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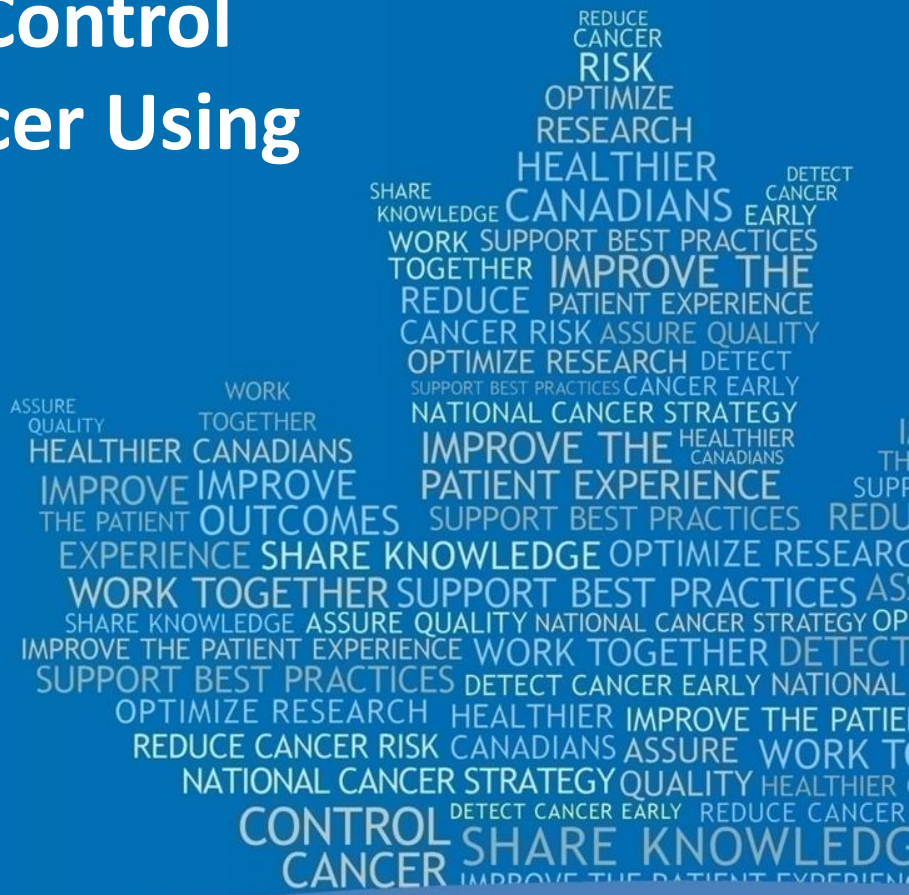
The Evaluation of Cancer Control Interventions in Lung Cancer Using a Canadian Cancer Risk Management Model



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Development of the Cancer Risk Management Model (CRMM)

The need:

- Annual direct costs of health care and cancer care are rapidly increasing and growing concern re sustainability of health care systems

  Bending the Cost Curve on Cancer Care. Smith KJ, Hilner BE. NEJM 364:21, May 26, 2001

- Economic analyses are increasingly required by governments prior to the approval of drugs and some other health technologies
- Useful for policy makers to see the impact of the introduction of new therapies on the use of health care resources, in relation to the potential benefits and economic impacts

Canadian Cancer Risk Management Model (CRMM)

Objective:

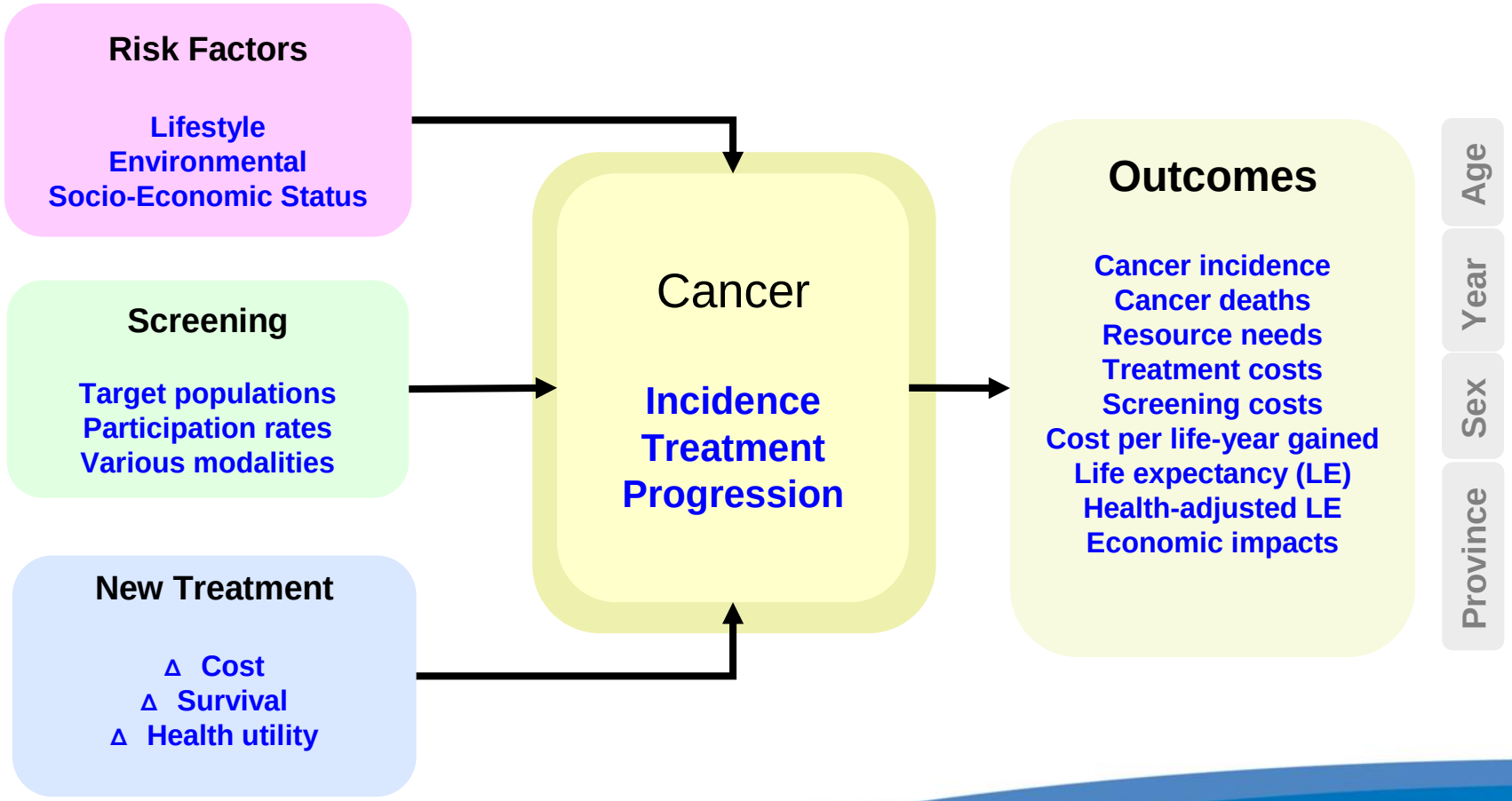
- To develop a comprehensive, web-based modeling platform that forecasts the future burden of cancer and its macroeconomic impacts
- To simulate current and future cancer control interventions on both the population and the economy
- To inform policymakers concerning future investments in cancer control

