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BC Cancer Lung Screening Program: Insights on a risk model–based approach for primary care providers

Low-dose computed tomography provides a cost-effective means of reducing lung cancer mortality in high-risk individuals.

ABSTRACT: Lung cancer continues to be the most common cause of cancer death in Canada. Population-based lung cancer screening using low-dose computed tomography is a cost-effective means of reducing lung cancer mortality in high-risk individuals between 55 and 74 years of age who have ever smoked. Screening is provided by the BC Cancer Lung Screening Program. The downside of screening includes false-positive results, overdiagnosis, and exposure to ionizing radiation. The current screening policy in BC is based on a 6-year lung cancer risk score greater than 1.5% using the PLCOm2012 risk prediction tool. The Pan-Canadian Early Detection of Lung Cancer lung nodule malignancy prediction tool and volumetric measurement using computer-assisted diagnostic technology are used in the management of screening low-dose computed tomography findings. Primary care providers can use the information provided in this article and other resources on the BC Cancer Screening website to share decision making with their patients about enrollment in the screening program.

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Lung cancer is the most commonly diagnosed cancer and the leading cause of cancer deaths in Canada and worldwide.[1] In British Columbia, an average of seven people die of lung cancer every day; in Canada, more people die from lung cancer than from breast, colon, and pancreatic cancers combined.[2] Approximately 72% of lung cancers are attributable to smoking, which creates an opportunity for targeted screening for lung cancer.[3] Randomized clinical trials in the US and Europe showed a 20% to 39% reduction in lung cancer mortality using low-dose computed tomography screening compared with usual care or screening with chest X-ray.[4-6] Screening works through downstaging—the process of finding lung cancers at an earlier stage, when patients are more likely to benefit from curative treatments and have an improved long-term quality of life. Approximately 40% of lung cancer cases are diagnosed at stage 4, when the 5-year survival rate is less than 10%.[7] However, when lung cancers are diagnosed at stage 1, the 5-year survival rate is between 73% and 90%; hence the importance of screening.[7] In 2013, the US Preventive Services Task Force recommended annual screening for individuals 55 to 80 years of age who currently smoked or had quit within the last 15 years and had a smoking history of 30 or more pack-years.[8] The Centers for Medicare & Medicaid Services have provided reimbursement for low-dose computed tomography screening in the US since 2014.[9] In 2016, the Canadian Task Force on Preventive Health Care recommended annual low-dose computed tomography screening in people 55 to 74 years of age who currently smoked or had quit within the last 15 years and had a smoking history of 30 or more pack-years.[10] In 2021, the US Preventive Services Task Force updated the lung cancer screening guideline to reduce the lower age limit to 50 years and the number of pack-years to 20 or more to address disparity in sex and race (B recommendation, moderate net benefit).[11] The Canadian Task Force on Preventive Health Care is in the process of updating its guideline. In September 2020, based on the strength of evidence and health economic analyses,[12,13] the BC Ministry of Health announced the

implementation of the first provincial lung screening program in Canada. In May 2022, the BC Cancer Lung Screening Program began conducting low-dose computed tomography screening. Ontario Health has also implemented an organized lung screening program.[14] Pilot implementation programs are ongoing in Quebec and Alberta. Business case proposals are being submitted by several other provinces.

Risk model–based approach to lung screening

Lung screening is unique in that it targets a specific portion of the population that is considered to be high risk. Its purpose is to maximize the benefits and avoid unnecessary harms of screening for those who have a lower risk of lung cancer.[15] For example, data from the National Lung Screening Trial showed that if the 6-year lung cancer risk is less than 0.64%, low-dose computed tomography screening does not reduce lung cancer mortality compared with screening with chest X-ray.[16] Therefore, lung cancer screening is not recommended for everyone 55 years of age and older.

In BC, Ontario, and Quebec, screening eligibility is determined based on an individual's calculated lung cancer risk, using the PLCOm2012 risk stratification model.[17] An overview of the PLCOm2012 risk stratification tool, the reasons for its selection, and the predictors involved is presented below.

PLCOm2012 risk stratification tool

The risk factors used in the PLCOm2012 risk stratification tool are shown in the **Box**. A 6-year lung cancer risk score greater than 1.5% is required to participate in the screening program. This threshold is based on the International Lung Screening Trial, which included people between 55 and 80 years of age who had ever smoked and had a PLCOm2012 6-year lung cancer risk greater than 1.5% or who met the 2013 US Preventive Services Task Force age and pack-years criteria.[18] The PLCOm2012 prediction tool was shown to be 15.8% more sensitive than the 2013 US Preventive Services Task Force criteria, and the positive predictive value was significantly higher (4.0% vs 3.4%, $P = .01$).[18] Of those deemed ineligible for lung screening based on the PLCOm2012 or US Preventive Services Task Force criteria, lung cancer developed in 0.50% versus 0.85%, respectively ($P < .001$).[18] Other studies in Canada and several countries around the world also showed that the PLCOm2012 prediction tool had higher sensitivity and negative predictive value than the US Preventive Services Task Force criteria, more lung cancers deaths were averted, more life-years were gained, and the tool was more cost-effective.[13,16,19]

