ONLINE EXCLUSIVE

Barriers to Lung Cancer Screening With Low-Dose Computed Tomography

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PROBLEM IDENTIFICATION: Despite lung cancer screening guidelines and insurance coverage changes, rates of lung cancer screening with low-dose computed tomography remain suboptimal among the eligible population in the United States.

LITERATURE SEARCH: Electronic literature databases, including PubMed, CINAHL®, PsycINFO, and Google Scholar, were searched.

DATA EVALUATION: After applying filter information and inclusion and exclusion criteria, 10 articles were reviewed. Methodological rigor was evaluated.

SYNTHESIS: Based on the social–ecological approach, barriers to lung cancer screening at the individual level, including sociodemographic characteristics, financial cost, lack of knowledge, inaccurate beliefs about lung cancer screening, distrust of the medical system, stigma around smoking and lung cancer, negative attitudes about outcomes of lung cancer screening, and inconvenience of receiving lung cancer screening, were identified. Barriers at the health-system level included lack of information from primary care providers.

IMPLICATIONS FOR PRACTICE: Overcoming barriers to lung cancer screening at individual and health-system levels is essential to increase lung cancer screening uptake rates.

KEYWORDS lung cancer screening; barriers; low-dose computed tomography; lung cancer
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Lung cancer is the leading cause of cancer-related deaths in the United States (World Health Organization, 2018). Although the lung cancer mortality rate has dramatically decreased during the past two decades—primarily because of the decrease of cigarette smoking—the incidence rate of lung cancer still ranks second in both genders (American Cancer Society [ACS], 2019).

Patients with lung cancer have one of the lowest five-year survival rates (McCarthy, 2014). When diagnosed at an early stage, patients with lung cancer have a 52% survival rate at five years, but the five-year survival rate drops to 15% when diagnosed at a late stage (McCarthy, 2014). To diagnose lung cancer at an early stage and increase the five-year survival rate, obtaining lung cancer screening at an early stage is essential (Parker et al., 2015).

In 1970, ACS recommended chest x-ray with or without sputum cytology to find lung cancer early (Wender et al., 2013). However, in 1980, ACS retracted this guideline, because evidence was lacking to support chest x-ray's efficiency to decrease the lung cancer–related mortality rate (Wender et al., 2013). In 2002, the National Lung Screening Trial (NLST) research team began to conduct an eight-year randomized clinical trial to test the efficiency of chest x-ray and low-dose computed tomography (LDCT) in decreasing the lung cancer mortality rate (Aberle et al., 2013). This clinical trial was conducted among 53,454 participants who were at high risk for lung cancer (being aged 55–74 years, having a smoking history of at least 30 pack-years during the lifetime, being a current smoker or having quit smoking in the past 15 years) (Aberle et al., 2013). Participants were required to receive three annual lung cancer screenings with chest x-ray or LDCT. Results showed that LDCT can significantly decrease the lung cancer mortality rate by 20%, compared to chest x-ray (Tota, Ramanakumar, & Franco, 2014; Wender et al., 2013).

Based on the NLST results, in 2013, the U.S. Preventive Services Task Force ([USPSTF], 2016) began to recommend that high-risk populations receive LDCT to screen for lung cancer annually. In January 2015, the Affordable Care Act mandated private insurance companies that cover lung cancer screening with LDCT for eligible populations following the USPSTF guideline (Bindman, 2015). In February 2015, the Centers for Medicare and Medicaid Services ([CMS], 2015) began to cover LDCT lung cancer screening with a physician's prescription and shared decision-making documents. After that, several other organizations, such as ACS, the American College of Chest Physicians, the American Society of Clinical Oncology, the American Lung Association, and the National Comprehensive Cancer Network started to support and recommend lung cancer screening with LDCT (Latimer & Mott, 2015).

Although the supportive landscape for lung cancer screening has changed, uptake rates of lung cancer screening with LDCT remain low following the publication of the USPSTF guideline (Hoffman et al., 2015; Lewis et al., 2015). The percentage of the eligible population who had received lung cancer screening with LDCT only increased from 3.3% in 2010 to 3.9% in 2015 (Jemal & Fedewa, 2017). Possible reasons for the low uptake rate of lung cancer screening with LDCT suggested by Jemal and Fedewa (2017) include lack of access to care, lack of knowledge about LDCT among smokers, and physicians' lack of knowledge about screening recommendations and reimbursement.

The purpose of this integrative review is to identify and summarize the barriers to screening for lung cancer with LDCT that may help explain nonadherence to lung cancer screening guidelines among the eligible U.S. population.