Canadian Cancer Risk Management Model (CRMM)

Microsimulation approach:

- Monte Carlo, discrete event, continuous time model that simulates individual persons (patients) one at a time (case-based model)
- Adds up a representative sample of individuals to create aggregate results for the whole population
- Can report results by province, age, sex and range of personal characteristics
- Includes competing risk of illness and death from all causes

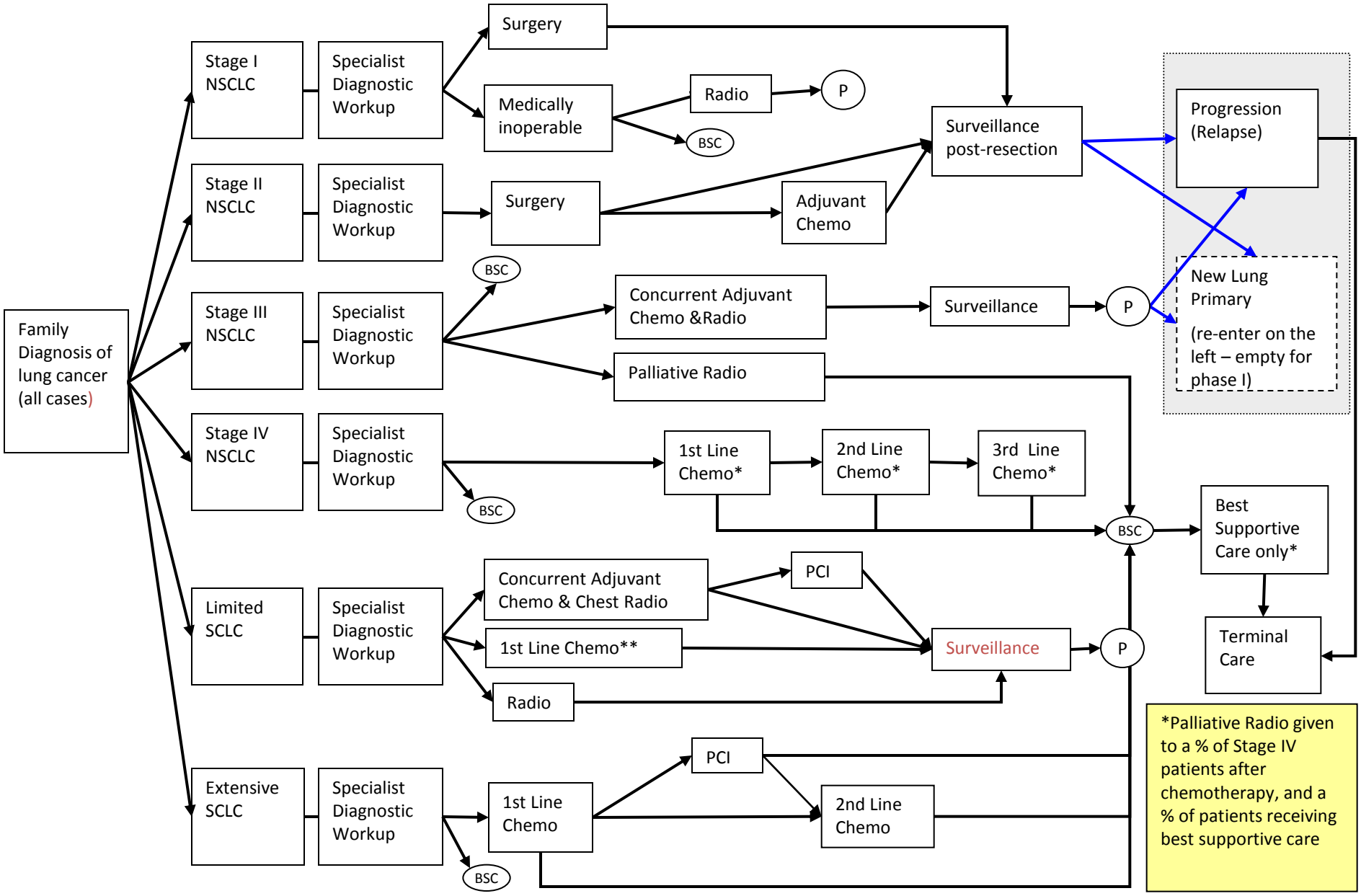
Cancer Risk Conceptual Model



Data Sources

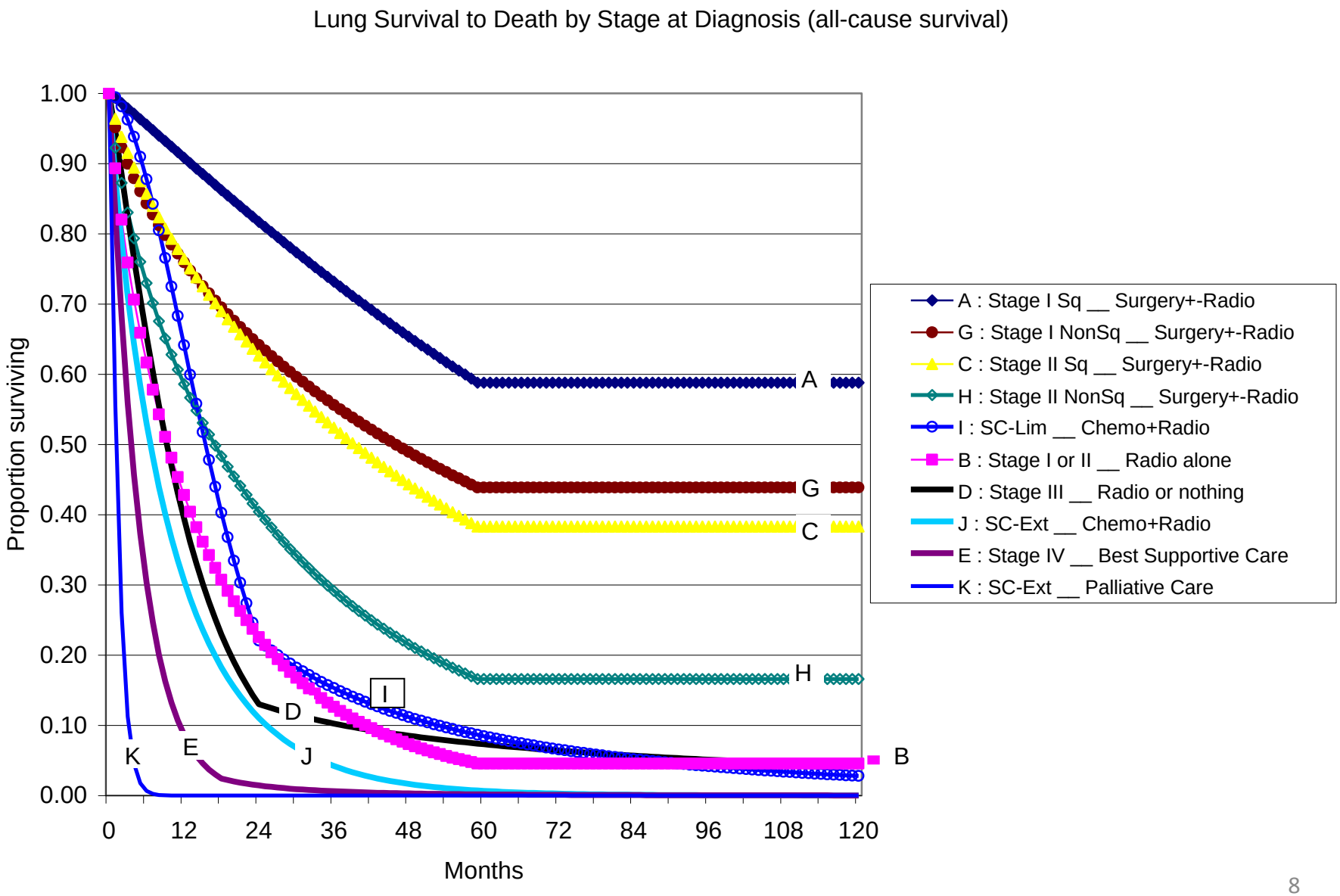
SOURCE	DATA TYPE
Vital Statistics, Census	Mortality, Birth, Population projections
Canadian Cancer Registry	Incidence, Staging
Canadian Community Health Survey; National Population Health Survey	Smoking rates, Population health utilities
General Social Survey	Time use data
