



## Discussion

## Rural areas are disproportionately impacted by smoking and lung cancer

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## ABSTRACT

Rural populations have higher rates of late stage lung cancer incidence and mortality compared to urban populations, making them important target populations for low dose computed tomography (LDCT) screening. LDCT screening has been shown to reduce lung cancer mortality and is recommended by the United States Preventive Services Task Force for individuals who meet certain risk criteria. However, rural populations may experience greater system, provider, and individual-level barriers to screening and related health-seeking behavior (e.g. smoking cessation). LDCT screening was first tested in urban, academic centers, so it is still unknown how readily it may be implemented in rural areas. Additionally, rural populations have limited access to both primary care physicians who may refer to LDCT screening and specialty physicians who may perform the screening. Further, rural populations may be less likely to seek screening due to lack of awareness and understanding or other unknown knowledge or psychosocial barriers. There are several strategies that may address these rural specific challenges. First, further research is needed to better understand the individual-level barriers that rural patients experience. Second, to reduce system-level barriers, additional efforts should be made to increase rural access to screening through improved referral processes. Third, creation of decision support materials to equip rural providers to engage their patients in a shared decision making process regarding screening may help reduce physician level barriers. Fourth, development of a holistic approach to smoking cessation may help reduce lung cancer risk in conjunction with LDCT screening.

## 1. Introduction

Lung cancer (LC) is the leading cause of cancer-related death for both men and women in the United States, with an annual mortality exceeding that for breast, prostate, colon, and pancreatic cancers combined (Howlader et al., 2014). The overall 5-year survival for LC is approximately 17% and has not changed significantly in 25 years despite advances in diagnosis, imaging, staging, and treatment (Howlader et al., 2014). The American Cancer Society estimates there will be ~222,500 new LC cases and ~155,870 deaths (~13% of all cancer cases and ~26% of deaths) in 2017 (American Cancer Society, 2017a). Further, these figures are not equitably distributed, with known disparities by race, socioeconomic status, geography, and gender (Ward et al., 2004; National Institutes of Health, 2008; Tabatabai et al., 2016).

Of particular concern is the rural-urban disparities in lung cancer incidence and mortality (2000–2006 data) (Atkins et al., 2017). However, recent advances may have significant impact, as the pivotal outcomes of the National Lung Cancer Screening Trial (NLST) demonstrated the benefit of screening using low dose computed tomography (LDCT) (Bach et al., 2012; National Lung Screening Trial Research Team et al., 2011).

However, the demographic engaged in the NLST was not reflective of the barriers seen in LC screening in rural communities (Bach et al., 2012; National Lung Screening Trial Research Team et al., 2011). A review of national, population-based cancer registries (2009–2013 data) indicates that lung and bronchus cancer incidence, distant stage incidence, and mortality rates are all elevated in rural areas (Table 1; not published elsewhere). Individuals who reside in rural areas

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**Table 1**  
Rural-urban rate ratios lung cancer incidence and mortality; 2009–2013.

	All rate ratio (95% CI)	Male rate ratio (95% CI)	Female rate ratio (95% CI)
Incidence rate ratio <sup>a</sup>	1.14 (1.14–1.15)	1.20 (1.19–1.20)	1.08 (1.07–1.09)
Distant stage incidence rate ratio <sup>a</sup>	1.15 (1.15–1.16)	1.18 (1.17–1.20)	1.10 (1.09–1.11)
Mortality rate ratio <sup>b</sup>	1.20 (1.19–1.21)	1.24 (1.24–1.25)	1.13 (1.12–1.14)

Urban is the reference group.

<sup>a</sup> Data from the NAACCR public use dataset (Lichter, 2012).

<sup>b</sup> Data from the NCHS mortality data embedded in SEER\*Stat (Caldwell et al., 2016).

traditionally have worst health outcomes, lower educational levels, and travel longer distances to receive care in comparison to individuals who reside in urban areas (Stamm et al., 2007; McCord et al., 2012; Murimi and Harpel, 2010). These influential patient-level factors mold physicians' healthcare practices, including the provision of preventive care services (Brems et al., 2006). Ultimately, the approximately 19.3% of the US population residing in rural areas face a host of challenges and barriers to lung cancer prevention, detection, and care (United States Census Bureau, 2017). While much of the observed LC disparities may be attributed to higher smoking rates, the data indicate a need to aggressively pursue multiple means to examine and subsequently reduce lung cancer in disproportionately impacted rural areas.