Methods

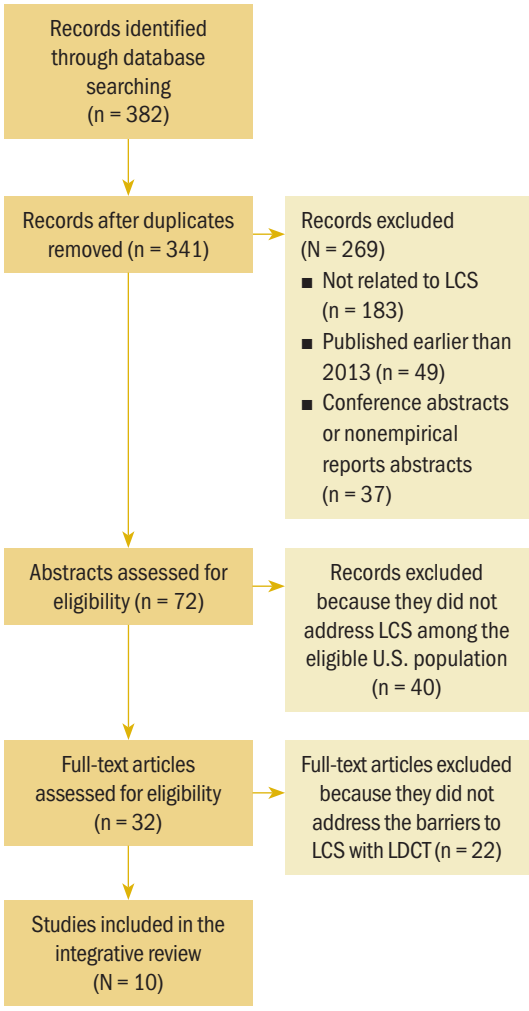
Data Sources and Studies Selection

Electronic literature databases, including PubMed, CINAHL®, PsycINFO, and Google Scholar, were searched. Studies were selected if they met the inclusion criteria and survived the search and review strategy.

Search Strategy

The following keywords were used to identify potentially eligible studies: *lung cancer screening*, *LCS*, *low dose computed tomography*, *low dose CT*, *LDCT*, *barrier*, *perception*, *perspective*, *knowledge*, *belief*, *attitude*, *adherence*, and *compliance*. The publication year of the studies was filtered first (after 2013, when the lung cancer screening guideline was published), then the title of the articles and inclusion and exclusion criteria were evaluated. Initially, 382 records were retrieved from the databases (up until January 2018); after adjustment of repeated articles and inspection of titles, 72 article abstracts were screened. The inclusion criteria were as follows: were peer-reviewed primary studies, focused on barriers to lung cancer screening with LDCT, published in English after 2013, and conducted in the United States. Studies were excluded if they were meeting abstracts, literature reviews, or nonempirical reports (e.g., commentaries); not specific to lung cancer screening with LDCT

FIGURE 1. PRISMA Flow Diagram



LCS—lung cancer screening; LDCT—low-dose computed tomography; PRISMA—Preferred Reporting Items for Systematic Reviews and Meta-Analyses

(e.g., focused on barriers to all-site cancer screening); and not related to lung cancer screening barriers among eligible U.S. smokers (e.g., studies focused on the technical barriers to lung cancer screening with LDCT among radiologists). The search resulted in the identification of 10 relevant articles that met the inclusion criteria; these consisted of 4 quantitative and 6 qualitative studies. Figure 1 is a flowchart reporting the search results. The features, including purpose, design, sample, setting, methods, results, discussion, and limitations, were extracted from each study. Procedural rigor and methodology were considered for each study design by using Whittemore and Knafl's approach (Moher, Liberati, Tetzlaff, & Altman, 2009).

Review Strategy

The review process was conducted in two steps. The first author examined all abstracts according to the eligibility criteria, consulting the full-text articles if in doubt about inclusion. The reference lists of the included articles were checked for additional relevant publications meeting eligibility criteria. The second author checked the literature review process and all full-text articles of the selected abstracts. The results, conclusions, and methodologies of the sources were compared, classified, and synthesized by the two authors to draw conclusions.

Results

Study Characteristics

Among the four quantitative studies (Cataldo, 2016; Delmerico, Hyland, Celestino, Reid, & Cummings, 2014; Duong et al., 2017; Tanner, Egede, Shamblin, Gebregziabher, & Silvestri, 2013) that met the inclusion and exclusion criteria, all were survey studies with sample sizes ranging from 80–338. Most participants were Caucasian, with the percentage ranging from 50.8% (Tanner et al., 2013) to 87.5% (Duong et al., 2017). All studies used self-reported data. The response rate ranged from 18.7% (Cataldo, 2016) to 58% (Duong et al., 2017). A web-based survey (Cataldo, 2016), a telephone survey (Delmerico et al., 2014), an in-person survey (Tanner et al., 2013), and online–telephone-combined surveys (Duong et al., 2017) were used to collect data. The surveys for the four studies were developed based on previous nationwide surveys or literature, most of which focused on participants' attitude, knowledge, and belief toward lung cancer screening with LDCT. The most frequently used analysis methods were t test (Cataldo, 2016; Duong et al., 2017; Tanner et al., 2013) and logistic regression (Cataldo, 2016; Delmerico et al., 2014; Tanner et al., 2013). None of the four studies reported using a theoretical framework to guide study design. More details about the setting, sample, eligibility criteria, age, gender, and ethnicity can be found in Table 1.