Census, T1-Family File, SPSD/M	Earnings, Transfers and Taxes
Canadian Institute for Health Information	Total health care expenditures
Ontario Case Costing Initiative; Provincial Formulary; Provincial Ministries of Health	Health care costs of diagnosis, treatment, follow-up, palliative and terminal care
Expert Opinion	Current treatment practice
Literature	Lung cancer risk equation, Screening parameters, Radon mitigation options, Radon exposure
Chart Review, Literature	Cancer survival
Population Health Impact of Disease in Canada study	Health-related quality of life associated with living with cancers

Lung Cancer Management Algorithm



Details of costs, transition probabilities, durations and health utilities found in Lung Cancer Management Data 2009-06-30.xls

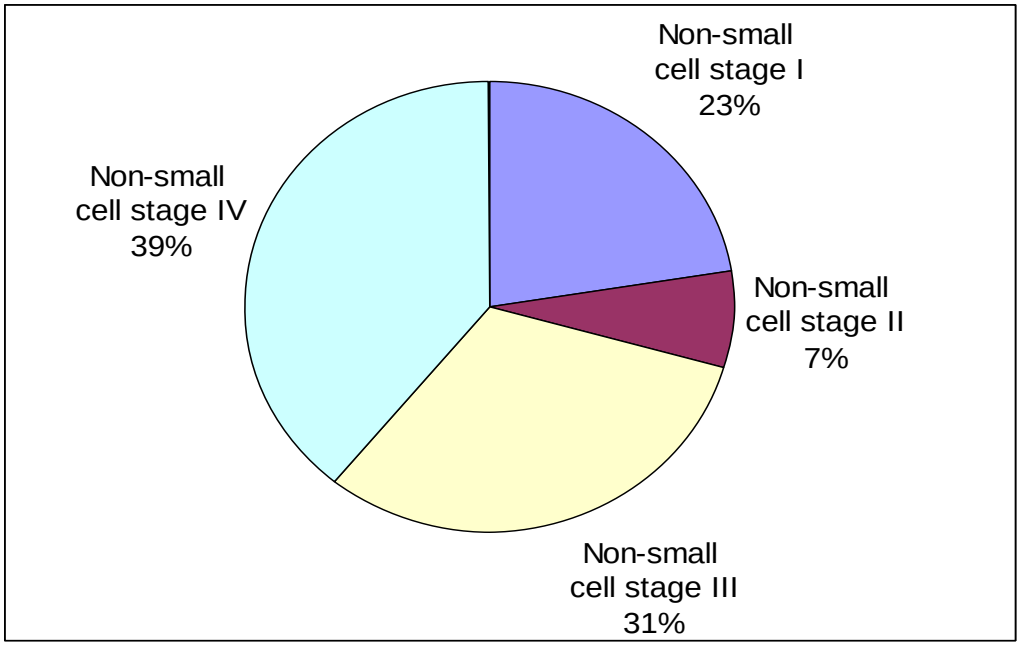
Survival curves for lung cancer



Potential lung cancer policy questions that CRMM could address:

