emission tomography scan (n = 12) and a lung biopsy (n = 53) were performed for certain individuals who had anomalies observed on the screening lung LDCT scan. A total of 42% of patients enrolled in group tobacco cessation classes quit smoking.
Conclusions: This study provides a unique perspective of a lung LDCT scan screening program driven by primary care providers in a state plagued by cigarette smoking and lung cancer deaths and offers a valuable message into the prevention, high-risk screening and diagnosis of lung cancer.

Key Words: Family practice, low-dose computed tomography scan, lung cancer, primary care providers, screening, smoking.

Background

According to the Centers for Disease Control and Prevention (CDC), lung cancer is the second most common cancer in both men and women, following prostate and breast cancer, respectively (1). Two-thirds of people diagnosed with lung cancer are older than 65; the average age at the time of diagnosis is 70. Cigarette smoking is the primary risk factor for lung cancer and is associated with 80–90% of lung cancers in the USA (2).

Lung cancer is the leading cause of cancer death in both men and women in the USA (1). More people die of lung cancer annually than colon, breast and prostate cancers combined. Kentucky has both the highest incidence and death rates for lung and bronchus cancer in the USA (3). In 2015, the incidence and death rates per 100 000 of lung and bronchus cancer in Kentucky was 89.6 compared to 57.5 nationally and 64.3 versus 40.6 nationally, respectively (3).

Key Messages

- Lung cancer is the leading cause of cancer death in the USA.
- Lung cancer screening is recommended if certain criteria are met.
- Nodules >4 mm were seen on screening low-dose CT scan in 20.9% of patients.
- Stage 1 non-small cell lung cancer was most commonly detected (54.3%).
- A total of 42% of patients in group tobacco cessation classes quit smoking.
- Our program is driven by primary care providers to increase patients screened.

The vast majority (80–90%) of lung cancer deaths result from cigarette smoking (2). In 2017, a total of 24.6% of adults in Kentucky smoked while the national average was 14.0% (4).

A low-dose computed tomography (LDCT) scan of the lungs has been shown to detect many lung tumours at early stages (5). The National Lung Screening Trial (NLST) investigated 53 454 individuals at high risk for lung cancer at 33 US medical centres who were randomized to three annual screenings with either lung LDCT or single-view posteroanterior chest radiography (5). There were 247 deaths from lung cancer per 100 000 person-years in the lung LDCT group compared to 309 deaths per 100 000 person-years in the radiography group ($P = 0.004$). The rate of death from any cause was lower in the lung LDCT group compared with the radiography group ($P = 0.02$). These findings reflect a reduction in the relative risk of death from lung cancer by 20% and the absolute risk by 0.33%.

In February 2015, the Centers for Medicare and Medicaid Services (CMS) initiated annual screening for lung cancer with a LDCT of the lungs as a preventive service benefit under Medicare if the following criteria were met: (i) age 55–77 years; (ii) asymptomatic; (iii) tobacco smoking history of at least 30 pack-years and (iv) current smoker or one who has quit smoking within the last 15 years (6). The US Preventive Services Task Force (USPSTF) advocates a similar LDCT screening, with a recommendation that screening should not be initiated if a person has not smoked for 15 years or should be discontinued if an individual develops a health condition that significantly limits life expectancy or the ability to have curative lung surgery (7,8). Additionally, the USPSTF advocates screening in adults aged 55–80 years.

The present study evaluated the impact of the CMS-approved lung LDCT screening in a metropolitan community in Kentucky. We discuss the three factors integral to the comprehensive lung program at our institution: (i) baseline lung LDCT screening; (ii) smoking prevention in our community tobacco cessation program and (iii) diagnosis of lung cancer. We also highlight the unique features of our lung LDCT screening program driven by primary care providers (PCPs).

Methods

Under an institutional review board-approved protocol, this prospective observational cohort study presents the findings of patients who underwent a baseline screening lung LDCT over a 2-year period between 1 November 2015 and 31 October 2017. Patients who were eligible and appropriate candidates for a lung LDCT and who met the CMS criteria were identified during an office visit with their PCP. During a patient's routine PCP visit for either an annual physical or a general visit, the electronic medical record software application Epic at our institution alerted PCPs when a patient fulfilled the CMS criteria to undergo a baseline screening lung LDCT. If a patient met the CMS criteria and desired a screening lung LDCT, the PCP and patient discussed the benefits and harms in a shared decision-making process (Table 1). If the patient agreed to participate, he/she was automatically enrolled in the study at the same visit. PCPs were the only providers who enrolled patients in this study, and they provided the patients with a written order for the screening lung LDCT. Individuals who were enrolled in our study and initiated lung cancer screenings were instructed to have annual screenings until age 80. Due to the high smoking rate in Kentucky, our study wanted to capture the higher age of patients. Therefore, our upper age is 80 based on the USPSTF recommendations.