Female smokers typically accumulate fewer pack-years than male smokers. Age and pack-years criteria underestimate lung cancer risk in females. Compared with non-Indigenous people, Indigenous people have a higher risk of lung cancer despite smoking less tobacco.[20] The PLCOm2012 race model removes race/ethnicity disparity and reduces sex disparity more than the 2021 US Preventive Services Task Force screening criteria.[18,21,22] The 2021 US Preventive Services Task Force criteria also exclude those who have stopped smoking for more than 15 years. A meta-analysis showed that the reducible relative risk after smoking cessation declines only marginally from 26.7% (95% CI, 20.2-34.3) after 15 years to 19.7% (95% CI, 13.3-26.4) at 20 years.[23] The duration of smoking cessation is not an exclusion criterion in the PLCOm2012. In people who have stopped smoking, low-dose computed tomography screening is one of the best options for reducing the risk of dying from lung cancer.[3] Additionally, when using the PLCOm2012 to determine screening eligibility, screening can be prioritized according to individual risk scores, with the highest-scoring individuals being offered screening first. This is particularly beneficial when low-dose computed tomography resources are limited, such as during the COVID-19 pandemic.[24]

Personalizing screening interval

A unique feature of the BC Cancer Lung Screening Program is the use of the Pan-Canadian Early Detection of Lung Cancer (PanCan) lung nodule malignancy risk prediction tool[25,26] to personalize the screening interval after the baseline low-dose computed tomography has been conducted. The Canadian Agency for Drugs and Technologies in Health reviewed the diagnostic test accuracy of the PanCan versus the Lung Imaging Reporting and Data System[27] nodule management protocol. The PanCan protocol had significantly better specificity and positive predictive value in six studies and had similar diagnostic test accuracy in three studies: a case-control study, a study that included only subsolid nodules, and a study with a small sample size.[28] A prospective study conducted in Vancouver as part of the International Lung Screening Trial[29] confirmed that the PanCan protocol had a significantly higher sensitivity and positive predictive value than the Lung Imaging Reporting and Data System or NELSON[30] management protocols. The International Lung Screening Trial protocol is the only one that has a biennial screening provision for lower-risk individuals, which comprise approximately two-thirds of the screening population.[30] This management protocol can significantly reduce health care resource use, costs, and cumulative radiation exposure. In subsequent screenings, growth of existing lung nodules and appearance of new nodules are important indicators for malignancy risk.[31-33] BC screening sites are equipped with state-of-the-art computer-assisted

BOX. PLCOm2012 predictors.[17]

The PLCOm2012 model incorporates lung cancer risks based on demographic, environmental, and clinical risk factors, including:

- Age
- Education (proxy for socioeconomic status)
- Family history of lung cancer
- Body mass index
- Chronic obstructive pulmonary disease
- Smoking duration
- Smoking intensity
- Smoking quit time (if any)
- Personal history of cancer
- Race or ethnicity

diagnostic tools that accurately and consistently measure lung nodule volume and growth. A structured reporting system minimizes potential harms of screening, such as unnecessary diagnostic biopsy or surgery for false-positive findings; reduces overdiagnosis and overtreatment; and minimizes radiation exposure from additional imaging studies.[15] A rapid referral process to a regional diagnostic workup team for patients with findings that suggest malignancy facilitates timely diagnosis and treatment.

Role of primary care providers

Primary care providers play an important role in identifying patients who would benefit from lung cancer screening and encouraging them to participate **[Figure]**. Primary care providers are provided with tear-off pads to give to individuals who are between 55 and 74 years of age and have ever smoked for 20 years or more to encourage them to call the BC Cancer Lung Screening Program (1 877 717-5864) and complete a detailed risk assessment with the screening centre navigators to confirm their eligibility. A fax referral form may also be used for any patient the primary care provider thinks may experience barriers to self-referral (e.g., language barrier, screening hesitancy).

Twenty years or more of smoking is used to simplify messaging because the duration of smoking is a major risk factor for lung cancer.[34] The Lung Screening Program navigators administer the PLCOm2012 risk assessment tool to determine screening eligibility, a process that takes, on average, 10 minutes. The navigators, who are trained in smoking cessation counseling, also provide telephone counseling and education material on smoking cessation. For those who are still actively smoking, quitting can double the benefits of screening in reducing lung cancer mortality and all-cause mortality.[35-37] Primary care providers will be asked to prescribe pharmacotherapy such as varenicline, which has been shown to significantly improve the smoking cessation rate when combined with telephone counseling.[38]

Incidental findings in the thyroid, heart, lung, kidneys, adrenals, and liver are common in lung cancer screening.[31] Findings of severe coronary calcification, for example, can trigger important lifestyle and risk management discussions in those patients. A guide to managing common incidental findings is provided in the low-dose computed tomography screening report to the primary care provider. A provider guide for health care professionals, and other resource materials, can be accessed via the BC Cancer Screening website (www.bccancer.bc.ca/screening/health-professionals/lung/resources).

