Work-Related Lung Cancer: The Practitioner's Perspective

See also Frank, p. 1276; Pyenson and Tomicki, p. 1292; Mulshine, p. 1294; and Markowitz et al., p. 1296.

Work exposures are well-known risk factors for lung cancer. A recent review noted that the International Agency for Research on Cancer (IARC) has found "sufficient evidence" that 19 occupational agents can cause lung cancer in humans (IARC Group 1; see the box on the next page).[1] Two key factors affecting risk for work-related lung cancer are level of exposure to one or more occupational carcinogens[2] and smoking history, with these two factors often having greater than additive effects.[3]

Primary prevention by reducing or eliminating causative exposures to occupational carcinogens and tobacco smoke is the best way to prevent the human and economic costs of work-related lung cancer. The National Institute for Occupational Safety and Health has published an updated *Chemical Carcinogen Policy*, including a new occupational exposure limit: the Risk Management Limit for Carcinogens,[2] which generally will be set at a risk level of one excess cancer case per 10 000 workers in a 45-year working lifetime. The National Institute for Occupational Safety and Health also has published recommendations for preventing tobacco-related illness through workplace policies such as smoke-free workplaces and providing cessation support for employees who use tobacco products.[4]

LUNG CANCER SCREENING

If primary prevention fails and an individual acquires a very high risk of lung cancer, secondary prevention through screening for lung cancer with low-dose chest computerized tomography (CT) has emerged as a clinical intervention.[5–7] Recent guidelines from the American College of Chest Physicians provide the following positive but cautionary endorsement[5]: "low-dose CT screening for lung cancer results in a favorable but tenuous balance of benefits and harms." This favorable balance depends on proper attention to issues such as patient selection, image acquisition and evaluation, management of findings, and inclusion of smoking cessation interventions.[5]

The intended benefit of low-dose chest CT screening is to detect lung cancer at early stages when treatment has better outcomes. Examples of potential harms include morbidity and mortality from procedures performed after screening such as biopsies and surgeries, unnecessary procedures triggered by identification of nodules ultimately found to be benign, overdiagnosis and overtreatment of cancer that would not have affected the well-being of an individual before death (either because the cancer was indolent or because the individual died from another condition), risk of iatrogenic cancer from cumulative radiation exposure, and psychological consequences of screening. Cost-effectiveness is also a concern.[5]

REIMBURSEMENT CRITERIA

In the United States, the Centers for Medicare and Medicaid Services (CMS) has issued eligibility criteria for receiving reimbursement for annual low-dose CT screening.[6] Key criteria are age 55 to 77 years, a smoking history of at least 30 pack-years, and quitting smoking less than 15 years ago. Patients must participate in shared decision-making, and data from screening must be reported to a CMS-approved registry (currently operated by the American College of Radiology).

The CMS reimbursement criteria parallel the inclusion criteria of the landmark National Lung Screening Trial (NLST), differing mainly in upper age limit (age 74 in NLST). In NLST, most lung cancers were identified at early stages, and about three lung cancer deaths were prevented per 1000 persons screened, at an overall cost of $81 000 per quality-adjusted life-year.[5] To achieve these benefits, well-organized programs are needed to provide the clinical follow-up that is frequently required for screening-identified nodules.[5,6] The frequency of nodule identification in NLST during the screening period was 39.1% and in the Veterans Health Affairs Lung Cancer Screening Demonstration Project was 59.7%.[5]

CMS reimbursement criteria and most authoritative recommendations to date support screening of those with a smoking history of 30 pack-years or more and less than 15 years since cessation of smoking. Most do not account for risk associated with exposure to occupational carcinogens.[5,6] The National Comprehensive Cancer Network (NCCN) recommendations are an exception, recommending that those older than 50 with smoking histories greater than 20 pack-years and at least one additional lung cancer risk factor (including exposure to occupational lung

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OCCUPATIONAL AGENTS IDENTIFIED AS HAVING SUFFICIENT EVIDENCE FOR CAUSING LUNG CANCER IN HUMANS (INTERNATIONAL AGENCY FOR RESEARCH ON CANCER GROUP 1)

