ORIGINAL RESEARCH

Primary Care Providers Experiences Implementing Low-Dose Computed Tomography Recommendations for Lung Cancer Screening

Sara E. Golden, PhD, Jessica J. Currier, PhD, NithyaPriya Ramalingam, PhD, Mary Patzel, MBA, Jackilen Shannon, PhD, Melinda M. Davis, PhD, MCR, and Christopher G. Slatore, MD, MS

Purpose: Describe primary care providers' (PCPs) barriers and facilitators to implementation of lung cancer screening programs in rural settings.

Methods: We conducted qualitative interviews with PCPs practicing in rural Oregon from November 2019 to September 2020. The interview questions and analytic framework were informed by the 2009 Consolidated Framework for Implementation Research. We used inductive and deductive approaches for analysis.

Results: We interviewed 15 key participants from 12 distinct health care systems. We identified several Consolidated Framework for Implementation Research factors affecting lung cancer screening implementation. 1) Most PCPs did not have workflows to assist in discussing screening and relied on their memory and knowledge of the patient's history to prompt discussions. PCPs supported screening and managed the patient throughout the process. 2) PCPs reported several patient-level barriers, including geographic access to lung cancer screening scans and out-of-pocket cost concerns. 3) PCPs reported that champions are necessary to create opportunities for local practices to adopt lung cancer screening programs.

Conclusions: Rural-practicing PCPs were supportive of lung cancer screening, however workflow processes, time challenges, and patient-reported barriers remain impediments to improved screening in their clinics. We identified several areas for improvement in lung cancer screening implementation in rural primary care practices, ranging from designing clinic workflows and processes to designating clinic staff to support referral, screening, and follow-up care for patients. (J Am Board Fam Med 2023;00:000–000.)

Keywords: Cancer Screening, Follow-Up Care, Lung Cancer, Oregon, Primary Health Care, Referral and Consultation, Workflow

Introduction

Lung cancer is the leading cause of cancer-related deaths in the United States—surpassing breast, prostate, and colon cancer-related deaths combined.[1,2] Lung cancer screening using annual low-dose computed tomography (low-dose CT) increases early detection of lung cancer and reduces lung cancer mortality.[3,4] Many organizations, including the United States Preventive Services Task Force, recommend lung cancer screening for high-risk individuals with some stipulations.[3,5,7] For instance,

patients should engage in a shared decision making interaction with a qualified clinician before making a decision on undergoing lung cancer screening.[3,7,8] Shared decision making should involve high-quality communication that takes into account individual characteristics and values, as well as the amount of control the patient desires when making the actual decision.[9–11]

Despite recommendations, lung cancer screening uptake has been slow overall, with multiple studies suggesting uneven adherence among rural patients to recommended follow-up guidelines.[12–16] Unfortunately, of all lung cancer screening eligible patients, only approximately 5 to 15% undergo screening.[12,17] Rural patients are more likely than urban patients to smoke, have lung cancer, late stage lung cancer, and die from lung cancer once diagnosed.[14,18,19] Yet, access to screening is more limited in rural areas compared with urban areas.[15,20] For example, in 2019, only 51% (17/29) of surveyed (29/37) rural hospital-based radiology facilities offered LCS using low-dose CT in Oregon.[21] Furthermore, challenges exist to implementing lung cancer as well as other screening programs (eg, diabetic eye and colon) in rural settings, such as overburdening of small rural health-care workforces, limited EHR functionality, and geographic isolation, making it important to identify system-level processes to support screening in rural settings.[22–26]

Primary care providers (PCPs) often identify eligible patients, engage in shared decision making interactions, refer patients, communicate results, ensure patients are adherent to follow-up recommendations, and coordinate with diagnostic and treatment specialists should lung cancer be suspected.[27] Understanding PCPs' experience with lung cancer screening is necessary to create solutions for implementing high-quality programs in rural areas because we are currently do not know of

rural-specific barriers to implementation from the PCP perspective. The purpose of this study was to describe primary care providers' barriers and facilitators to implementation of lung cancer screening programs in rural settings. We focused on actionable mechanisms to change screening uptake and adherence.

Methods

We conducted qualitative interviews with PCPs practicing in rural Oregon between November 2019 and September 2020. Study activities were conducted in partnership with the Oregon Rural Practice-based Research Network, a network that conducts research and quality improvement projects with clinics across the state.[28] Our study was approved by the VA Portland Health Care System/ Oregon Health & Science University IRB (#18865). Of note, the term 'lung cancer screening' or 'screening' herein refers to the process of screening while 'low-dose CT' refers to the scan. We make the distinction since perceptions about the process may differ from those about the scan.

Participants and Data

We sampled participants from clinics in rural Oregon who indicated interest in participating. We recruited by snowball sampling through advertising via the Research Network newsletter (641 recipients) for 3 months and contacts (eg, practice facilitator networks, existing clinic relationships, etc.) (recipients unknown). We emphasized variation in the clinic's affiliation and hospital designation (critical access hospitals or not). We define rural as geographic areas > 10 miles from a population center of more than 40,000, in alignment with Rural-Urban Commuting Area definitions.[29,30] We included PCPs in more urban geographic areas if they self-identified as serving rural-residing patients.

A pulmonologist and health services researcher with experience in qualitative methods, conducted all interviews by phone using a semistructured interview guide (Appendix). Another investigator accompanied to take notes. We obtained consent by phone from participants before each interview.

Corresponding author: Sara Golden, PhD, VA Portland Health Care System, 3710 SW US Veterans Hospital Rd RD66, Portland, OR 97239 (E-mail: sara.golden1@va.gov).