Among the six qualitative studies (Carter-Harris, Brandzel, Wernli, Roth, & Buist, 2017; Carter-Harris, Ceppa, Hanna, & Rawl, 2017; Gressard et al., 2017; Mishra et al., 2016; Simmons, Gray, Schabath, Wilson, & Quinn, 2017; Sin, Ha, & Taylor, 2016), two studies were individual interview studies (Carter-Harris, Brandzel, et al., 2017; Mishra et al., 2016), three were focus group studies (Carter-Harris, Ceppa, et al., 2017; Gressard et al., 2017; Simmons et al., 2017), and one study used individual and focus group interview methods (Sin et al., 2016). The interview time ranged from 25–120 minutes, and the sample size ranged from 18–105 participants. Five studies used a purposive sampling approach (Carter-Harris, Brandzel, et al., 2017; Carter-Harris, Ceppa, et al., 2017; Mishra et al., 2016; Gressard et al., 2017; Simmons et al., 2017), and one used a convenience snowballing sampling method (Sin et al., 2016). All the qualitative studies used a content analysis method.

A taxonomy method based on the social–ecological approach was used to organize the category of the barriers (see Table 2). The social–ecological approach emphasizes the importance of the individual and the environment, and the interaction between the two in examining health behavior (Stokols, 2000). The social–ecological approach provides a broad framework to understand the influence of biological, psychological, sociocultural, and environmental factors on health behavior (Stokols, 1996).

Individual-Level Barriers

Sociodemographic characteristics: Depending on individuals' age, gender, ethnicity, and smoking history, barriers to the adherence of lung cancer screening with LDCT varied. Duong et al. (2017) reported that older (aged older than 66 years), male, non-Caucasian smokers were less adherent, but at a nonsignificant level. Of note, among different ethnicities, Hispanic participants in the study were less adherent than their non-Hispanic counterparts ($p = 0.04$). On the contrary, Delmerico et al. (2014) reported that the younger age groups (aged younger than 55 years) were significantly less adherent to lung cancer screening with LDCT than the older age group (aged older than 55 years), and no differences were found among different racial and gender groups, which conflicted with

the finding of Duong et al. (2017). In terms of smoking history, compared with patients who smoked less than they used to or quit smoking, current smokers showed less adherence to lung cancer screening (p = 0.03) (Duong et al., 2017), which also conflicted with the finding of Delmerico et al. (2014) that reported

TABLE 1. Sample and Eligibility Criteria of Studies Included in the Integrative Review (N = 10)

Study	Sample	Eligibility Criteria
Qualitative studies		
Carter-Harris, Brandzel, et al., 2017	18 participants with a mean age of 68 years; 7 men and 11 women; 16 were Caucasian, and 2 were African American or multiracial.	Aged 55–77 years; current or former smoker who has quit within the past 15 years; 30 pack-year tobacco smoking history
Carter-Harris, Ceppa, et al., 2017	12 screened and 14 unscreened long-term smokers with a mean age of 66 years; 8 men and 18 women; 20 were Caucasian, 5 were African American, and 1 was Hispanic.	Aged 55–80 years; current or former smoker who has quit within the past 15 years; 30 pack-year tobacco smoking history
Gressard et al., 2017	105 current smokers with a mean age of 53 years; 54 men and 51 women; 60 were Caucasian, 41 were African American, and 4 were other.	Aged 40–70 years; current smoker with a history of smoking at least 1 pack of cigarettes per day for 20 years; no history of cancer or major lung conditions; English speaker; insured; has had a physical examination within the past 2 years
Mishra et al., 2016	22 patients with a mean age of 58.6 years; 13 men and 9 women; 14 were Hispanic, 7 were Caucasian, and 1 was African American.	Aged 50–80 years with a history of heavy smoking who met NLST enrollment criteria
Simmons et al., 2017	38 high-risk community members; 21 were aged 55–60 years, 10 were aged 61–70 years, and 7 were aged 71 years or older; 19 men and 19 women; 23 were Caucasian, 11 were African American, and 4 were other.	Aged 55–80 years; 30 pack-year smoking history; current or former smoker who has quit within the past 15 years. Individuals who had a previous LDCT screening for lung cancer or who were undergoing cancer treatment were excluded.
Sin et al., 2016	24 Korean immigrant men with a mean age of 69 years	Men aged 55–79 years; 30 or more pack-year smoking history; current smokers or former smokers who have stopped smoking within the previous 15 years. Men with a history of LDCT were included. Men with a history of lung cancer were excluded.
Quantitative studies		
Cataldo, 2016	338 smokers with a mean age of 61.5 years; 151 men and 187 women; 295 were Caucasian, and 43 were non-Caucasian.	Current and former smokers aged older than 55 years
Delmerico et al., 2014	334 adult current and former smokers; of those who had ever had a CT scan, 9 were aged 18–39 years, 10 were aged 40–54 years, and 26 were aged 55 years or older; of those who had ever had a CT scan, 30 were Caucasian, 8 were African American, and 6 were Hispanic.	Current and former smokers
Duong et al., 2017	80 patients with a mean age of 65 years; 45 men and 35 women; 6 were Hispanic, and 74 were non-Hispanic.	NLST and National Comprehensive Cancer Network LDCT eligibility criteria
Tanner et al., 2013	209 veterans with a mean age of 56.2 years; 182 men and 27 women; 106 were Caucasian, and 103 were non-Caucasian.	Outpatients aged 18 years or older

LDCT—low-dose computed tomography; NLST—National Lung Screening Trial

no difference among different smoking status groups. Other demographic variables, such as education level, cancer history, type of insurance, residential area, occupation, and immigration status, were not significantly related to the participants' adherence to lung cancer screening with LDCT (Duong et al., 2017).

