The Cost-Effectiveness of Lung Cancer Screening in Saskatchewan

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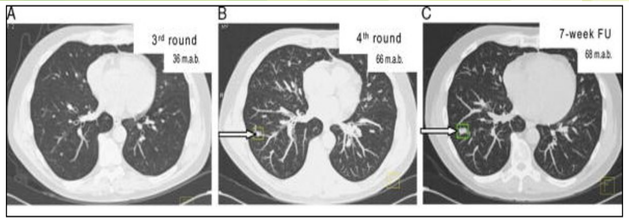

Figure 1. Low-dose computed tomography (LDCT) scan of a growing malignant lung cancer lesion at a) 36 months after baseline screening (m.a.b) and 3rd round of screening b) 66 m.a.b. and 4th round of screening c) 68 m.a.b. Figure adapted from Heuvelmans, 2015.

Background

Lung cancer causes more deaths than any other cancer in Canada[1]. The majority of cancers are diagnosed at later, incurable, stages[2].

The randomized control National Lung Screening Trial (NLST) found that lung cancer screening with low-dose computed tomography (LDCT) can identify more lung cancers at earlier stages[3]. Screening is more effective in high-risk individuals[4] and can be optimized by changing population and protocol parameters.

Current Canadian screening recommendations are based on the NLST study design. Both suggest three annual LDCT scans for high-risk asymptomatic adults ages 55-74 with ≥30 pack-year smoking history and less than 15-years since quitting smoking for former-smokers[5]. Currently, there are no organized lung cancer screening programs implemented in Canada.

Screening is projected to be cost-effective in Canada since the estimated incremental cost-effectiveness ratio (ICER) is below the typically accepted threshold of $100,000/quality-adjusted life year (QALY)[6].The cost-effectiveness and impact of lung cancer screening on cancer outcomes is unknown in Saskatchewan.

This study aims to describe how different lung cancer screening variables influence health outcomes (QALYs and life-years (LY) gained) and cost-effectiveness outcomes (incremental cost, ICER) in Saskatchewan.

Methods

The Canadian Partnership Against Cancer (CPAC) Cancer Risk Management Model (CRMM) was used to generate lung cancer screening estimates for Saskatchewan.

The CRMM is a dynamic microsimulation model that simulates 32 million people from birth to death. Aggregate results are fit to Canadian demographic, disease, and economic parameters. Outcomes are produced by filtering simulated lung cancer patients through probabilistic decision trees based on real Canadian treatment and cost data.

The reference population scenario is based on Canadian recommendations under an ideal, NLST-based screening scenario between 2016 to 2035. More than 50 sensitivity analyses were conducted. Costs and QALYs are discounted at 3% and analyses are from the public health system perspective.

Reference Scenario		Reference Scenario	
Age (years)	55 - 74	Participation Rate	100%
Pack-years	≥30	Re-screen participation	95%
Years Since Quit	<15	Phase-in period	1 year

Results

Reference Scenario	Saskatchewan 2018	Saskatchewan 2016-2035
No Screening		
Total lung cancer costs	-	$633,000,000
Total lung cancer deaths	671	14,500
Total new lung cancers	729	17,500
With Screening		
Eligible for screening	2,735	43,650
Total screens	43,570	206,500
Incremental cost	-	$71,500,000
Incremental QALY	-	570
ICER ($/QALY)	-	125,400
Life-years saved	76	2,200
Lung cancer deaths	634	14,280
Total new lung cancers	811	18,014

Results

Reference Scenario ICER Saskatchewan: $125,400/QALY
Compared to no screening, the incremental cost of adding a lung cancer screening program in Saskatchewan is $71.5 million between 2016-2035, with 570 QALYs gained.

One-Way Sensitivity Analyses: Changes to the eligible population and screening protocol can improve the cost-effectiveness of lung cancer screening in Saskatchewan.

$$\text{ICER}=\frac{[\text{Total lung cancer cost with screening}-\text{Total cost without}]}{[\text{Total QALY with screening}-\text{Total QALY without}]}$$

Scenario	Incremental Cost	QALY saved	ICER ($/QALY)	LY gained
Pack-Year Smoking History (PY)				
20	100,200,000	730	137,000	2,800
40	52,500,000	625	**84,000**	2,000
Screening Age Eligibility				
55-79	76,600,000	690	111,000	2,600
55-64	47,400,000	555	85,400	1,500
65-74	59,000,000	660	89,400	2,700
Continuous Screening Interval				
5 Annual	105,300,000	1,110	**94,800**	3,700
Annual	232,200,000	3,255	**71,300**	10,000
Biennial	123,300,000	4,780	**25,800**	9,500
3-Year Risk of Developing Lung Threshold				
0.5%	71,000,000	540	131,300	2,200
2%	62,400,000	560	111,400	2,700
Cost lung cancer screening				
0.5	41,000,000	570	**72,000**	2,200
2	132,400,000	570	232,300	2,200
Smoking Cessation Program Success Rate				
5%	95,000,000	1,845	**51,500**	4,100
22.5%	85,800,000	7,565	**11,300**	12,200

Discussion and Conclusion

Lung cancer screening is not cost-effective is Saskatchewan using current three annual LDCT scan recommendations.

The NLST study design is not optimized to identify high-risk individuals who would benefit most from screening, leading to improved screening and cost-effectiveness outcomes[6-8]. A Saskatchewan screening program could improve cost-effectiveness and outcomes by isolating higher-risk participants with a 40 pack-year smoking history, expanded eligible age, or using a predicted risk threshold. Screening cost-effectiveness improves using continuous screening, reducing the cost of screening and adding a smoking cessation program.

As a limitation, the CRMM primarily uses Ontario-based costs, so Saskatchewan specific cost estimates are needed.

Directions for future research should include exploring a population-based screening program in Saskatchewan. Implementation should take into consideration equitable access to screening for all eligible groups (rural, First Nations, lower socioeconomic status) and understand opportunity costs to other health care areas.

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