Summary

Lung cancer continues to be the most common cause of cancer deaths in Canada and worldwide. Population-based lung cancer screening using low-dose computed tomography is a cost-effective means of reducing lung cancer mortality in those who are at high risk of lung cancer. We encourage primary care providers to use the information we have provided and other resources on

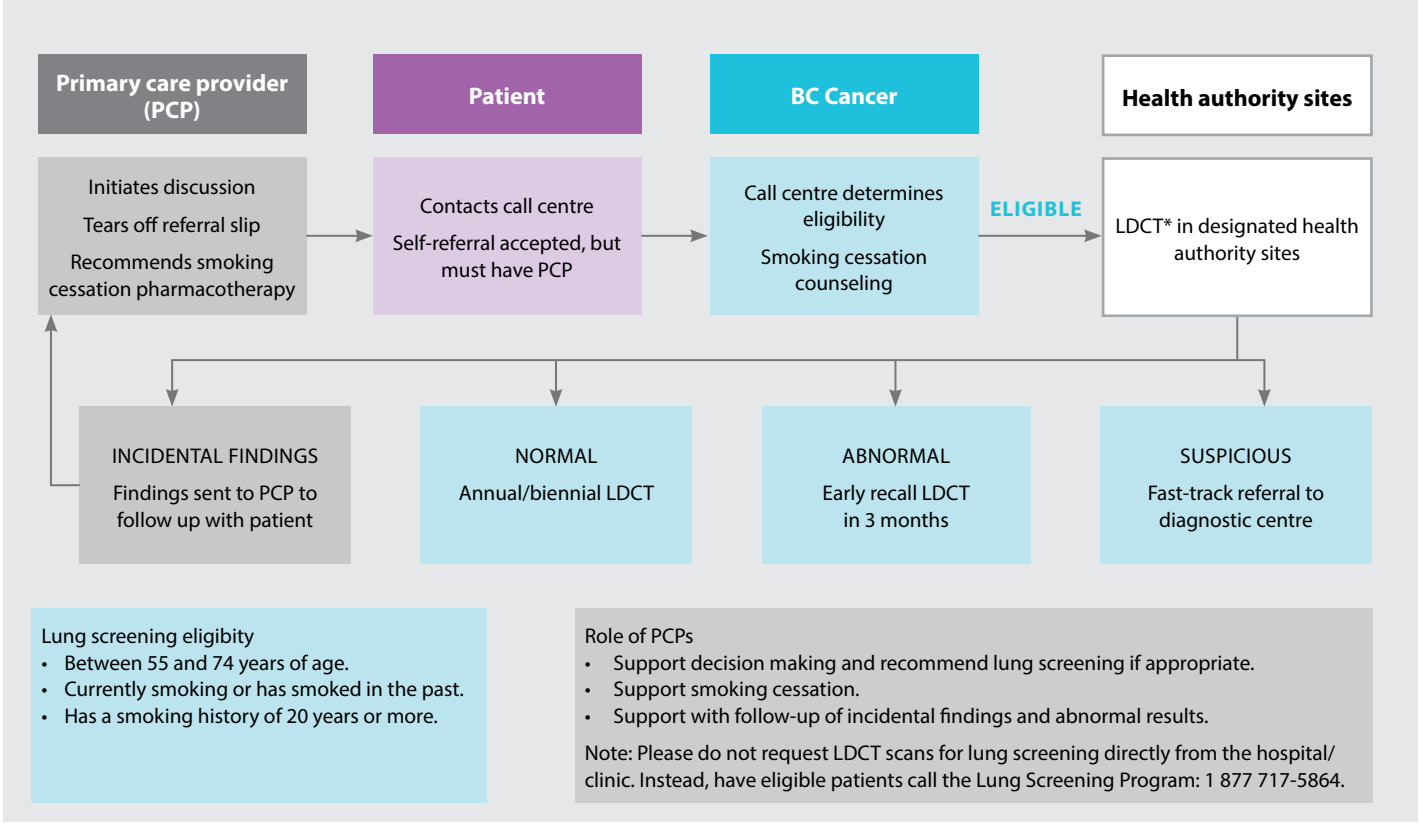

FIGURE. BC Cancer Lung Screening Program flowchart.

*LDCT = low-dose computed tomography

the BC Cancer Screening website to share decision making with their patients about enrollment in the screening program. Lung cancer screening policy in BC will evolve through research, critical review of emerging evidence, internal system performance review, and outcome evaluation. ■

Competing interests

None declared.

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