Financial cost: Financial cost, including insurance coverage and self-pay cost, may hinder eligible individuals' lung cancer screening behavior. Before the private and public insurance coverage policies of lung cancer screening were issued, cost of lung cancer screening with LDCT was a significant barrier among the eligible U.S. population (Jonnalagadda et al., 2012). In a telephone survey study with 1,290 adult former and current smokers (Delmerico et al., 2014), 25% of former smokers and 33% of current smokers reported lack of health insurance coverage as a reason that prevented them from receiving lung cancer screening with LDCT. Since February 2015, lung cancer screening with LDCT has been covered by private and public insurances; however, economic barriers among the eligible U.S. population still appear to exist. Of the four studies that investigated service cost for lung cancer screening with LDCT (Gressard et al., 2017; Mishra et al., 2016; Simmons et al., 2017; Sin et al., 2016), all identified financial costs as one of the perceived barriers. Possible reasons for the widely identified economic barriers to screening for lung cancer after the insurance coverage landscape changed were reported as patients not knowing whether the lung cancer screening would be covered by their health insurance and concerns about future costs associated with an abnormal screen (Simmons et al., 2017; Sin et al., 2016).

Lack of knowledge: A lack of knowledge or misconception of lung cancer screening with LDCT may hinder screening adherence. Of the six studies that explored knowledge of lung cancer screening with LDCT, all (Carter-Harris, Brandzel, et al., 2017; Carter-Harris, Ceppa, et al., 2017; Gressard et al., 2017; Mishra et al., 2016; Simmons et al., 2017; Sin et al., 2016) identified limited knowledge as a barrier for eligible U.S. individuals to screen for lung cancer with LDCT. Most participants had never heard about lung cancer screening with LDCT before they took part in the studies (Carter-Harris, Ceppa, et al., 2017; Gressard et al., 2017; Mishra et al., 2016; Simmons et al., 2017); inaccurate information or confusion related to the causes and risk factors of lung cancer existed; knowledge related to lung cancer screening and its procedures was low; and awareness about the relationship between long-term smoking and lung cancer risk remained suboptimal (Carter-Harris, Brandzel, et al., 2017). Although lack of knowledge about lung cancer screening with LDCT was commonly revealed in the studies, most participants expressed strong interest in obtaining knowledge about screening (Mishra et al., 2016) and agreed to go for screening later (Cataldo, 2016; Gressard et al., 2017; Mishra et al., 2016; Tanner et al., 2013). In an online survey (Cataldo, 2016), 77.3% of participants said they would like to learn more and agreed to screen for lung cancer with LDCT today, and in a self-administered paper-and-pencil survey study (Tanner et al., 2013), 92.8% expressed their willingness to learn and agreed to receive a lung cancer LDCT scan.

Inaccurate beliefs: Individuals' beliefs, particularly those that are not accurate, about lung cancer screening and lung cancer also may act as a barrier to lung cancer screening adherence. Of the six studies (Carter-Harris, Brandzel, et al., 2017; Carter-Harris, Ceppa, et al., 2017; Cataldo, 2016; Duong et al., 2017; Gressard et al., 2017; Tanner et al., 2013) that investigated beliefs about lung cancer screening with LDCT among the eligible U.S. population, all reported inaccurate beliefs related to lung cancer screening with LDCT. Cultural beliefs, including fatalistic beliefs and the belief that lungs are not a treatable organ (Gressard et al., 2017), and personal beliefs, including perceived low value of lung cancer screening with LDCT (Carter-Harris, Ceppa, et al., 2017), appeared to be common factors that undermined the potential value of lung cancer screening. In a model that tested older smokers' willingness to screen lung cancer with LDCT (Cataldo, 2016), strong predictors of LDCT agreement were perceived accuracy of LDCT (odds ratio [OR], 3; 95% confidence interval [CI] [1.13, 7.95]), beliefs that they were at a high risk for lung cancer (OR, 2.1; 95% CI [1.17, 3.79]), beliefs that early detection of lung cancer would lead to a good prognosis (OR, 2.7; 95% CI [1.47, 4.9]), and not being afraid of CT scans (OR, 0.41; 95% CI [0.23, 0.75]).