Table 1. Key Construct Definitions

Key Constructs	Definition
Domain: Inner Setting Construct: Implementation Climate	A climate within health care to improve and encourage lung cancer screening.
	Participants noted the importance and value of lung cancer screening implementation and utilization. To prompt lung cancer screening, it would be helpful to create structured workflow processes, like electronic health record (EHR) reminders, to identify eligible patients.
Domain: Inner Setting Construct: Networks & Communications	Formal or informal connections between individuals, units, services, and hierarchies.
	The use of decision aids to guide decision-making conversations with patients could improve engagement with LCS, particularly in populations with lower health literacy, but there are barriers to use.
Domain: Outer Setting Construct: Patient Needs, Resources, & Barriers	Barriers that are outside of the Health Care System control, usually to do with geographical distance, level of education of patients, economical or financial situation of patients.
	Many PCPs perceived the geographic location of the low-dose CT as the biggest barrier. Many patients also do not have access to personal transportation, and others have a distrust of big cities and hospitals.
Domain: Implementation Process Construct: Champions	A team member who takes the role of champion and spearheads a program within a clinic to motivate and encourage the patient population to engage.
	Participants practicing in clinics without a lung cancer screening champion described an environment where clinic leadership were not visibly supportive of lung cancer screening, opposed to clinics with a champion. Champions were seen as key facilitators of screening implementation and uptake. They were seen as essential to successful lung cancer screening programs.

Abbreviations: LCS, lung cancer screening; CT, computed tomography; PCP, primary care providers.

We asked about PCP perceptions of lung cancer screening, workflow processes, shared decision making, champions, and patient barriers. Herein we define workflow processes as "a series of tasks performed by various people within and between work environments to deliver care."[31] We based interview questions on the 2009 Consolidated Framework for Implementation Research, which identified factors associated with implementation; it is a theory-based guide for assessing barriers and facilitators of strategies to improve future implementation and maintenance.[32] The interview guide focused on the following Framework constructs, or factors, based on previous studies and that aligned with study goals: individuals involved (eg, knowledge, beliefs, and perceptions about screening), inner setting (eg, implementation climate, structural characteristics, workflow factors, shared decision making), outer setting (eg, patient needs, resources, and barriers), and implementation process (eg, champions) (Table 1).[32] The research team stopped interviews after information power on our focused topic was satisfactory.[33,34]

Interviews lasted an average of 44 minutes. Each interview was transcribed verbatim, deidentified, and verified for accuracy before analysis by team member. We performed member checking with all participants. All participants received $100 renumeration for their time and effort.
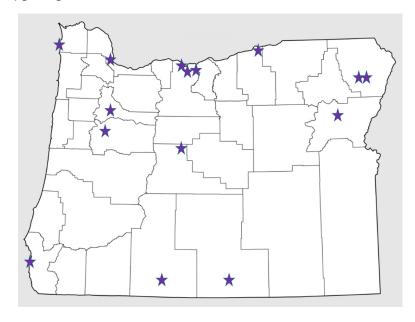
Analysis
We used Atlas.ti version 8 to organize qualitative data. We used conventional content analysis to identify and systematically code text and develop an organizational structure for coded data to help look for patterns within and across participants.[35,36] First, our multidisciplinary team created a codebook using inductive and deductive approaches, including components of the interview guide. Reviewers met frequently as a group to discuss and refine the codebook. The remaining transcripts were independently coded. We met frequently to discuss findings, refine codes, and recode as needed. We resolved differences through consensus and used an audit trail and memos to ensure consistency and rigor by tracking decisions related to coding and analysis.

Results
We interviewed 15 key participants who were associated with 12 distinct health care systems in

Figure 1. Map of key participant locations.

Oregon (Figure 1). Informant characteristics are included in Tables 2 and 3. We identified the following constructs as affecting lung cancer screening implementation: 1) Inner setting, 2) Outer setting), and 3) Implementation process. Each construct is similar to a theme, wherein they are factors mentioned across participants that characterize experiences. While we queried about individuals involved, it

Table 2. Self-Reported Participant and Institution Characteristics

TRAINING (Physician or APP*)	RUCA CATEGORY**	FEDERAL DESIGNATION***	OWNERSHIP	ACCESS TO LOW-DOSE CT
Physician	10	Patient Centered Primary Care Home	System	31 to 60 minutes
Physician	2	Rural Health Clinic (RHC)	System	31 to 60 minutes
APP	7	RHC	System	At institution
APP	4	Unknown	System	>1 hour
Physician	1	RHC	System	>1 hour
Physician	10	Federally Qualified Health Center	Independent	At institution
Physician	7	RHC	Independent	At institution
APP	7	Unknown	System	>1 hour
APP	10	RHC	System	<30 minutes
APP	7	RHC	Independent	31 to 60 minutes
Physician	10	RHC	System	At institution
APP	4	RHC	System	At institution
APP	7	RHC	System	At institution
Physician	4	RHC	System	At institution
Physician	Unknown	RHC	Unknown	Unknown

Abbreviations: APP, advanced practice practitioner; CT, computed tomography.
Notes. **RUCA Category, codes classify U.S. census tracts using measures of population density, urbanization, and daily commuting; urban codes: 1-3, large rural codes: 4-6.1, small rural codes: 7-9.2, and isolated codes: 10-10.6.[75]
***Definitions: Patient Centered Primary Care Home, A model of primary care organization that delivers primary health care.[76]
Rural Health Clinic, Clinics intended to increase access to primary care for rural communities in underserved areas.[77]
Federally Qualified Health Center, Centers intended to increase access to primary care in underserved areas or for underserved populations, regardless of rural/urban location.[78]

Table 3. Aggregate Self-Reported Informant and Institution Characteristics

Characteristics	N (%)
Gender	
Woman	10 (66%)
Man	5 (33%)
Racial Background	
White/Caucasian	14 (93%)
More than one race	0 (0%)
Preferred not to say	1 (7%)
Spanish, Hispanic or Latino	0 (0%)
Role of Informant	
Physician	8 (53%)
Non-Physician	7 (47%)
Clinic Ownership	
Independent	3 (20%)
System affiliated	11 (73%)
Unknown	1 (7%)
Clinic Federal Designation	
Rural Health Clinic	11 (73%)
Federally Qualified Health Center	1 (7%)
Unknown	3 (20%)

did not surface as a theme in our data. There were no differences based on training level (ie, physician vs advanced practice practitioner), presence of a program, or distance to the low-dose CT.