Arsenic and inorganic arsenic compounds
Asbestos (all forms, including actinolite, amosite, anthophyllite, chrysotile, crocidolite, tremolite)
Beryllium and beryllium compounds
Bis(chloromethyl) ether and chloromethyl methyl ether (technical-grade)
Cadmium and cadmium compounds
Chromium (VI) compounds
Coal-tar pitch
Engine exhaust, diesel
Nickel compounds
Outdoor air pollution
Particulate matter in outdoor air pollution
Plutonium
Radon-222 and its decay products
Silica dust, crystalline, in the form of quartz or cristobalite
Soot
Sulfur mustard
Tobacco smoke, secondhand
Welding fumes
X-radiation and gamma radiation

Source. Adapted from Loomis et al.[1]

carcinogens) be eligible for low-dose chest CT screening.[6] An analysis performed by a French working group of lung cancer risk from occupational carcinogens supports the general approach of considering combined risk from occupational carcinogens and smoking as an indication for low-dose chest CT screening.[3] It estimates that a level of lung cancer risk equivalent to 30 pack-years of smoking is reached only after combined exposure to occupational carcinogens and less than 20 pack-years of smoking for a few types of occupational carcinogens (plutonium; arsenic and its compounds; bis[chloromethyl] ether; chloromethyl methyl ether).

NUCLEAR WEAPONS WORKERS

In this issue of *AJPH,* Markowitz et al. (p. 1296) reported screening yields and lung cancer stages at time of diagnosis resulting from low-dose CT lung cancer screening provided to nuclear weapons workers aged 50 years or older with a smoking history of one pack-year or greater. A baseline low-dose CT scan was obtained in 7159 workers, and a follow-up low-dose CT scan (range = 10–18 months) was obtained in 3110.

At baseline examination, screening yields from the subsets of workers meeting NLST eligibility criteria or NCCN (but not NLST) criteria were similar to those reported by the NLST. At the follow-up examination, screening yield in the NCCN (but not NLST) group declined substantially. At initial and follow-up examinations, most lung cancers identified were at lower stages (IA and IB). Screening yields in those not meeting eligibility criteria for either NLST or NCCN were low at baseline and follow-up examinations.

Currently reported results do not quantify the proportion of workers with lung nodules requiring follow-up (which might be high among those working in dusty trades), potential harms of low-dose CT screening, or benefits expressed as metrics such as lives saved or quality-adjusted life-years gained. Additional reports from this cohort of nuclear weapons workers may help address these issues.

THE PRACTITIONER PERSPECTIVE

Given the many types of occupational carcinogens, usual lack of exposure information needed for quantitative estimates of individual lung cancer risk, incomplete nature of the science, and frequent lack of reimbursement, how can a practitioner determine when low-dose CT screening might be appropriate for someone with a history of exposure to occupational carcinogens? Recognizing the limitations of current data, the following approach is currently reasonable. Regardless of whether low-dose CT screening occurs within the context of established indications for reimbursement, decisions about embarking on a screening program always should be shared with the patient and based on a foundation of counseling about potential benefits and harms (including the potential for lack of reimbursement). Low-dose CT screening always should be considered if a patient meets CMS or US Preventive Services Task Force criteria.[6] It is appropriate to discuss low-dose CT screening with patients satisfying NCCN's recommendations and reach a shared decision about screening. To improve the evidence base and refine recommendations, even low-dose CT screening not meeting indications for reimbursement should be performed in a fashion consistent with CMS requirements and data describing benefits and harms reported to the American College of Radiology's national registry. Screening within the context of well-designed research studies is also appropriate. Finally, diagnostic evaluation of patients with clinical findings suggestive of lung cancer and appropriate follow-up of nodules identified by low-dose chest CT screening should be pursued as part of routine clinical practice.

With improved effectiveness data and technological advances such as blood biomarkers for lung cancer and ultra-low-dose CT, the practice of low-dose chest CT screening for work-related lung cancer undoubtedly will continue to evolve. Still, it is important never to forget that primary prevention of lung cancer—that is, preventing exposure to tobacco, occupational carcinogens, and other lung carcinogens—is the most effective type of prevention. AJPH

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REFERENCES

1. Loomis D, Guha N, Hall AL, Straif K. Identifying occupational carcinogens: an update from the IARC Monographs. *Occup Environ Med*. 2018;75(8):593–603.

2. Whittaker C, Rice F, McKernan L, et al. *NIOSH Chemical Carcinogen Policy*. Current Intelligence Bulletin 68. Cincinnati, OH: US Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health; 2017. DHHS (NIOSH) publication 2017–100.