Distrust of the medical system: Lack of trust in doctors and hospitals seems to be an issue. Two focus group studies (Carter-Harris, Brandzel, et al., 2017; Gressard et al., 2017) that aimed to explore smokers' perceptions of lung cancer screening with LDCT reported distrust of the medical system as a barrier to lung cancer screening, particularly among minority populations (Gressard et al., 2017). Participants cited that doctors and insurance companies were in cahoots (Gressard et al., 2017); doctors did not have time for them and just pushed them in and out (Gressard et al., 2017); and the new

TABLE 2. Barriers and Results of Studies Included in the Integrative Review (N = 10)

Barrier	Study	Results
Individual level		
Distrust of the medical system	Carter-Harris, Brandzel, et al., 2017	■ Participants reported that the new machine to screen lung cancer was a scam.
Distrust of the medical system	Gressard et al., 2017	■ Reported distrust of the medical system as a cultural barrier to LCS, particularly among minority populations ■ Participants cited that doctors and insurance companies were in cahoots. ■ Participants reported that doctors did not have time for them and just pushed them in and out.
Financial cost	Delmerico et al., 2014	■ 25% of former smokers and 33% of current smokers cited lack of insurance coverage as the reason that prevented them from LCS with LDCT.
Financial cost	Gressard et al., 2017; Mishra et al., 2016; Simmons et al., 2017; Sin et al., 2016	■ Participants identified financial costs as a perceived barrier.
Inconvenience of receiving LCS	Carter-Harris, Brandzel, et al., 2017	■ 1 of the 5 primary barriers to LCS that emerged from participants' perceptions was practical barriers, which referred to the time and logistical issues associated with an inconvenience.
Inconvenience of receiving LCS	Carter-Harris, Ceppa, et al., 2017	■ Some eligible individuals opted out of LCS as a result of time constraints and schedule conflicts.
Inconvenience of receiving LCS	Mishra et al., 2016	■ Transportation issues and distance were great challenges to LDCT.
Incorrect LCS beliefs	Carter-Harris, Ceppa, et al., 2017	■ Personal beliefs, such as perceived low value related to LCS with LDCT
Incorrect LCS beliefs	Cataldo, 2016	■ Reported incorrect beliefs related to LCS with LDCT
Incorrect LCS beliefs	Gressard et al., 2017	■ Cultural beliefs (e.g., fatalistic beliefs, the belief that lungs are not a treatable organ) appeared to be common contributors to poor survival rates and undermined the potential value of LCS.
Lack of LCS knowledge	Carter-Harris, Brandzel, et al., 2017; Carter-Harris, Ceppa, et al., 2017; Mishra et al., 2016; Gressard et al., 2017; Simmons et al., 2017; Sin et al., 2016	■ Inaccurate information or confusion related to the causes and risk factors of lung cancer ■ Knowledge related to LCS and its procedures was low. ■ Awareness about the relationship between long-term smoking and lung cancer risk remained suboptimal. ■ Most participants had never heard about LCS with LDCT before they took part in the studies.
Negative attitudes about LCS outcomes	Carter-Harris, Brandzel, et al., 2017	■ Among 18 participants who opted out of LCS, 1 of the 5 primary barriers cited among them was a false-positive worry. ■ Participants reported that the invasive procedures, stress, and anxiety following false-positive results caused them to distrust the screening's value.
Negative attitudes about LCS outcomes	Cataldo, 2016; Gressard et al., 2017	■ Personal confusion about the accuracy of LDCT
Negative attitudes about LCS outcomes	Delmerico et al., 2014	■ 33% of current smokers were afraid to find out cancer diagnoses through LDCT.

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TABLE 2. Barriers and Results of Studies Included in the Integrative Review (N = 10) *(Continued)*

Barrier	Study	Results
Individual level *(continued)*		
Negative attitudes about LCS outcomes	Gressard et al., 2017	■ 105 current smokers in a focus group interview study expressed confusion about false-positive and false-negative results. ■ Participants did not believe the screening test could tell them whether they had cancer; instead, they thought that once they went over the CT scan, doctors would force them to do another ultrasound because the doctors were not able to tell them the diagnosis results.
Negative attitudes about LCS outcomes	Mishra et al., 2016	■ 22 participants in an individual interview study expressed concerns of radiation exposure regarding screening.
Negative attitudes about LCS outcomes	Simmons et al., 2017	■ Fear of bad results acted as a perceived barrier among smokers.
Sociodemographic characteristics	Delmerico et al., 2014	■ Younger age groups (younger than 55 years) were significantly less adherent to LCS with LDCT than the older age group.
Sociodemographic characteristics	Duong et al., 2017	■ Older, male, non-Caucasian smokers were less adherent, but at a nonsignificant level. ■ Hispanic patients were revealed to be less adherent at a significant level ($p = 0.04$). ■ Current smokers showed less adherence to LCS ($p = 0.03$). ■ Participants' adherence to LCS with LDCT has no relationship with education level, cancer history, type of insurance, residential area, occupation, or immigration status.
Stigma around smoking and lung cancer	Carter-Harris, Ceppa, et al., 2017	■ Perceived blame and stigma around lung cancer and smoking may act as an important social deterrent among the eligible population for LCS. ■ 1 of the 3 perceived barriers identified by both groups was perceived smoking-related stigma. ■ The perceived stigma that came from younger healthcare providers and feeling like a social outcast inhibited their motivations to screen lung cancer with LDCT
Health-system level		
Lack of LCS information from PCP	Duong et al., 2017	■ Lack of physician referrals was a barrier reported by participants.
Lack of LCS information from PCP	Simmons et al., 2017	■ More than 50% of high-risk smokers had never gotten a recommendation about LCS from their healthcare providers. ■ More than 50% of PCPs had limited knowledge with LCS and had never recommended LDCT before.