CFIR Domain: Inner Setting

Construct: Implementation Climate

The majority of participants noted the importance and value of lung cancer screening implementation and utilization. The benefits of early detection stemmed from PCPs' reported objective to prevent disease as well as their knowledge of, and experience with, patients with lung cancer. National recommendations and guidelines for clinical practice issued by the Preventive Services Task Force and the National Comprehensive Cancer Network were also identified as contributing factors that influenced perceptions of screening. One PCP stated,

> I'm of the attitude that there's a national body of experts who are far more versed on the literature and spend their career looking at this stuff and spending time looking at and sleuthing through the data and making recommendations. For me to ignore that takes a bit of hubris.

The lung cancer screening process involves multiple, interrelated clinic workflow processes ranging from identifying eligible patients for LCS, initiating shared decision making interactions with patients, referring patients for the low-dose CT, monitoring patients through the process, and following-up with patients post low-dose-CT. To prompt lung cancer screening, a minority of participants had helpful structured workflow processes, like electronic health record (EHR) reminders, to identify eligible patients. The majority of participants stated that they relied on their memory, clinical knowledge, and knowledge of the patient as a reminder to discuss screening rather than a specific clinical process. One participant stated:

> I guess I'm old school and I still rely on [memory of eligibility criteria]. I've not totally abandoned that for the EHR and the tickler. I suspect at some time, once it's more facile with the EHR and how they're building these reminders, maybe I'll find some utility in using them.

Several participants were concerned that patients would be nonadherent to follow-up recommendations due to the lack of systematic processes. Some described challenges when patients referred for lung cancer screening did not show up for their CT at an outside facility. They reported they relied on their own clinic staff to manually track and follow-up with patients who missed their low-dose CT appointment via time intensive reliance on overdue screening order reports. Several PCPs commented it helped to set personal reminders to follow-up with their patients after the low-dose CT as they felt responsible. They also noted ineffective communication between primary care and radiology could lead to nonadherent follow-up care since PCPs sometimes were not alerted when a patient (had not) received their CT. They reported a structured alert would be helpful.

Our participants offered insights to improve lung cancer screening in relation to rural primary care, noting several opportunities to improve and streamline through workflow processes and dedicated staff (Table 4).

Construct: Networks and Communications—

Shared Decision Making. The PCPs in our sample were aware of the Centers for Medicare and Medicaid Services[37] requirement for shared decision-making interactions to help patients decide about lung cancer screening. PCPs shared that they were responsible for initiating these conversations

with their patients and that it generally happened during annual wellness visits. Our participants supported some core tenets of shared decision making, but did not describe structured workflows to support the decision making process. Very few used a formal online or article-based decision aid describing the risks and benefits of screening to guide those conversations, such as the one provided by the Agency for Healthcare Research and Quality.[38] They cited low levels of health literacy among their patients, difficulty accessing a decision aid through the EHR, transition away from printed decision aids, and not finding a decision aid that they like as reasons for electing not to use one. Some participants volunteered that some decision aids were cumbersome and hard to use. One participant stated,

> I think the hard thing about using the decision aid is that patients in our community tend to have lower health literacy, and talking to patients from a screening perspective about things like number needed to treat or here's all the potential outcomes that could occur, it can be challenging because it oftentimes doesn't become real to them until they have something wrong with them.

Not enough time in the primary care visit was identified as another reason for not using a decision aid. One participant stated, "[The interaction is] 3 minutes and its part of a visit where we do 8 million other things." Another commented:

> In reality, I think the amount of time that it does take to have a good shared decision-making [interaction] with somebody around something like this, because it typically opens up a can of worms one way or another. If it's hard to do that without giving up something else that you're talking about... I think it should be done, but I think it would come at the price of giving up something else.

Smoking Cessation Communication. Similar to conducting shared decision-making for lung cancer screening, participants reported screening conversations were a good opportunity to discuss and document a patient's smoking behavior, as well as discuss lung cancer screening, but they did not always have structured workflow processes in place or clinical time to do so. However, there was a feeling among some participants that conversations about screening and smoking cessation were inherently different. The lung cancer screening conversation is a response to tobacco use health behaviors, while smoking cessation conversations focus on health promotion and disease prevention to improve health. One participant stated,

> My general conversations with patients around smoking cessation asks where are you with it?... Then the conversation...with lung cancer screening is a little bit different. Their smoking is why we are screening them for it, but I think it's more just like any other screening exam here. This is preventative, this is checking to see if we can find something before it becomes an issue.

CFIR Domain: Outer Setting

Construct: Patient Needs, Resources, and Barriers
When asked about external patient barriers to lung cancer screening, geographic location of the low-dose CT was perceived to be the biggest barrier as "driving far is a pretty tough sell (to rural patients)." PCPs mentioned many patients did not have access to personal transportation. In addition to traveling far distances, a few reported that there exists patients' "abstract distrust of cities and of big hospitals. I think if [patients] trust [clinicians] in the clinic, anything that we can get done there is better." Cost-effectiveness and radiation exposure were noted as perceived concerns within their patient population too. For example, 1 participant said,

> Of the different cancers that we can screen for, I think lung cancer screening probably does not get the attention that it deserves. I think it is either overlooked or maybe even dismissed because, within this [rural patient] community, there's skepticism as to whether or not it is truly beneficial, whether or not it is cost-effective, if the risk of radiation annually is worth it. I mean these are the things that I've heard from other people.

PCPs reported that patients concern about out-of-pocket costs due to uncertainty of insurance coverage for the scan, combined with concerns about lost wages from taking time off work were a significant barrier to patients' use of lung cancer screening. Some participants reported that clinics with established programs should incorporate patient education about the program itself. A few PCPs indicated the need for patients to be aware of screening's purpose and benefit in detecting cancer early when it is more easily treated as that would encourage adherence and uptake. They mentioned using public service announcements such as