The findings observed on the screening lung LDCT, specifically, whether the scan was normal, the size of the nodule and other abnormal non-nodule findings, dictated the subsequent management strategies as outlined in the lung imaging reporting and data system (Lung-RADS™) Version 1.0 assessment categories (Supplementary Table 1) (9). A mass was classified as positive or 'suspicious' for cancer on the screening lung LDCT if it fulfilled the criteria for Categories 3 or 4 (nodules >4 mm) in the Lung-RADS™ Version 1.0. A certified general radiologist read the LDCTs in a timely manner at one of the six treating screening facilities in our metropolitan area. Patients smoothly transitioned from fulfilling the CMS criteria for a screening lung LDCT and automatically enrolling in the study at their PCP visit to undergoing the screening lung LDCT with a potential lung cancer diagnosis.

All patients enrolled in the study were offered 1:1 tobacco cessation counselling visits, with a special emphasis on those individuals diagnosed with Categories 3 or 4 by Lung-RADS™. Patients were also given the option of participating in group smoking cessation classes for 8 weeks in duration utilizing evidence-based techniques. These classes discussed the effects of smoking and why quitting is essential, motivational interviewing and aids to quit smoking such as gum and patches.

Comprehensive lung centre

Our institution initiated a comprehensive lung centre on 1 November 2015 managed by our cancer institute, which offered personalized

Table 1. Benefits and harms of screening lung LDCT scan

Benefits	Harms
• Reduces mortality from lung cancer • Early diagnosis allows more effective treatment • Lower radiation exposure than full chest CT scan • More treatment options if detect lung cancer before symptoms • Identifies smaller nodules than chest radiographs	• High rate of false positives necessitating additional tests and treatments • Radiation exposure leading to radiation-induced cancers • Overdiagnosis • Complications of diagnostic procedures after screening lung LDCT if abnormality detected • Costs of tests and procedures after screening lung LDCT if abnormality detected

attention and continuity of care focussing on the screening and prevention of lung cancer with a particular emphasis on smoking cessation. The comprehensive lung centre consists of pulmonologists, medical and surgical oncologists and a lung navigator. This latter individual was assigned to all patients who were enrolled in the study and referred for lung LDCT screening. The navigator educated, tracked and ensured adequate follow-up with a PCP or specialist based on the findings of the screening lung LDCT and assisted the PCP in developing a tobacco cessation plan for patients who continue to smoke cigarettes.

The participants enrolled in this study provided no negative feedback in response to their procedures. Individuals were educated at multiple instances about the possibility of high false-positive rates on the screening lung LDCT. Patients who were eligible for a screening lung LDCT discussed the potential of obtaining a false-positive result with their PCP prior to enrolling in the study and, subsequently, when evaluated at the comprehensive lung centre.

Multidisciplinary lung clinic

The patients diagnosed with lung cancer were treated at the multidisciplinary lung clinic that offered a full-care plan replete with medical, radiation and behavioural oncologists, thoracic surgeons, oncology psychologists and nurses, dosimetrists and a lung navigator. All patients diagnosed with lung cancer were guaranteed same-day appointments at our cancer institute.

Results

Lung cancer screening with LDCT scan

Of the 62 406 individuals eligible for a screening lung LDCT at our institution, a total of 6433 patients (10.3%) were evaluated by their PCP over the 2-year course of this study. Of the patients seen by their PCP, a total of 4170 (64.8%) patients agreed to enrol and underwent a screening lung LDCT (Table 2). The mean age was 64.5 years, and 2254 (54.0%) patients were female. Most individuals [3635 (87.2%)] were Caucasian followed by African American [441 (10.6%)]. The leading payor was Medicare [1277 (30.62%)] followed by Medicare Advantage [835 (20.0%)], Anthem [803 (19.2%)] and Self Pay [305 (7.3%)].