LCS—lung cancer screening; LDCT—low-dose computed tomography; PCP—primary care provider

screening device for lung cancer was a scam (Carter-Harris, Brandzel, et al., 2017).

Stigma around smoking and lung cancer: Perceived blame and stigma around lung cancer and smoking may act as an important social deterrent among the eligible population for lung cancer screening (Carter-Harris, Ceppa, et al., 2017). In a focus group study with 12 screened and 14 unscreened long-term smokers, one of the three perceived barriers identified by both groups was perceived smoking-related stigma, which was defined as the stigma of being blamed for having smoked, feeling like a social outcast, and "feeling like an idiot or stupid for smoking" (Carter-Harris, Ceppa, et al., 2017). In addition, many participants reported that they felt stigma from younger healthcare providers who did not understand the culture in which they grew up (Carter-Harris, Ceppa, et al., 2017).

Negative attitudes about outcomes: As a detection instrument, LDCT is more reliable and valid than chest x-ray. However, researchers found several negative attitudes about outcomes of having a lung cancer screening, including worry about radiation exposure (Mishra et

al., 2016), having false-positive results (Carter-Harris, Brandzel, et al., 2017; Gressard et al., 2017), having incidental findings (Delmerico et al., 2014; Simmons et al., 2017), unfavorable cost–benefit ratio, overdiagnosis, and procedure- and diagnosis-related anxiety or distress (NLST Research Team, 2011), all of which may hinder the eligible U.S. population's screening behaviors. Delmerico et al. (2014) reported that 33% of current smokers were afraid of receiving a cancer diagnosis after LDCT, and Simmons et al. (2017) found that fear of having bad results acted as a perceived barrier among smokers. In a telephone survey study (Carter-Harris, Brandzel, et al., 2017), among 18 participants who had opted out of lung cancer screening, one of the five primary barriers cited among them was worry about receiving a false-positive result, followed by the invasive procedures, stress, and anxiety following false-positive results. Similarly, 105 current smokers in a focus group interview study (Gressard et al., 2017) also expressed the same confusion about false-positive and false-negative results. Participants did not believe the lung cancer screening test could tell them whether they had cancer; instead, they thought that once they went over the CT scan, doctors would force them to do another ultrasound examination because the doctors were not able to tell them the results (Gressard et al., 2017). In addition, 22 participants in an individual interview study (Mishra et al., 2016) expressed concerns about radiation exposure during screening as a factor in their decision.

Inconvenience: For the perceived inconvenience of accessing lung cancer screening services, three qualitative studies found that lack of transportation, time constraints, and appointment conflicts can be a hindrance to eligible individuals' screening adherence. Carter-Harris, Brandzel, et al. (2017) reported that some eligible individuals opted out of lung cancer screening as a result of time constraints and schedule conflicts, and Mishra et al. (2016) stated that transportation issues and distance to the facility to receive lung cancer screening were great challenges to LDCT. In a qualitative telephone interview study (Carter-Harris, Brandzel, et al., 2017), practical barriers, such as the time and logistical issues associated with the inconvenience, emerged as a main theme.

Health System–Level Barriers

Lack of information from primary care providers: Lack of information provided by primary care providers (PCPs), including lack of a PCP recommendation and inadequate patient education about LDCT, was significantly related to nonadherence among the eligible population. Simmons et al. (2017) found that more than 50% of high-risk smokers had never received a recommendation about lung cancer screening from their healthcare providers, and Duong et al. (2017) reported rates of physician referrals from 2011–2016 that ranged from 16% in 2011 to 63% in 2015. The referral rates increased over time, but the suboptimal referral rates could be still a barrier for eligible participants to receive lung cancer screening.

Certain factors, including physicians' limited knowledge, time constraints, and distrust of the guideline, have been associated with inadequate recommendations and patient education (Duong et al., 2017; Simmons et al., 2017). Simmons et al. (2017) reported that more than 50% of PCPs had limited knowledge about lung cancer screening and had never recommended LDCT to their eligible patients prior to the study. Similarly, among 36 PCPs in a study conducted by Duong et al. (2017), only 31% were able to correctly answer questions about the lung cancer screening eligibility criteria for age and smoking status. Another contributor to lack of information from physicians was time constraints during patient visits (Duong et al., 2017). Eighteen PCPs (72%) reported they "sometimes" did not have enough time to discuss the screening test during a patient visit, and five PCPs (20%) reported they "usually" have no time to talk about lung cancer screening during their patient visits. In addition, the perception of the moderate effectiveness of the screening among physicians (Duong et al., 2017) limited the information they gave their patients. In the study conducted by Duong et al. (2017), only 64% of PCPs believed current lung cancer screening guidelines were at least moderately effective, which influenced their practices and recommendation of lung cancer screening.

Improving PCPs' recommendation for lung cancer screening appears to be essential to increasing the uptake rates of lung cancer screening. A study conducted by Delmerico et al. (2014) showed that 81.4% of former smokers and 78.5% of current smokers would agree to have an LDCT scan when it was recommended by their doctors, suggesting that improving PCP recommendations may be particularly influential on lung cancer screening adherence.