Table 4. Lung Cancer Screening Workflow Process Improvement Suggestions

Lung Cancer Screening Component	Lung Cancer Screening Barriers	Workflow Process Improvement Facilitators
Patient Identification	Lack of adequate workflow systems & Patient non-adherence	Document tobacco use in the patient's EHR; Use the EHR as an LCS patient identification tool *via a checklist with the United States Preventive Services Taskforce guidelines; Use of a "huddle" sheet fastened to the exam room door to remind PCPs about preventive services with another staff member who could assure it gets completed*
Referral	Lack of adequate workflow systems	*Champions to help establish processes like* thorough communication pathways between PCP referring clinic and radiology facility performing the low-dose CT scan *via electronic health records, a shared online database, or scheduled phone calls*
Screening	Lack of adequate workflow systems	Use the EHR or a database to track low-dose CT screening orders and missed low-dose CT scan appointments
Result	Lack of adequate workflow systems	Rely on flags in the EHR to follow-up with patients regarding their scan results; *use of the "huddle" sheet to remind the PCP to discuss results*
Patient Follow-up Post Screen	Lack of adequate workflow systems (Lack of support from clinic leadership)	Use the EHR or other database to track and monitor patients with abnormal screen results, ideally a database that has alerts and reminders embedded to create reports; Designate clinic staff to track and monitor patients post LCS
Patient Navigation	Transportation, cost, radiation exposure	Designate a patient navigator who is a member of the clinic staff to track and monitor all LCS patients from referral to post-screening follow-up, and can assist with patient needs; Use of mobile CT scanners, SDM interactions conducted via telehealth, increasing awareness of federal cancer centers, and round-trip transportation vouchers
Shared Decision-Making Tools	Health literacy & Impractical decision aids	*Use shared decision-making tools, such as toolkits, decision aids, or information sheets, and web-based resources or apps*

Abbreviations: EHR, electronic health record; LCS, lung cancer screening; low-dose CT, low-dose computed tomography.
Note: Italicized portions indicate suggestions from the literature. Non-italicized portions indicate suggestions from our respondents.

billboard and social media outlets to increase screening awareness. Others stated that the onus is on providers to educate patients.

CFIR Domain: Implementation Process

Construct: Champions

We asked participants whether a clinic champion instigated or led lung cancer screening implementation in their clinic. Of note, champions are "individuals who dedicate themselves to supporting, marketing, and 'driving through' an implementation."[32] A minority of participants practiced in clinics with an established program spearheaded by a program champion, and the champions were seen as key facilitators of screening implementation and uptake. In these cases, the champion self-identified themselves to lead lung cancer screening in their clinic, meaning they initiated talks with leadership, sometimes identified mechanisms within the EHR or other systems to find eligible patients, or educated colleagues. Champions were motivated by the clinic's patient population, creating an opportunity for local change, and lung cancer screening's benefit for their community to detect cancer early. One

participant said, "If you had to champion for something, it is possible to create local change around that... (If) the champion in the clinics that decide that it (screening) is important, I think the rates are going to go up."

Participants practicing in clinics without a champion described an environment where clinic leadership (eg, medical director or corporate executive officer of a clinic group) did not visibly support lung cancer screening implementation and some fostered a perception that changes to screening processes could not happen. Participants mentioned the lack of time available to undertake additional duties, such as championing an initiative. In the absence of a clinic-level champion, screening processes were managed at the provider level rather than the clinic or program level. In such cases, participants noted screening can be difficult for individual clinicians to negotiate system-level workflow processes such as preauthorization of a CT scan, preauthorization for Medicaid beneficiaries or activating reminders and tracking in the EHR, without the assistance of decision support tools.

Discussion

Our study assessed facilitators and barriers for PCPs to implement lung cancer screening programs. In contrast to prior studies, we focused on rural settings. Our results suggest screening uptake in rural settings is influenced by: 1) PCP perceptions of screening, and networks and communication, 2) patient needs, resources, and barriers, and 3) implementation process characteristics.

We found that all participants were knowledgeable about the benefits of lung cancer screening in detecting lung cancer and the majority were supportive of this procedure. Other investigators have reported mixed results whether PCPs lack of support and knowledge is a barrier to screening uptake.[21,27,39,40] Notably, no participants mentioned the American Academy of Family Physicians 2018 statement not to recommend screening,[41] which has since changed to a recommendation in support of lung cancer screening. It is possible that respondents did not mention the recommendation because some may not have been family medicine clinicians.[42] We previously reported that among rural Oregon PCPs surveyed in 2020, 87% had referred patients for the low-dose CT.[27] These and others' results along with our current findings suggest that PCPs' knowledge about lung cancer screening has likely increased in the years since the 2013 USPSTF recommendations were published.[43]

A recent systematic review that reviewed mainly screening in urban settings,[40] found that (lack of) structured programmatic elements of high-quality lung cancer screening strongly influenced patient referral rather than individual-level PCP practice, similar to our findings.[22,44,45] Some workflow process improvements could include integration of eligibility checklists and decision support into the electronic health record to help PCPs initiate shared decision-making discussions, which could be particularly helpful for PCPs who are less familiar with a patient. Electronic reminders implemented as standards for eligibility and adherence have been helpful for PCPs in other settings, with a direct impact on enhancing the use of medications, improving the recording of medical diagnosis, immunization rates, and increasing implementation of screenings.[46–49] Or PCPs could use a "huddle" sheet that could be fastened to the examination room door to remind PCPs about preventive services with another staff member who could assure it gets completed and highlight abnormal results.[22]

Indeed, introducing the lung cancer screening process is the initial step of a patient's experience – ensuring adherence to follow-up recommendations is also critical. Unfortunately, less than a quarter of patients in routine care settings have appropriate adherence.[50] The responsibility for adherence is perceived to lie with the PCP in both nonrural and rural settings, similar to participants in our study.[21,51] Like a larger survey study of rural-serving PCPs, our participants suggested use of systematic processes like centralized programs and dedicated lung cancer screening coordinators.[27]

We found that, while all PCPs interviewed reported they engaged in shared decision-making interactions with their patients, they did not rely on or use a decision aid to guide the conversation. Similar to studies in other mainly urban settings, PCPs cited a lack of time as the primary reason for not using a decision aid.[40,52,53] One solution to relieve the time pressure of a primary care visit is to redesign clinic workflow processes to involve other clinic staff members. For example, nurses can engage in shared decision-making interactions, and having a dedicated lung cancer screening coordinator has been helpful for PCPs in other studies.[39,54,55]