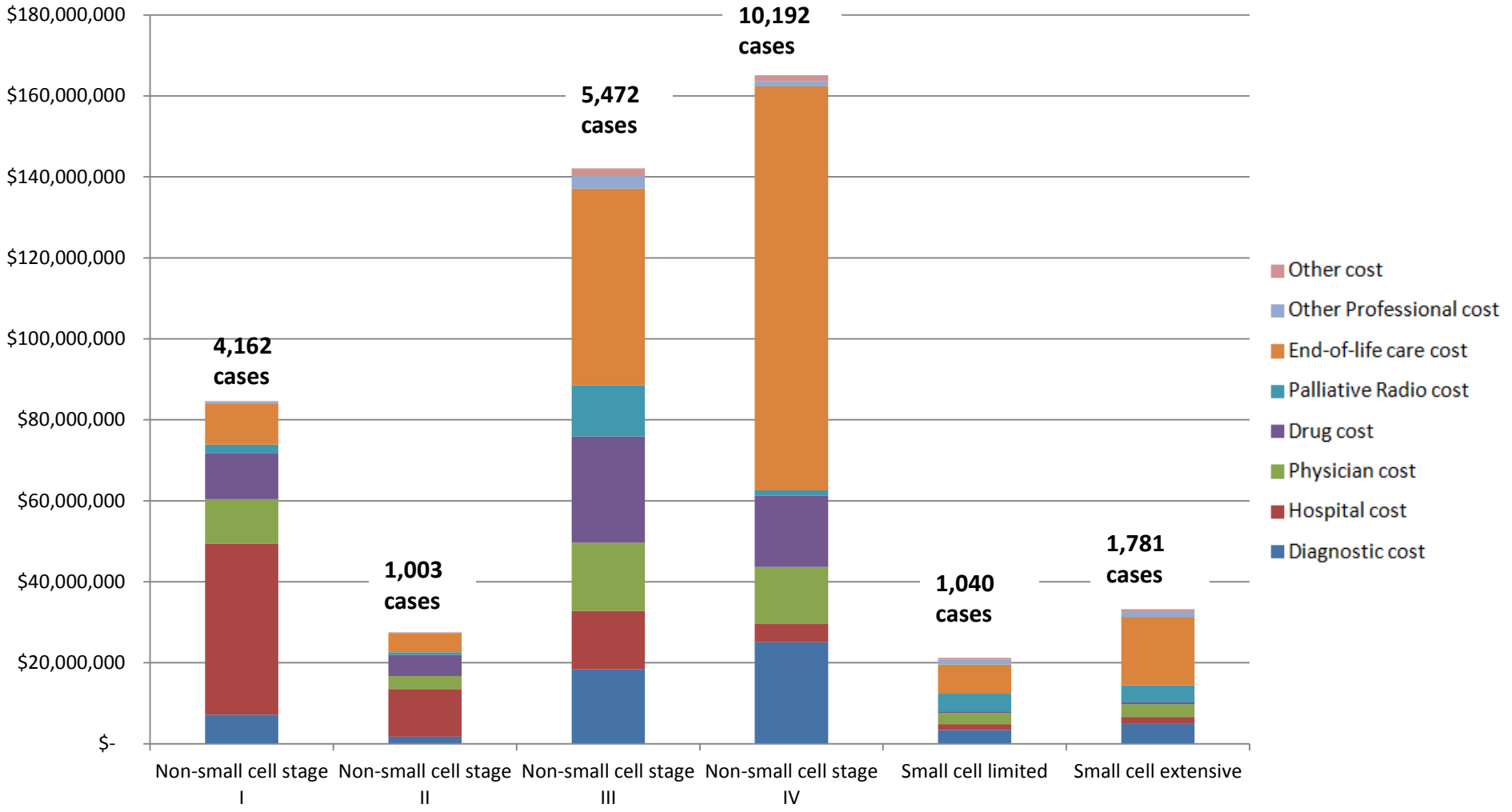
- What is the likely **incidence by stage** of lung cancer over the next 20 years, given current health behaviors and treatment practices?
- How would **changes in smoking rates** effect the incidence of lung cancer and the number and cost of lung cancer treatment by year and by province?
- How would the introduction of **lung cancer screening** effect the number and cost of lung cancer treatment?
- How **cost effective** is any new treatment intervention?
- What would be the likely **effect of any new intervention** on disease progression, life expectancy and years lived in health?
- What would be the impact on employment rates and on aggregate wages in the **economy**?
- How would these changes effect **governments' expenditures and revenues**?

Proportion of First-year Total Direct Medical Care Costs for NSCLC by Stage at Initial Diagnosis



	Non-small cell stage I	Non-small cell stage II	Non-small cell stage III	Non-small cell stage IV	First–year total
Incident cases	4,182	1,008	5,502	10,225	20,916
Average first - year direct healthcare cost	$15,029	$19,165	$15,905	$10,677	$13,327
First-year total direct healthcare cost ($Cdn M)	$62.9 M	$19.3 M	$87.5 M	$109.1 M	$278.8 M
Lifetime direct healthcare costs ($Cdn M)	$86.	$29.7	$141.9	$148.5	$406.4

Lifetime cost of NSCLC and SCLC by stage and treatment type for cases diagnosed in 2011



Source: CRMM version 1.3

Other cost includes pharmacy and MRI (non-physician).
Other professional cost includes outpatient and chemo nursing.

Lung cancer incidence cases projected under two different smoking cessation scenarios

Legend: The Base case scenario projected recent downward trends in smoking after 2010. The smoking rate used in the model for 2010 was 22%; a 50% reduction in the smoking rate to 11% was achieved over a two year period. The risk reduction equations used in the model are not yet published but are available on the web as part of the model's parameter information and incorporate a reduced risk of lung cancer for former smokers. Former smokers have gradually diminishing but elevated risk of lung cancer.