Discussion

To comprehensively summarize the barriers to lung cancer screening among the eligible U.S. population, individual-level and health system–level barriers were identified in the literature. At the individual level,

financial coverage issues, lack of knowledge about lung cancer screening, concerns about the accuracy and procedure of LDCT, and practical barriers appeared to hinder eligible individuals' health behaviors of lung cancer screening.

Regarding the financial coverage issue, Eberth et al. (2014) reported that, among medical centers that offered lung cancer screening with LDCT, 44% reported that their lung cancer screening services were self-pay only, and about half of the centers charged $200–$500 for screening. As a solution for the consideration of financial cost, as well as time and distance barriers, the number and accessibility of screening facilities should be increased. Also, as the implementation of lung cancer with LDCT is widely expanding, more effort on educating eligible U.S. individuals about the insurance coverage and lung cancer screening guideline is needed (Simmons et al., 2017). In addition, education tools, such as pamphlets and DVDs, should be tailored to meet patients' literacy levels and their preferences of knowledge-seeking behaviors (Mishra et al., 2016).

Inaccurate beliefs about lung cancer screening and negative attitudes about outcomes of having lung cancer screening appear to greatly hinder eligible U.S. smokers' lung cancer screening behaviors. To decrease the uncertainty regarding the benefits of having lung cancer screening (Iaccarino et al., 2015; Raz et al., 2018) and to increase the acceptance of trial evidence and guidelines (Iaccarino et al., 2015), improvement in educating the public about lung cancer screening guidelines has become a crucial factor for screening programs (Eberth et al., 2014). As a preventive health service, lung cancer screening with LDCT is relatively new among the U.S. population. To reduce the eligible U.S. population's negative attitudes toward outcomes of having lung cancer screening, improvements to the standards of screening guidelines, such as selecting eligible population, radiation dose, diagnosis technology, and screening procedures, are still needed (Carter-Harris, Ceppa, et al., 2017; Mishra et al., 2016). Initiating shared decision making with participants could help address their misconceptions about lung cancer screening and decrease the possibility of negative outcomes. Information, such as the possible benefits, limitations, and harm from receiving lung cancer screening (e.g., radiation exposure, false-positive findings leading to unnecessary invasive investigations, overdiagnosis), should be shared and discussed thoroughly to facilitate participants' decision making.

In addition, stigma related to smoking or lung cancer may prevent eligible individuals from receiving lung cancer screening. The stigma and perceived feelings of self-blame and shame have been reported to affect patients' behavior in seeking medical help (Else-Quest, LoConte, Schiller, & Hyde, 2009). Among patients who had lung cancer, those who perceived higher stigma were more likely to have more depressive symptoms, poorer quality of life, and lower levels of engagement in medical care (Else-Quest et al., 2009). Of 159 screening-eligible smokers, those who were less likely to engage in medical care were less likely to participate in cancer screening (Carter-Harris, Ceppa, et al., 2017). To decrease the perceived level of stigma among screening-eligible patients, PCPs should hold a nonjudgmental attitude when interacting with patients and offer their opinions of lung cancer screening based on each patient's self-condition.

Distrust of the healthcare system also prevented eligible individuals from lung cancer screening, which is similar to other studies that identified distrust as a barrier to obtaining other kinds of cancer screening (Buki, Borrayo, Feigal, & Carrillo, 2004; Fowler, 2006; Moy, Park, Feibelmann, Chiang, & Weissman, 2006; Peek, Sayad, & Markwardt, 2008). Rebuilding trust between patients and providers appears to be a key element to expanding the application of lung cancer screening with LDCT. Approaches to rebuilding trust could be including screening-eligible patients' typical lung cancer screening experiences in the development of advertising materials (Carter-Harris, Ceppa, et al., 2017), as well as highlighting previously screened patients' comments related to lung cancer screening; this could help patients who are undergoing lung cancer screening to have a general and comprehensive view on the lung cancer screening.

At the health-system level, offering sufficient information about lung cancer screening and initiating necessary discussion of lung cancer screening by PCPs also emerged as important factors that influenced the uptake rates of LCS. During patient visits, shared decision making should be initiated among eligible U.S. smokers. The reason for the screening, benefits and potential risks of screening, procedures of LDCT screening, and possible treatment if the result is positive should be addressed during the shared decision making.