3. Delva F, Margery J, Laurent F, Petitprez K, Pairon JC; RecoCancerProf Working Group. Medical follow-up of workers exposed to lung carcinogens: French evidence-based and pragmatic recommendations. *BMC Public Health*. 2017; 17(1):191.

4. National Institute for Occupational Safety and Health. *Promoting Health and Preventing Disease and Injury Through Workplace Tobacco Policies*. Cincinnati, OH: US Department of Health and Human Services, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health; 2015. DHHS (NIOSH) publication 2015–113.

5. Mazzone PJ, Silvestri GA, Patel S, et al. Screening for lung cancer: CHEST guideline and expert panel report. *Chest*. 2018;153(4):954–985.

6. Thomson CC, McKee A, Borondy-Kitts A, et al. *American Thoracic Society and American Lung Association Lung Cancer Screening Implementation Guide*. May 2018. Available at: http://www.lung.org/assets/documents/lung-cancer/implementation-guide-for-lung.pdf. Accessed June 20, 2018.

7. Soneji S, Yang J, Tanner NT, et al. Underuse of chest radiography versus computed tomography for lung cancer screening. *Am J Public Health*. 2017; 107(8):1248–1250.

Lung Cancer Screening: A Cost-Effective Public Health Imperative

See also Frank, p. 1276; Weissman and Howard, p. 1290; Mulshine, p. 1294; and Markowitz et al., p. 1296.

Lung and bronchus cancer cause the most deaths of all cancers and account for about one quarter of US cancer deaths. The five-year survival rate (portion of people still living five years after their initial diagnosis) for lung and bronchus cancer is only 18.6%[1]; however, 88% of those with screen-detected stage I cancer are alive 10 years after diagnosis.[2] Screenings that increase early detection of lung and bronchus cancer will decrease mortality, which makes low-dose computerized tomography (CT) screening a public health imperative.

Traditionally, physician-based medicine focused on treating conditions, whereas public health focused on preventing or controlling disease. Today, the distinction is blurred; physician quality assessments often include metrics on the portion of their patients who receive guideline-based screening. However, the dismal uptake of low-dose CT screening through physician-focused efforts suggests that the public health community needs to champion low-dose CT screening and embrace its cost-effectiveness.

ESTABLISHED BENEFITS OF SCREENING

In this issue of *AJPH*, Markowitz et al. (p. 1296) offers additional evidence that lung and bronchus cancer is detectable at early stages with low-dose CT. Low-dose CT screening is recommended by the US Preventive Services Task Force, and its effectiveness in reducing mortality among high-risk populations has been established by randomized controlled trials, cohort studies, and actuarial studies. Low-dose CT screening can also identify other modifiable conditions associated with smoking—specifically, chronic obstructive pulmonary disease and coronary artery disease.[3] The scan is not invasive or painful, and research shows that the few false-positive results are rarely harmful.[4]

Markowitz et al.'s article extends the well-established benefits of low-dose CT screening to an occupational hazard cohort; the context is worksite-screening efforts. The authors have provided important evidence that (1) worksite programs' health promotion of low-dose CT screening is effective, especially for union-supported health programs; (2) low-dose CT screening programs in rural areas can be effective; and (3) the practical program's results are similar to those of randomized controlled trials. Worksite health initiatives are not new,[5] but this demonstration that worksite-related low-dose CT screening can be effective is important, because the usual medical settings have been frustratingly slow to adopt low-dose CT screening.

OVERCOMING ACCESS BARRIERS

In an effort to remove cost barriers, health insurance policies usually are required to cover screenings recommended by the US Preventive Services Task Force for individuals deemed to be at elevated risk based on age, gender, and other characteristics. Covered screenings include mammograms; cervical, colorectal, and prostate cancer screening; and sexually transmitted infection screening. Medicare and commercial insurance cover low-dose CT for adults aged 55 to 80 who have an elevated risk for lung cancer, but individuals can face access barriers through lack of awareness or excessively narrow at-risk criteria.

Markowitz et al.'s findings support widening the criteria for defining the at-risk population that should be provided low-dose chest CT screening, particularly the smoking "time since quitting" criteria—30.3% of lung cancer detected in Markowitz et al.'s study occurred in individuals who had quit smoking at least 15 years earlier, which would have excluded them from screening based on National Lung Screening Trial criteria. Widening these criteria will increase the population eligible for insurance-covered screening.

Lung cancer deaths could become a "disease of the poor" through lack of screening

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