Source: Cancer Risk Management Model 1.3

National Lung Screening Trial

Nov 2010

- Prospective, randomized trial comparing LDCT screening to routine chest x-ray
- Annual CT or chest x-ray x 3
- N=53,464
- High risk eligibility criteria:
  - 30 pack year smoking history
  - If former smoker have quit within 15 years
  - Ages 55 – 74
    - Aged 55-59 → 43%
    - Aged 60-64 → 31%
    - Aged 65-69 → 18%
    - Aged 70-74 → 9%
- 48% current smokers

Stage Shift with LDCT Screening

	Canada		NLST CT scan arm		
	All ages	Age 55-75	Screen-Detected	Interval Detected	"Post-screen" Detected
Stage I	17%	20%	63%	16%	31%
Stage II	4%	6%	7%	11%	6%
Stage III	26%	25%	17%	41%	26%
Stage IV	53%	49%	13%	32%	36%

Source: Canadian Cancer Registry; NLST trial paper Table 5 (Berg et al)

NLST Main Findings

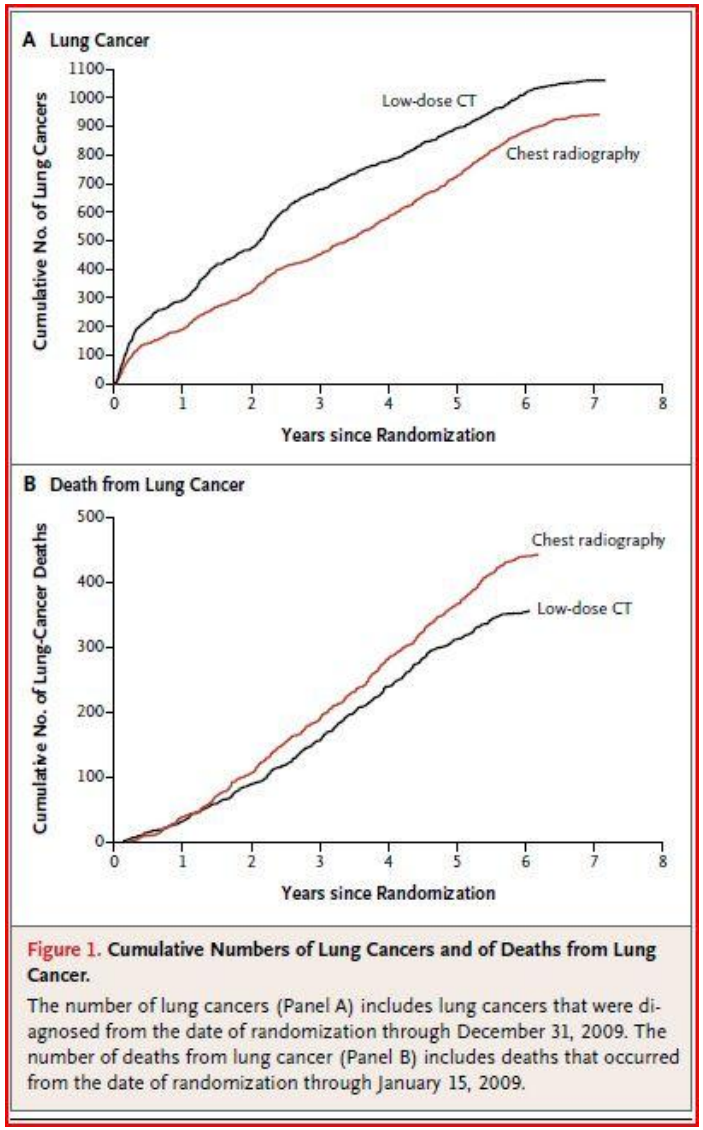
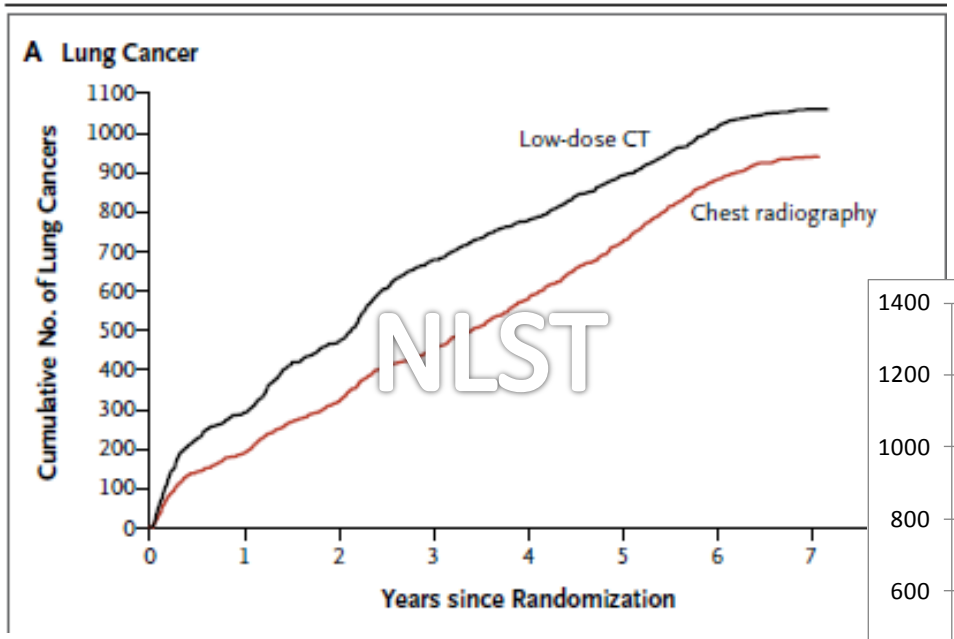