While conversations about tobacco use can prompt screening discussions, many clinicians in this and other studies considered conversations about lung cancer screening and smoking cessation to be inherently different and not related.[56] This is perhaps because discussions of tobacco use are focused on health behavior change, (ie, primary prevention). Lung cancer screening, rather, is a secondary prevention conversation about identifying lung cancer in the earliest stages. Clinicians and patients may feel that there are other motivators for changing smoking behaviors beyond screening, or there may not be enough emotional distress involved within discussions to lead to a "teachable moment" to elicit a health behavior change.[56] PCPs may be able to leverage other motivations and aspects of communication, such as building trust within the patient-clinician relationship, to improve motivation for cessation within lung cancer screening discussions. Discussing the importance of screening as only one part of prevention, or discussing risk lung cancer may be helpful to personalize discussions. PCPs may also need to include postscreening

interventions, or interventions beyond the commonly used techniques like the 5A's.[57]

PCPs shared that rural patients face many persistent barriers to lung cancer screening. One previous qualitative study from 2019 interviewed 10 PCPs in New Mexico who provided care to underserved populations.[61] The participants did not use low-dose CT screening and were skeptical of the evidence-based behind lung cancer screening. This is different from our study since our participants endorsed the evidence base and were aware of the benefits of using low-dose CT vs other modalities. Our findings support the importance of addressing *patient-level* barriers to screening that are unique to rural populations and have been shown to diminish patient access and utilization of screening.[58,62,63] Possible solutions that were not mentioned in our study to mitigate transportation barriers include mobile CT scanners,[64,65] shared decision-making interactions conducted via telehealth,[66] increasing awareness of federal cancer centers,[59] and round-trip transportation vouchers[67] to a qualified medical center for the low-dose CT scan. Lastly, health navigators who provide high-quality communication[60,68,69] and are positioned to support patients through the screening process can help to respond to barriers and address mistrust and health literacy issues among rural-residing patients.[60,70,71]

System-level facilitators for implementation include the usage of champions who are known for facilitating change efforts in health care settings.[72] Our results similarly suggest primary care champions are necessary to create change and obtain resources by elevating the importance of screening. Importantly, lung cancer screening champions do not always have to be a clinician. To identify champions, the Institute for Healthcare Improvement suggests the following: seeking volunteers rather than formally appointing a staff member, giving the champion power to implement solutions, having leadership remind other staff that the champion is not a disciplinarian but is there to help, training the champion on Human Factors Engineering (which identifies why people make mistakes), integrating the champion within other disciplines to learn from each other, and checking with staff to assess ongoing implementation processes.[73] Although participants in our study noted the lack of available time to champion initiatives, there may be opportunities for clinics to appoint a staff member to champion multiple wellness or prevention initiatives.

Limitations

While this study is one of a handful that qualitatively examine rural PCPs' perceptions of factors related to lung cancer screening implementation, it has limitations. First, we may have obtained a biased sample of PCPs who were more knowledgeable about screening and more likely to volunteer to be interviewed. However, as our cohort was diverse in other ways, we believe the information gathered can be extrapolated to reflect barriers and concerns among most PCPs practicing in other rural regions of the United States serving similar patient populations. Second, there were refusals due to COVID-related strain that made recruitment challenging; we could not determine the percentage who responded to the study invitation, and we could not assess for differences compared with nonrespondents. However, the goal of qualitative research is not to be representative, but instead to give voice to participants with knowledge of the topic. Third, we did not assess the quality of local programs in the regions for each participant or based on the setting in which they practice (eg, independent or system affiliated). Future work should explore if clinician views toward lung cancer screening vary based on regional program quality or clinician type. Fourth, our participants were not racially or ethnically diverse, reflecting the demographics of Oregon PCPs, but limiting generalizability.[74] Finally, we did not conduct interviews with patients and therefore our patient perspective is from a clinician lens.

Conclusion

We found that rural-practicing PCPs were supportive of lung cancer screening and discussing it with patients, although workflow processes, time challenges, and patient-reported barriers remain impediments to improved lung cancer screening in their clinics. PCP participants described how rural patients have accessibility and referral needs that need to be addressed. Overall, our findings point to the need for clinic- and system- level tools to improve lung cancer screening uptake.

References

1. Howlader NA, Krapcho M, Miller D, et al. SEER cancer statistics review, 1975–2018, National Cancer Institute. 2020.

2. Siegel RL, Miller KD, Fuchs HE, Jemal A. Cancer statistics, 2021. CA Cancer J Clin 2021;71:7–33.

3. U.S. Preventive Services Task Force. Screening for lung cancer: US preventive services task force recommendation statement. JAMA 2021;325:962–70.

4. Ersek JL, Eberth JM, McDonnell KK, et al. Knowledge of, attitudes toward, and use of low-dose computed tomography for lung cancer screening among family physicians. Cancer 2016;122: 2324–31.

5. Church TR, Black WC, National Lung Screening Trial Research Team, et al. Results of initial low-dose computed tomographic screening for lung cancer. N Engl J Med 2013;368:1980–91.

6. de Koning HJ, van der Aalst CM, de Jong PA, et al. Reduced lung-cancer mortality with volume CT screening in a randomized trial. N Engl J Med 2020;382:503–13.

7. Force USPST. Lung Cancer Screening Final Recommendation Statement. 2021. April 19, 2021. Available at: https://www.uspreventiveservicestaskforce.org/uspstf/recommendation/lung-cancer-screening.

8. Mead N, Bower P. Patient-centredness: A conceptual framework and review of the empirical literature. Soc Sci Med 2000;51:1087–110.

9. Elwyn G, Frosch D, Thomson R, et al. Shared decision making: a model for clinical practice. J Gen Intern Med 2012;27:1361–7.

10. Sullivan DR, Golden SE, Ganzini L, Wiener RS, Eden KB, Slatore CG. Association of decision-making with patients' perceptions of care and knowledge during longitudinal pulmonary nodule surveillance. Annals ATS 2017;14:1690–6.

11. Levinson W, Kao A, Kuby A, Thisted RA. Not all patients want to participate in decision making. A national study of public preferences. J Gen Intern Med 2005;20:531–5.

12. Fedewa SA, Kazerooni EA, Studts JL, et al. State variation in low-dose computed tomography scanning for lung cancer screening in the United States. J Natl Cancer Inst 2021;113:1044–52.