Table 2. Screening LDCT scan of the lungs at our institution (1 November 2015–31 October 2017)

Data points	Number of patients
Screening lung LDCT	4170
Categories 3 and 4 of Lung-RADS™ Version 1.0 on screening lung LDCT	838 (20.9%; cancer, adenopathy, effusion, emphysema, interstitial lung disease and bronchiectasis
Diagnosed with lung cancer following screening lung LDCT	70 (rate of cancer detection: 1.7%) ▪ NSCLC Stage 1: 38 (54.3%) ▪ NSCLC Stage 2: 4 (5.7%) ▪ NSCLC Stage 3: 13 (18.6%) ▪ NSCLC Stage 4: 6 (8.6%) ▪ NSCLC Stage Unknown: 3 (4.3%) ▪ SCLC: 6 (8.6%)
Additional testing following screening lung LDCT	Follow-up lung LDCT: 897 PFT: 157 PET scan: 12 Lung biopsy: 53
Referral to a pulmonologist within 6 months of screening lung LDCT	182
Lung clinic visits	768
Quit rate for 1:1 tobacco cessation sessions and group tobacco cessation classes	28% and 42%

The majority [3892 (93.3%)] of patients were referred for lung LDCT screening by their PCP at our institution. The remaining patients were managed by their PCP alone. In these latter cases, patients who were enrolled in our study were not assigned to a lung screening navigator and were not evaluated at the comprehensive lung centre. The patients were solely under the care of the PCP who determined the lung LDCT follow-up scans. They were not seen by a specialist unless they were diagnosed with lung cancer. Of the 4170 individuals who underwent a screening lung LDCT, a total of 768 (18.4%) patients were evaluated at the comprehensive lung centre.

Findings of screening lung LDCT scan and additional testing

All patients who underwent a screening lung LDCT were assigned a score based on the Lung-RADS™ algorithm, as represented by Categories 1–4 (Supplemental Table 1) (9). The majority [3332 (79.9%)] of individuals were in either Lung-RADS™ Categories 1 or 2, specifically, prior to the development of cancer. Of the 4170 patients who underwent a screening lung LDCT, a total of 838 (20.9%) abnormalities in Lung-RADS™ Categories 3 and 4 were observed (Table 2). These findings ranged from various types and stages of lung cancer to myriad other abnormal findings, such as adenopathy, effusion, emphysema, interstitial lung disease and bronchiectasis (Table 2). A total of 70 individuals were diagnosed with lung cancer following the screening lung LDCT, reflecting a rate of detection rate of 1.7%. The most common type of cancer was Stage 1 non-small cell lung cancer (NSCLC) in 38 (54.3% patients), where the cancer was confined to the lung without involvement of the lymph nodes. The false-positive rate was 91.6% (768/838). The stage of NSCLC was unknown in three cases where the patients were treated outside of our institution's system. Two patients diagnosed with lung cancer following the screening lung LDCT succumbed to their cancer during the course of our study.

A follow-up lung LDCT, a pulmonary function test (PFT), a positron emission tomography (PET) scan, a lung biopsy or a pulmonologist appointment were performed for certain individuals who had anomalies observed on the screening lung LDCT based on the Lung-RADS™ algorithm (Table 2).

Cigarette smoking

A total of 2653 (63.6%) individuals enrolled in our study continued to smoke cigarettes. The quit rate for the 1:1 tobacco cessation counselling sessions was 28% compared to 42% for the group tobacco cessation classes (Table 2). The quit rate was determined at 6 months following the 8-week group program or the completion of the individual counselling. The higher quit rate percentage for the group classes was likely attributed to the group mentality, patients' less prone to miss a class and accountability to be adherent to the nicotine replacement therapy. In addition, the individuals in the class were often accompanied by a friend or loved one, whereby they took the journey together and both quit smoking.

Discussion

Several differences existed between our study and the groundbreaking NLST 2011 study and Kinsinger *et al.*'s study of 4246

individuals aged 55–80 in a veteran health administration setting who underwent a lung LDCT (5,10). The NLST study included two groups of patients, specifically, those who underwent lung LDCT or single-view posteroanterior chest radiography for three annual screenings and a different age criteria of individuals compared to ours (55–74 versus 55–80 years, respectively). All of the enrolled patients in our study underwent the screening lung CT based on the CMS recommendations. The veteran health administration study had a greater number of men compared to ours (96.3% versus 46.0%, respectively).

The benefits and harms associated with screening lung LDCT have been reported in the literature (Table 1) (5,11–17). In the NLST 2011 study, the rate of positive screening lung LDCTs was 24.2%, of which 96.4% were false-positive results. In Kinsinger *et al.*'s study, there was a 97.5% false-positive rate (10). Our 91.6% false-positive rate was the lowest of these three studies. Overdiagnosis results from the detection of cancers that never would have become symptomatic and serves as a source of controversy surrounding LDCT lung cancer screening (5,18). While we acknowledge that overdiagnosis and detection of false positives play a role when conducting lung LDCT screening and may negatively impact those individuals who do not have cancer, we believed that our efforts would be valuable for the entire population to ensure cancer detection in patients who actually have cancer and not to miss anyone.