Figure 1. **Cumulative Numbers of Lung Cancers and of Deaths from Lung Cancer.**

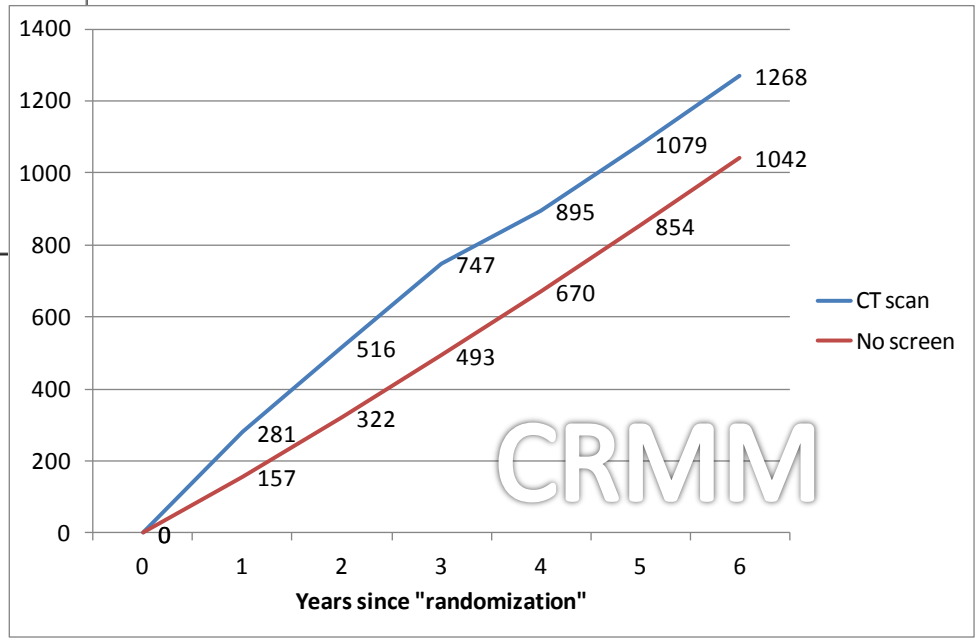
The number of lung cancers (Panel A) includes lung cancers that were diagnosed from the date of randomization through December 31, 2009. The number of deaths from lung cancer (Panel B) includes deaths that occurred from the date of randomization through January 15, 2009.

- Increased number of lung cancers in LDCT scan arm
- Decreased number of lung cancer deaths in Low-dose CT scan arm
- 20% mortality reduction from lung cancer after 6 years

Cumulative Lung Cancer New Cases



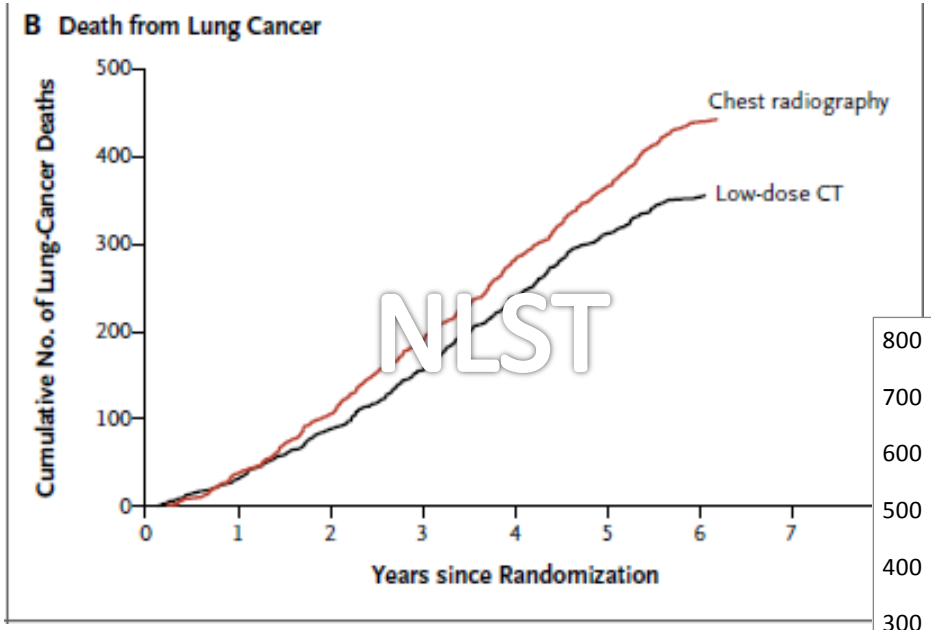
Cumulative lung cancer cases at 6 years			
	CT Scan	Reference	Δ
NLST	1030	860	16%
CRMM*	1268	1042	22%



*Proportional increase in number of new cases in CRMM (22%) estimated to be higher than NLST (16%) to allow for a 6% increase in cases from CXR screening.

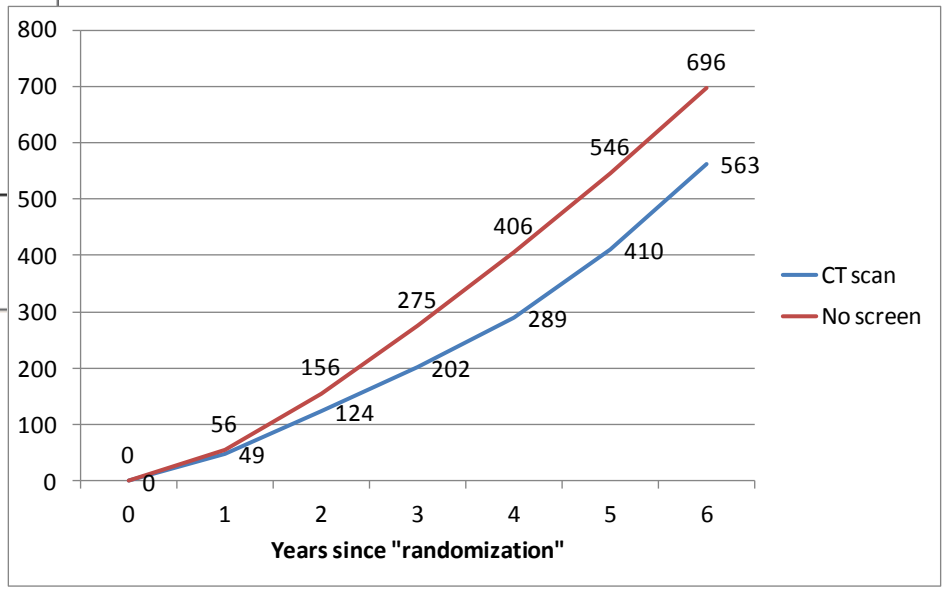
*CRMM counts have been *scaled* to CT Scan arm of NLST for comparability based on number eligible