13. Sahar L, Smith R. If we build it, they will come...maybe. Chest 2021;160:34–5.

14. Boudreau JH, Miller DR, Qian S, Nunez ER, Caverly TJ, Wiener RS. Access to lung cancer screening in the Veterans Health Administration: does geographic distribution match need in the population? Chest 2021;160:358–67.

15. Niranjan S, Opoku-Agyeman W, Carroll N, et al Access to lung cancer screening in the Veterans Health Administration: does geographic distribution match need in the population? Annals ATS 2021;18:1577–80.

16. Bodily B, Ashurst J, Fredriksen J. Results of lung cancer screening in a rural setting: a retrospective cohort study. Cureus 2022;14:e23299.

17. Zahnd WE, Eberth JM. Lung cancer screening utilization: a behavioral risk factor surveillance system analysis. Am J Prev Med 2019;57:250–5.

18. Henley SJ, Anderson RN, Thomas CC, Massetti GM, Peaker B, Richardson LC. Invasive cancer incidence 2004–2013, and deaths 2006–2015, in nonmetropolitan and metropolitan counties—United States. MMWR Surveill Summ 2017;66:1–13.

19. Zahnd WE, Fogleman AJ, Jenkins WD. Rural-urban disparities in stage of diagnosis among cancers with preventive opportunities. Am J Prev Med 2018;54:688–98.

20. Martin AN, Hassinger TE, Kozower BD, Camacho F, Anderson RT, Yao N. Disparities in lung cancer screening availability: lessons from southwest Virginia. Ann Thorac Surg 2019;108:412–6.

21. Slatore C, Golden S, Thomas T, Bumatay S, Shannon J, Davis M. "It's really like any other study": Rural radiology facilities performing low-dose computed tomography for lung cancer screenin. Annals ATS 2021;18:2058–66.

22. Nelson-Brantley H, Ellerbeck EF, McCrea-Robertson S. Implementation of cancer screening in rural primary care practices after joining an accountable care organisation: a multiple case study. Fam Med Community Health 2021;9.

23. Carey M, Noble N, Mansfield E, Waller A, Henskens F, Sanson-Fisher R. The role of eHealth in optimizing preventive care in the primary care setting. J Med Internet Res 2015;17:e126.

24. Deller B, Tripathi V, Stender S, Otolorin E, Johnson P, Carr C. Task shifting in maternal and newborn health care: key components from policy to implementation. Int J Gynaecol Obstet 2015; 130:Suppl S25–S31.

25. Liu Y, Zupan NJ, Shiyanbola OO, et al. Factors influencing patient adherence with diabetic eye screening in rural communities: a qualitative study. PLoS One 2018;13:e0206742.

26. Wang H, Roy S, Kim J, Farazi PA, Siahpush M, Su D. Barriers of colorectal cancer screening in rural USA: a systematic review. Rural Remote Health 2019;19:5181.

27. Slatore CG, Golden SE, Thomas T, et al. Beliefs and practices of primary care providers regarding performing low-dose CT studies for lung cancer screening. Chest 2022;161:853–9.

28. Davis MM, Gunn R, Kenzie E, et al. Integration of improvement and implementation science in practice-based research networks: a longitudinal, comparative case study. J Gen Intern Med 2021;36: 1503–13.

29. About rural and frontier data: Oregon office of rural health geographic definitions. Oregon Office of Rural Health. 2021. Accessed August 3, 2022.

Available at: https://www.ohsu.edu/oregon-office-of-rural-health/about-rural-and-frontier-data2021.

30. Urban and Rural. United States Census Bureau. 2020. Accessed May 25, 2023. Available at: https://www.census.gov/programs-surveys/geography/guidance/geo-areas/urban-rural.html.

31. Davis MM, Gunn R, Cifuentes M, et al. Clinical workflows and the associated tasks and behaviors to support delivery of integrated behavioral health and primary care. J Ambul Care Manage 2019;42:51–65.

32. Damschroder LJ, Aron DC, Keith RE, et al. Fostering implementation of health services research findings into practice: a consolidated framework for advancing implementation science. mplementation Sci 2009;4: 1–15.

33. Saunders B, Sim J, Kingstone T, et al. Saturation in qualitative research: exploring its conceptualization and operationalization. Qual Quant 2018;52:1893–907.

34. Malterud K, Siersma VD, Guassora AD. Sample size in qualitative interview studies: guided by information power. Qual Health Res 2016;26:1753–60.

35. Hsieh HF, Shannon SE. Three approaches to qualitative content analysis. Qual Health Res 2005;15:1277–88.

36. Miles MH. *Qualitative Data Analysis*. 2nd ed. Sage Publications; 1994.

37. Chin J, Jensen TS, Ashby L, et al. Screening for lung cancer with low-dose CT—translating science into Medicare coverage policy. N Engl J Med 2015;372:2083–5.

38. Is Lung Cancer Screening Right for Me? A Decision Aid for People Considering Lung Cancer Screening With Low-Dose Computed Tomography. Agency for Healthcare Research and Quality. 2016. Accessed May 25, 2023. Available at: https://effectivehealthcare.ahrq.gov/products/lung-cancer-screening/overview.

39. Melzer AC, Golden SE, Ono SS, et al. "We just never have enough time": Clinician views of lung cancer screening processes and implementation. Ann Am Thorac Soc 2020.

40. Sedani AE, Davis OC, Clifton SC, et al. Facilitators and barriers to implementation of lung cancer screening: a framework-driven systematic review. J Natl Cancer Inst 2022;114:1449–67.

41. Armstrong C. Lung cancer screening recommendations from the ACCP. Am Fam Phy 2021;98:688–9.

42. Clinical Preventive Service Recommendation: Lung Cancer. American Academy of Family Physicians. 2023. Accessed May 25, 2023. Available at: https://www.aafp.org/family-physician/patient-care/clinical-recommendations/all-clinical-recommendations/lung-cancer.html.

43. Moyer VA, US PST Force. Screening for lung cancer: U.S. preventive services task force recommendation statement. Ann Intern Med 2014;160:330–8.

44. Coughlin JM, Zang Y, Terranella S, et al. Understanding barriers to lung cancer screening in primary care. J Thorac Dis 2020;12:2536–44.

45. Mazzone PJ, Silvestri GA, Souter LH, et al. Screening for lung cancer: CHEST guideline and expert panel report. Chest 2021;160:e427–e494.