## 2. Low dose computed tomography (LDCT)

LDCT scans have been shown to benefit individuals at increased LC risk by both literature review and the results of the National Lung Cancer Screening Trial (NLST) (Bach et al., 2012; National Lung Screening Trial Research Team et al., 2011). The NLST compared chest X-ray and low dose computed tomography (LDCT) to detect lung cancer in high risk individuals (individuals aged 55–74 years with a 30 pack-year smoking history; including current or former smokers who had quit in the past 15 years). The relative reduction in LC mortality was 20.0% and absolute reduction in mortality was 0.33% for LDCT compared to chest X-ray; avoiding 87 deaths over 26,722 screened participants. Further, LDCT scans detected more early stage LC (Kramer et al., 2011). These findings have led to multiple medical organizations (e.g. United States Preventative Services Task Force [USPSTF]; American Lung Association; American Cancer Society) to endorse LDCT lung cancer screening for high risk patients (U.S. Preventive Services Task Force, 2015; American Lung Association, 2015; American Cancer Society, 2017b).

### 2.1. System barriers

Multiple system level barriers to implementing LDCT screening have emerged. The NLST study did not assess LDCT screening in rural centers, and barriers and facilitators to delivering LDCT screening there may vary from urban centers. According to qualitative findings on providers' perspective of LDCT screening in New Mexico (consisting of providers from four rural settings), providers expressed concern about access to LDCT equipment and potential financial burdens among rural populations (Hoffman et al., 2015). While USPSTF recommendations guide insurance coverage guidelines for preventive screening through Medicare and private insurance, coverage issues remain an implementation barrier (Eberth et al., 2014). Further, a study of Lung Cancer Alliance Screening Centers of Excellence noted logistic barriers to implementation, including financial issues of cost associated with screening implementation and overall operations (Qiu et al., 2016).

Another key recommendation from the USPSTF on LDCT screening involves the use of shared decision making (SDM). SDM is a Centers for

Medicare and Medicaid Services requirement for coverage and reimbursement to ensure the provider engages with the patient about the risks and benefits of LDCT for lung cancer screening and that the provider documents the SDM discussion in the medical record (Centers for Medicare and Medicaid Services, 2015; Watson et al., 2016). While, SDM does ensure that the patient is engaged in the screening decision making process, it can also serve as another barrier related to provider knowledge and can be impacted by patients' health literacy (Cardarelli et al., 2017). Still, one-on-one conversations with their physicians regarding screening details and the provision of decision support materials and desired by patients (Mishra et al., 2016; Kanodra et al., 2016).

### 2.2. Provider barriers

Rural health providers may face particular challenges in implementing screening. Rural areas often face the implementation barrier of reduced radiologist capacity relative to the number of those at risk, potentially limiting LDCT screening of eligible patients (Smieliauskas et al., 2014). Survey and focus group research on provider perspectives has indicated that primary care providers are inadequately aware of the recommended guidelines and order chest X-rays for screening purposes more often than LDCT (Hoffman et al., 2015; Lewis et al., 2015). Moreover, primary care providers are apprehensive about LDCT false positive rates, the potential complications of follow-up biopsies, and the feasibility of implementing LDCT screening in their health care settings. LDCT referrals are low among both primary care (only 41% made a referral in the past year) and pulmonologists (only 52.4% made guideline-concordant screening decisions) (Ersek et al., 2016; Iaccarino et al., 2015). Studies assessing other screening modalities have found that rural providers in general have lower rates of adhering to guidelines, which may be associated with characteristics of rural populations (Kulczycki et al., 2016; Luman et al., 2006; Beydoun and Beydoun, 2008). These barriers exist within the context of a general shortage of primary care providers, of which there are numerous documented disparities in rural areas (Laditka et al., 2009).

### 2.3. Individual barriers

Screening implementation in rural areas is not solely limited by provider-based limitations, but also involves a number of well-characterized socio-demographic and access barriers (Finney Rutten et al., 2004). Patient-level barriers to the receipt of LDCT screening include a lack awareness and understanding of LDCT screening, with patients often confusing chest X-rays and biopsy with LDCT screening (Cardarelli et al., 2017). Patients also perceive that screening adherence precludes them from the need to quit smoking, and those who have received LDCT screening may not appropriately understand their LC risk, especially in relation to their recent smoking history.

## 3. Other aspects of screening uptake and risk reduction

### 3.1. Smoking cessation counseling

A baseline clinical intervention may be the Five Major Steps to Intervention (The "5 A's"; ask, advise, assess, assist, and arrange) (Agency for Healthcare Research and Quality, 2014). Though this motivational intervention is brief and simple, some studies indicate that only a minority of primary care providers are familiar with them (generally), and/or fully utilize them for smoking cessation (specifically) (Addo et al., 2011; Balls et al., 2010; Tong et al., 2010). Further strategies include pharmacotherapeutic tools including nicotine replacement therapies and non-nicotine therapies (Anczak and Nogler, 2003). Additionally, tobacco cessation programs administered via telephone based programs (quitlines) have documented success in improving tobacco cessation in high risk populations. Yet, there is a

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