Cumulative Lung Cancer Deaths



Cumulative lung cancer deaths at 6 years

	CT scan	Reference	Δ
NLST :	350	443	-21%
CRMM*:	563	696	-19%



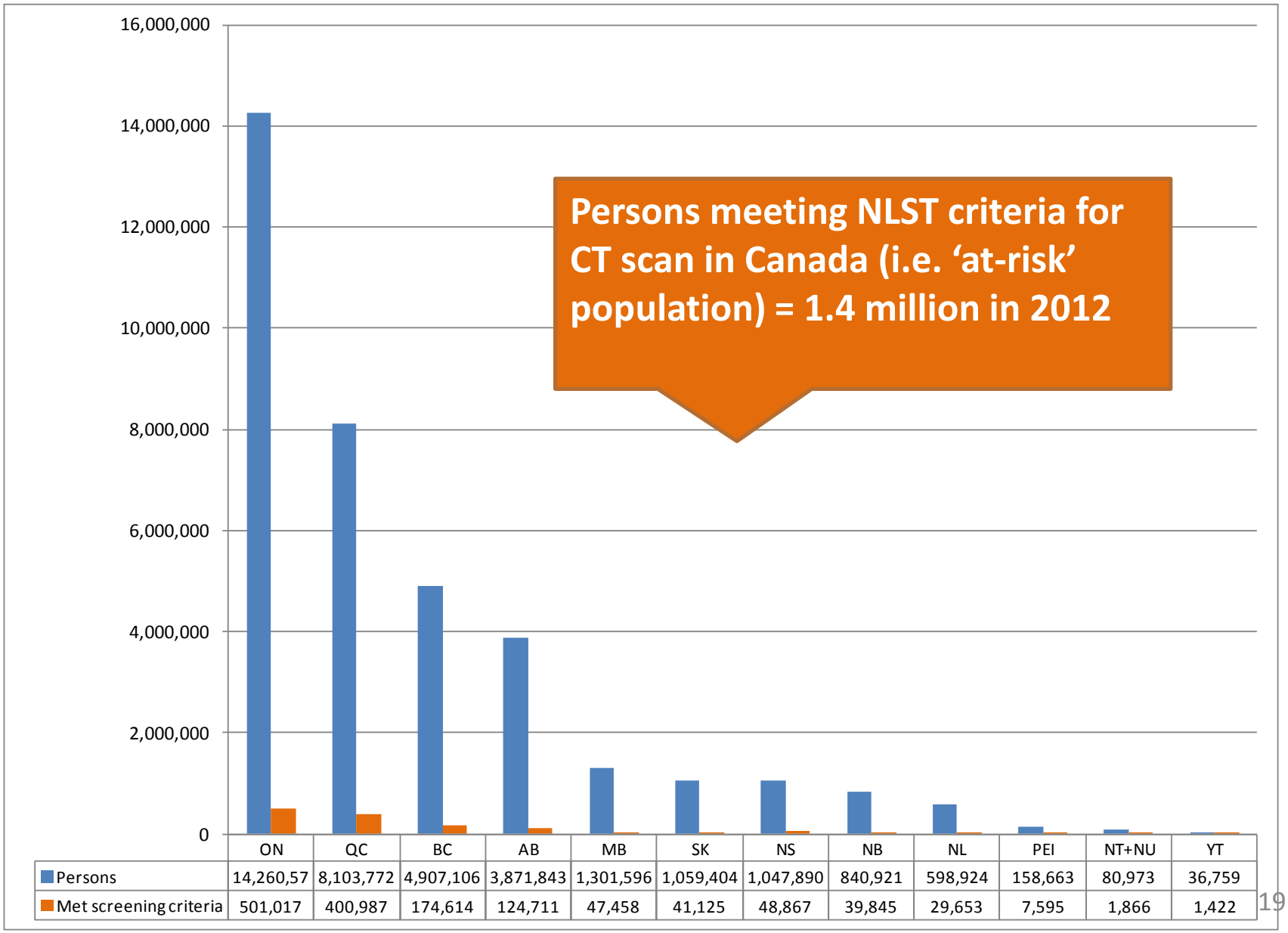
*CRMM counts have been *scaled* to CT Scan arm of NLST for comparability based on number eligible

Lung Cancer Screening Eligibility Criteria

	Minimum pack-years smoked (current smoker or former smoker quit within last 15 years)		
Screening age range	20+	30+	40+
50-74	2,241,886	1,785,698	1,239,583
55-74	1,665,526	1,392,751	1,022,178
60-74	1,084,193	946,548	739,599
50-70	2,014,728	1,576,373	1,053,423
55-70	1,438,368	1,183,426	836,018
60-70	857,035	737,223	553,439