46. Lehto M, Pitkala K, Rahkonen O, Laine MK, Raina M, Kauppila T. Do electronic reminders alter recorded diagnoses in primary care office-hours practices of health centers: a register-based study in a Finnish city. SAGE Open Med 2021;9:20503121211036117.

47. Filippi A, Sabatini A, Badioli L, et al. Effects of an automated electronic reminder in changing the antiplatelet drug-prescribing behavior among Italian general practitioners in diabetic patients: An intervention trial. Diabetes Care 2003;26:1497–500.

48. Kenealy T, Arroll B, Petrie KJ. Patients and computers as reminders to screen for diabetes in family practice. Randomized-controlled trial. J Gen Intern Med 2005;20:916–21.

49. Jacobson Vann JC, Jacobson RM, Coyne-Beasley T, Asafu-Adjei JK, Szilagyi PG. Patient reminder and recall interventions to improve immunization rates. Cochrane Database Syst Rev 2018;1:CD003941.

50. Silvestri GA, Goldman L, Burleson J, et al. Characteristics of persons screened for lung cancer in the United States: a cohort study. Ann Intern Med 2022;175:1501–5.

51. Weinstock TG, Tewari A, Patel H, et al. No stone unturned: Nodule Net, an intervention to reduce loss to follow-up of lung nodules. Respir Med 2019;157:49–51.

52. Porter J, Boyd C, Skandari MR, et al. Revisiting the time needed to provide adult primary care. J Gen Intern Med 2023;38:147–55.

53. Caverly TJ, Hayward RA, Burke JF. Much to do with nothing: microsimulation study on time management in primary care. BMJ 2018;363:k4983.

54. Mazzone PJ. Obstacles to and solutions for a successful lung cancer screening program. Semin Respir Crit Care Med 2016;37:659–69.

55. Black L. Lung cancer screening: implementation of and barriers to a nurse practitioner-led program. Clin J Oncol Nurs 2018;22:601–5.

56. Golden SE, Ono SS, Melzer A, et al. "I already know that smoking ain't good for me": patient and clinician perspectives on lung cancer screening decision-making discussions as a teachable moment. Chest 2020;158:1250–9.

57. Kathuria H, Detterbeck FC, Fathi JT, et al. Stakeholder research priorities for smoking cessation interventions within lung cancer screening programs. An official American Thoracic Society research statement. Am J Respir Crit Care Med 2017;196:1202–12.

58. Odahowski CL, Zahnd WE, Eberth JM. Challenges and opportunities for lung cancer screening in rural America. J Am Coll Radiol 2019;16:590–5.

59. Jenkins WD, Matthews AK, Bailey A, et al. Rural areas are disproportionately impacted by smoking and lung cancer. Prev Med Rep 2018;10:200–3.

60. Reihani AR, Ahari J, Manning EP, et al. Barriers and facilitators to lung cancer screening in the United States: a systematic review of the qualitative literature. J Health Soc Sci 2021;6:333–48.

61. Hoffman RM, Sussman AL, Getrich CM, et al. Attitudes and beliefs of primary care providers in New Mexico about lung cancer screening using low-dose computed tomography. Prev Chronic Dis 2015;12:E108.

62. Hasson RM, Fay KA, Phillips JD, et al. Rural barriers to early lung cancer detection: exploring access to lung cancer screening programs in New Hampshire and Vermont. Am J Surg 2021;221:725–30.

63. Mishra SI, Sussman AL, Murrietta AM, et al. Patient perspectives on low-dose computed tomography for lung cancer screening, New Mexico, 2014. Prev Chronic Dis 2016;13:E108.

64. Salmani H, Ahmadi M, Shahrokhi N. The impact of mobile health on cancer screening: a systematic review. Cancer Inform 2020;19:117693512095419.

65. Greenwald ZR, El-Zein M, Bouten S, et al. Mobile screening units for the early detection of cancer: a systematic review. Cancer Epidemiol Biomarkers Prev 2017;26:1679–94.

66. Severance TS, Milgrom Z, Carson A, et al. Cancer prevention, screening, and survivorship ECHO: a pilot experience with an educational telehealth program. Cancer Med 2022;11:238–44.

67. Pruthi S, Shmidt E, Sherman MM, et al. Promoting a breast cancer screening clinic for underserved women: a community collaboration. Ethn Dis 2010; 20:463–6.

68. Abubaker-Sharif M, Shusted C, Myers P, et al. Primary care physician perceptions of shared decision making in lung cancer screening. J Cancer Educ 2020;37:1–9.

69. Atere-Roberts J, Smith JL, Hall IJ. Interventions to increase breast and cervical cancer screening uptake among rural women: a scoping review. Cancer Causes Control 2020;31:965–77.

70. Triplette M, Thayer JH, Pipavath SN, et al. Poor uptake of lung cancer screening: opportunities for improvement. J Am Coll Radiol 2019;16:446–50.

71. Percac Lima S, Ashburner JM, Rigotti NA, et al. Patient navigation for lung cancer screening among current smokers in community health centers a randomized controlled trial. Cancer Med 2018; 7:894–902.

72. Miech EJ, Rattray NA, Flanagan ME, et al. Inside help: an integrative review of champions in health-care related implementation. SAGE Open Med 2018;6:205031211877326.

73. Changes: appoint a safety champion for every unit. Institute for Healthcare Improvement. 2018. Accessed August 14, 2023. Available at: https://www.ihi.org/resources/Pages/Changes.

74. The diversity of Oregon's licensed health care workforce. Oregon Health Authority. 2022. Accessed May 25, 2022. Available at: https://www.oregon.gov/oha/HPA/HP-HCW/Meeting%20Documents/4.-Workforce-Diversity Report.pdf.

75. Rural-Urban Commuting Area Codes. U.S. Department of Agriculture Economic Research Service. 2020. Accessed August 3, 2022. Available at: https://www.ers.usda.gov/data-products/rural-urban-commuting-area-codes.aspx.

76. Defining the PCMH. Agency for Healthcare Research and Quality. 2022. Accessed March 14, 2023. Available at: https://www.ahrq.gov/ncepcr/research/care-coordination/pcmh/define.html.