Limitations

Although the reviewed literature has brought awareness to the multiple barriers in the way of implementing

lung cancer screening with LDCT, limitations still exist among the studies. For the quantitative studies, the limitation of low response rate may weaken the results of the studies. Based on the four studies, the web-based surveys had the lowest response rates (18.7% [Cataldo, 2016] and 42% [Delmerico et al., 2014]), and the telephone survey had a higher response rate of 58% (Duong et al., 2017). Although Tanner et al.'s (2013) in-person survey study response rate was 75%, they did not report the exact response rate of the study because of their lack of data related to the total number of participants approached. In addition, the limitations of using unrepresentative data were observed quite obviously in the studies. The small sample sizes for each comparison group (e.g., analysis variable was age, sample size was 32 for nonadherent patients, sample size was 48 for adherent patients) (Duong et al., 2017), which were less than the power analysis–required sample sizes (Duong et al., 2017), may lead to inaccurate results between comparison groups. When using chi-square analysis, small sample size lacking representativeness of the population (minorities, sample size ranged from 6–43) (Duong et al., 2017) was also observed, which may have violated the rule of thumb for chi-square test (minimum expected value is larger than 5). In addition, lack of a theoretical framework for the study design is a notable issue among the four quantitative studies. For the qualitative studies, sampling bias (e.g., 60% of the sample was highly educated) (Gressard et al., 2017), underrepresented data (e.g., sample size for minority population ranged from 0–2; sample size for uninsured participants ranged from 1–2) (Carter-Harris, Ceppa, et al., 2017), and recall bias may also cause errors in the results of data analysis. Studies based on verified screening rates could provide a more accurate understanding of the phenomenon.

Directions for Future Research

Given the relatively newly updated lung cancer screening guidelines, recently issued insurance coverage policies, and limited literature on perceived barriers to lung cancer screening with LDCT, several gaps in the literature need to be explored in future studies. Barriers to screening for lung cancer among minority populations, such as social–cultural barriers (e.g., social support, cultural norms) and language barriers, have not been studied adequately. Social support could be important in improving lung cancer screening and other preventive behaviors. Social support was positively associated with cancer screening behaviors among minority populations (Pasick et al., 2009). Language barriers, experienced by most immigrant populations engaging health services in the United States, play a significant role in the processes and outcomes of accessing the preventive services. Exploring the specific barriers to lung cancer screening and designing tailored programs for minority populations will help increase the uptake rates of lung cancer screening among minority populations.

Intervention studies that aim to improve perceived benefits, risks, barriers, and availability of lung cancer screening are needed. Because key barriers, such as health insurance coverage, lack of knowledge about LDCT, and cost concerns, are particularly influential in the acquisition of lung cancer screening (Delmerico et al., 2014), designing tailored intervention projects to improve outcomes of lung cancer screening with LDCT among eligible populations could be quite essential. In addition, studies focused on distinguishing between initial and ongoing lung cancer screening behavior may be warranted. Although there may be some overlap in barriers for ever-screened and never-screened eligible U.S. populations (e.g., the practical barriers related to time and transportation), some barriers could be more specific for patients who have never been screened. For example, the never-screened eligible populations may have difficulty getting access to the lung cancer screening facilities compared with the ever-screened populations. Among the ever-screened population, different barriers may exist between regular and overdue-for-screening groups. For example, the overdue-for-screening population may have more concerns about negative outcomes of lung cancer screening relative to the population who have received regular lung cancer screening.

KNOWLEDGE TRANSLATION

- Individual-level and health system–level barriers to lung cancer screening exist among the eligible U.S. population.
- Barriers could prompt development of intervention programs for healthcare providers to help the at-risk population.
- Exploring specific barriers to lung cancer screening among diverse cultural and ethnic groups is a direction for future research.

Implications for Nursing

The implications for future nursing practice lie at the patient education and patient consultant levels. At the patient-education level, multiple education programs to strengthen patients' awareness of lung cancer screening (Cataldo, 2016) should be developed, with

topics such as health insurance coverage and screening risks and benefits (Simmons et al., 2017; Sin et al., 2016). Additional efforts should be taken to clarify high-risk populations' inaccurate beliefs about lung cancer screening and negative attitudes toward outcomes of lung cancer screening. During the process of patient health education, healthcare providers should address patients' distrust of the medical system, as well as stigma around smoking and lung cancer (Carter-Harris, Ceppa, et al., 2017; Sin et al., 2016). Education strategies, such as the teach-back method, could be applied to facilitate patients' understanding of lung cancer screening.

At the patient consultant level, smoking cessation and shared screening decision counseling should be offered with lung cancer screening recommendations among high-risk populations (Cataldo, 2016; Mishra et al., 2016). Lung cancer screening decisions should be made based on high-risk individuals' health status, smoking history, and life expectancy. Tailored decision aid tools should be developed and applied to provide patient support to decrease any conflicts or passivity while making decisions about receiving lung cancer screening (Carter-Harris, Ceppa, et al., 2017; Mishra et al., 2016).

Conclusion

In the new landscape of lung cancer screening guideline publication and insurance coverage, understanding the barriers to lung cancer screening can help facilitate patient–provider communication, thereby improving lung cancer screening uptake rates. In addition, lung cancer screening could identify lung cancer among eligible patients at an earlier stage, resulting in increased survival rates (Carter-Harris, Ceppa, et al., 2017) and decreased lung cancer–related suffering and mortality rates (Duong et al., 2017). By exploring barriers to lung cancer screening among the eligible U.S. population, problems that hinder lung cancer screening behaviors can be addressed to enhance the shared decision-making process (Carter-Harris, Ceppa, et al., 2017), to design culturally and linguistically appropriate community-based lung cancer screening intervention programs, and to improve intervention programs for guiding the healthcare providers who serve the eligible at-risk populations (Carter-Harris, Ceppa, et al., 2017).

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