In their NELSON trial, Horeweg *et al.* investigated 15 822 participants aged 50–75 years who were assigned to either LDCT or no screening (19–21). They reported that 200 individuals were diagnosed with 209 lung cancers in the first three screening rounds, the majority (70.8%) of which were detected at Stage 1 (19). Similarly, the highest percentage of cancers (54.3%) were detected at Stage 1 in our study.

Our unique study highlights the state of Kentucky with the highest diagnosis of and deaths from lung cancer and greatest number of cigarette smokers. Of the 4170 patients who underwent a screening lung LDCT over the 2-year period, a total of 838 (20.9%) findings in Lung-RADS™ Categories 3 and 4 were observed. In addition, our tobacco cessation groups proved effective in our study in that 42% of participants quit smoking. Our multifaceted lung program encompassing the screening lung LDCT, the smoking cessation classes and the diagnosis of lung cancer serves as a model for other community-based medical practices. Our study presents a change in health care delivery and economics in terms of operations and logistics following the implementation of the CMS-approved lung LDCT screening.

According to the American College of Radiology Lung Cancer Screening Registry in 2016, Kentucky ranked seventh in the nation for lung cancer screenings with an appropriateness of screening rate of 95% compared to 87% nationally. The appropriateness of screening rate refers to the percentage of patients screened for lung cancer who met the CMS criteria. The rate of smoking cessation offered was 76% in Kentucky and nationally. Our institution had an appropriateness of screening rate of 99% and a smoking cessation offered rate of 100%, representing higher rates than all individual states.

It has been shown that the majority of LDCT screening centres in the USA is located in the counties with the highest lung cancer incidence and mortality in the Northeast and East North Central states, with a paucity in several high-risk states (22,23). Interestingly, Kentucky was in the highest quartile (0.52 centres per 100 000 persons aged 55–79) and 10th best in the country, an encouraging sign given its high incidence and mortality from lung cancer (22). Funded by the CDC, the Kentucky Cancer Consortium Lung Cancer Prevention and Early Detection Network is comprised of 70 diverse organizations with the goals of prevention, early detection, treatment and care, and quality of life associated with lung cancer (22,24). This collaborative approach focussing on the cancer continuum may be a predominant reason why the screening rates are so high in Kentucky.

Strengths and limitations

The present study has significant implications for the prevention, high-risk screening and diagnosis of lung cancer. Our lung cancer program features several unique strengths compared to other lung screening programs. Unlike other lung screening programs where the specialists initially evaluate the patients and drive the volume, the PCPs in our program drive the number of patients flowing into the program which captures many more patients. In addition, the majority of other programs use their cancer centre to drive the program compared to our entire system (PCPs, radiologists, cancer centre, access centre and diagnostic centres) that treats the patients. In this respect, our continuum of care and quality of care are enhanced. Finally, many specialists such as thoracic surgeons, pulmonologists and medical and radiation oncologists are involved in the diagnostic, high risk and cancer clinics to offer their opinions about the screening CT scan and appropriate treatment course while informing the PCPs about their patients' treatment regimen. Our program serves as a model that may be implemented in other metropolitan communities in the USA. Our results in Kentucky may be generalized and applied to other states. One of the limitations of our study is the small percentage of our patient population who had the screening lung LDCT out of the individuals eligible for it at our Institution. As PCPs are the only providers who enrolled patients in our study for the screening lung LDCT, we did not capture patients evaluated in the Emergency Department or by a specialist who may be eligible for this test. Our goal is to encourage PCPs to schedule the screening lung LDCT for all eligible patients. Additionally, only a small percentage (18.4%) of patients who underwent a screening lung LDCT were evaluated at the comprehensive lung centre. As the majority (79.9%) of patients were in either Lung-RADS™ Categories 1 or 2, these patients may not feel the need to be seen at the comprehensive lung centre. Finally, our study only included patients from a metropolitan area instead of a rural setting.

Conclusions

The lung LDCT screening at our institution driven by PCPs offers a comprehensive and patient-centred system of maximizing benefits and minimizing harms coupled with shared decision-making and smoking cessation. Our multifaceted and standardized approach to detecting and treating abnormalities noted on the screening lung LDCT serves an important community health mission with the goal of decreasing the morbidity and mortality associated with lung cancer.

Supplementary material

Supplementary material is available at *Family Practice* online.

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Declaration

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Ethical approval: the University of Louisville Institutional Review Board

stated that our project did not meet the 'Common Rule' definition of human subjects' research. Therefore, this project did not require IRB review. The IRB number was 17.0005.

Conflicts of interest: none declared.

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