77. Rural Health Clinics. Office of Rural Health. 2021. Accessed March 14, 2023. Available at: https://www.ruralhealthinfo.org/topics/rural-health-clinics.

78. What is a community health center. Alameda Health Consortium. n.d. Accessed March 14, 2023. Available at: https://www.alamedahealthconsortium.org/community-health-center/.

Appendix.

Interview Guide

Walk me through your lung cancer screening program.

(Prompt if necessary regarding when/how it started, describe how a patient hears/asks about the program and how they go through the process from shared decision-making to results to follow-up, how many patients are seen per week (how do you know?), what were some of the barriers/facilitators, how important was having a champion, what do patients and PCPs say about the system... use questions below for more detailed prompts.)

(Will need to adapt questions based on if they have a LCS program or not.)

Individual and Program Characteristics	CFIR Construct-Subconstruct (if applicable); *Strategy*

1. First, please tell me about yourself.
   a. Type of provider, years practicing, years at current facility.
   b. What is your current role regarding lung cancer screening?	

2. What is the status of your facility's uptake of LCS? Why?
   a. What does having a LCS "program" mean to you?
   b. If no program, is your facility considering implementing an LCS program? If so, when? *(skip to #6)*
   c. If yes, what is your role in the LCS program?
      i. Please describe the LCS program at your facility. Walk me through the process a patient would go through to get screened and follow-up.	

3. Who manages the LCS program? How is it managed?
   a. What kind of specialist runs the program?
   b. Who is the primary manager and how much time do they spend on it?
   c. Do you have a screening nurse coordinator? If so, how involved are they in the program?	

4. Please tell me about the facility where you currently work. a. How is it structured and how are decisions about new service lines made?	
Implementation Process *Note: these questions can apply to a center where the CTs are performed there, if they're done in a referral center, or a stand-alone radiology department.*	

5. Please explain the implementation process at your clinical site. How did it work or not work?
   a. How did you identify and prepare individuals who dedicate themselves to supporting, marketing, and driving through an implementation, overcoming indifference or resistance? That is, how did you identify and prepare champions? Where do you refer patients if there is no LCS program at your site?
   b. How do your colleagues handle LCS implementation? Where do they refer patients? Is their procedure/process similar to yours?
6. (If no program) What are some specific barriers to uptake and how did you overcome them or how are you addressing them? What is your role?
	Engaging-Champions; *Identify and prepare champions*

a. How will you identify and prepare individuals who dedicate themselves to supporting, marketing, and driving through an implementation, overcoming indifference or resistance? That is, how will you identify and prepare champions? b. *Tell me about the patient-level barriers?*	
7. Did/Will you hold meetings targeted toward different stakeholder groups (e.g., providers, administrators, other organizational stakeholders, and community, patient/consumer, and family stakeholders)? What was/will be the purpose of these meetings?	Planning; *Conduct educational meetings, educational outreach visits, ongoing training*
a. Did/Will you develop and distribute manuals, toolkits, and other supporting materials in ways that make it easier for stakeholders to learn about the innovation and for clinicians to learn how to deliver the clinical innovation?	Engaging-Champions; *Develop & distribute educational materials*

Intervention Characteristics	
8. Tell me your thoughts about LCS. You may want to discuss strength of the evidence, clinical buy-in, implications for patients, or pros/cons. a. Does LCS appear to have more advantages than disadvantages for your patients? What about the program itself?	Relative Advantage
9. Did/Will your organization provide ongoing consultation with one or more experts in the strategies used to support implementing the innovation? Would you know who to call to help set up LCS? How open would you/your organization be to outside support? If so, what would that look like?	*Provide ongoing consultation; Purposely reexamine the implementation*
10. Tell me about your relationship with the OHSU Knight Cancer Network. a. If you have one, tell me about its role in LCS implementation.	
11. How do you define "successful implementation"? Discuss the importance of quality. a. (If program) Did you achieve this goal? What was most important? b. Is your facility concerned about implementation that is TOO successful (i.e., an influx of business)? c. How does/will your progress of implementation be measured? Collecting regular feedback from clinicians and/or management? Forums? Quality measures? d. How is/will communication maintained? Regular project meetings with the project champion and team members? Regular feedback to management or clinicians?	
Inner Setting	
12. Please discuss the role of partners and leadership in the implementation effort. a. How did/would you recruit and cultivate relationships with partners and leadership? b. Tell me about the staffing structure of your facility. c. Tell me about your referral patterns/partners. d. Where would you refer someone who had a suspicious finding or lung cancer? How does that vary by patient insurance status?	Engaging; *Build a coalition*
13. Does/Will your facility use a centralized referral system for LCS? Do you have a centralized tracking system for anything else? a. Are there any reminder methods used to encourage LCS? (e.g., flags, clinical reminders, routine look-up during visits, etc.) b. Does/Will your facility utilize a nodule tracking system? i. If so, what type and who (will) manages it? If not, is this planned? c. How do/will they work together?	Readiness for Implementation-Available Resources; *Use data warehousing techniques*
14. Do you feel there is any competition intensity for LCS in your area? a. How did/will your organization attempt to influence the market to increase competition intensity for LCS?	*Increase demand*
15. How is/will your LCS program (be) funded? Is/Will it (be) hard to manage multiple insurance providers?	
16. How does/will your organization integrate smoking cessation? a. What resources are available?	
Other	
17. Do/Will you track patients who were offered screening but declined? If so, how?	
18. Are there any unintended consequences of screening you're worried about (e.g., overdiagnosis, increased patient anxiety, etc.)? How does your facility manage these consequences? a. Was/Will this (be) discussed prior to implementation?	
19. How do/will you manage patient distress, anxiety, quality of life, and smoking cessation?	
20. How aware are you of the LCS page on your facility's website? (e.g., have they visited it? Is it correct? Useful?)	
For sites with LCS programs only:	
21. How many patients request LCS? How many request LCS but do not qualify?	
22. How are patients reacting to the LCS process so far? a. Have you received any feedback? b. Are there specific aspects of the process that you feel are more or less patient-centered? (e.g., feelings about shared decision-making) c. How do patients get information about LCS? What about results?	