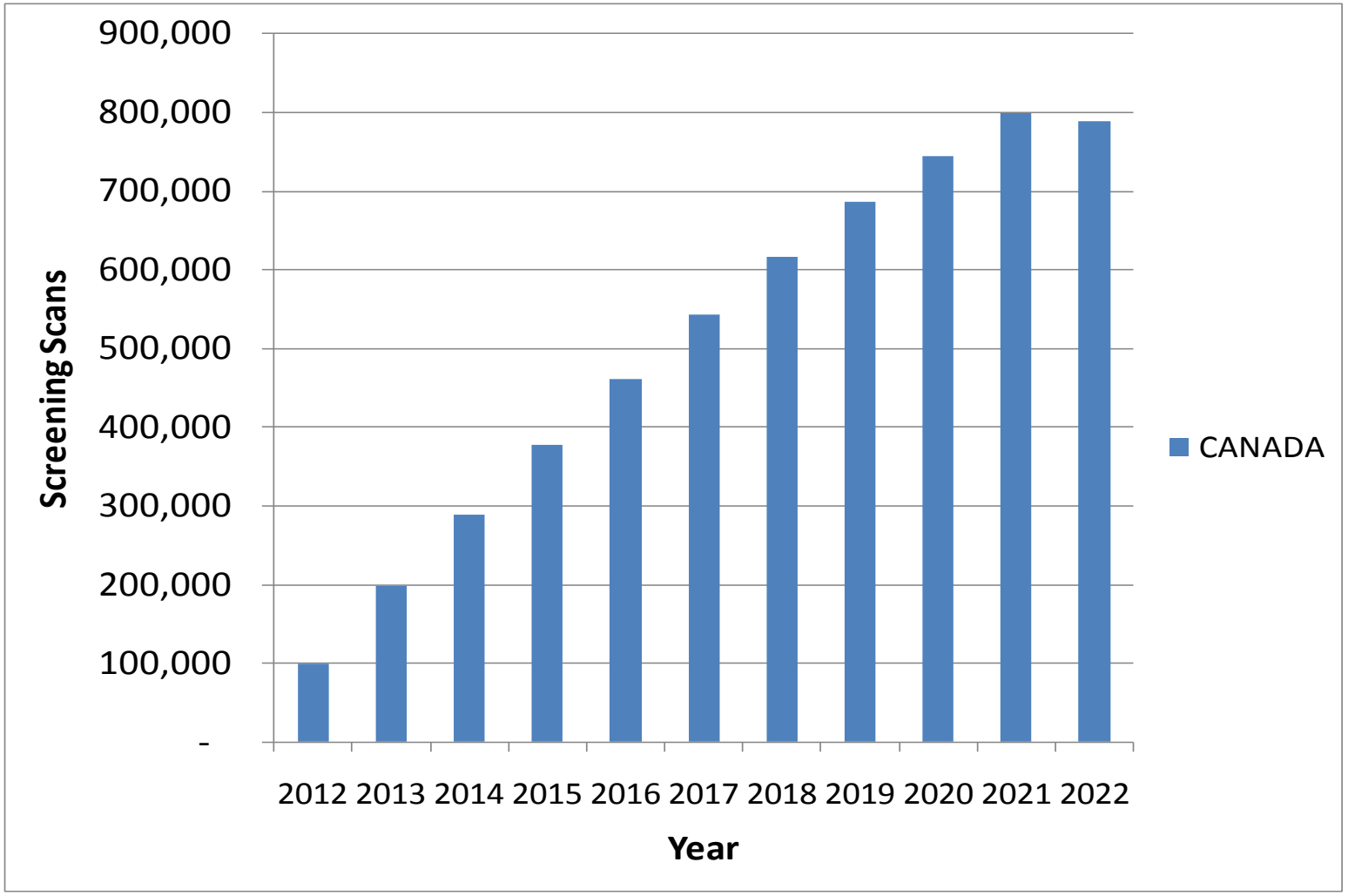
Source: CRMM version 1.3

Population Eligible for Screening



	ON	QC	BC	AB	MB	SK	NS	NB	NL	PEI	NT+NU	YT
Persons	14,260,57	8,103,772	4,907,106	3,871,843	1,301,596	1,059,404	1,047,890	840,921	598,924	158,663	80,973	36,759
Met screening criteria	501,017	400,987	174,614	124,711	47,458	41,125	48,867	39,845	29,653	7,595	1,866	1,422

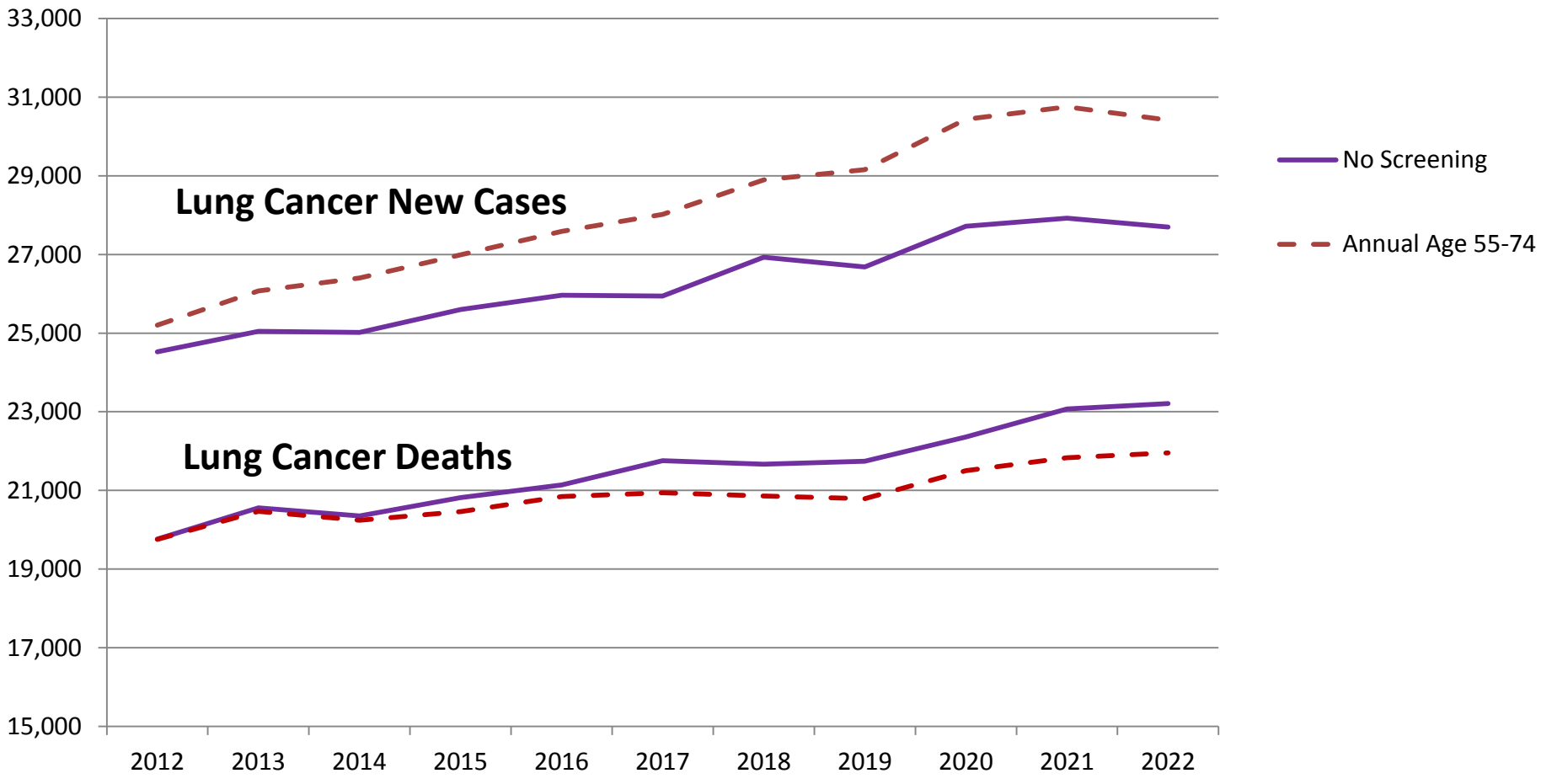
Number of LDCT Scans Performed



Cohort Aged 55-74, 2012-2032, 70% participation in 10 years

Source: CRMM version 1.3

Lung Cancer New Cases and Deaths



Source: CRMM version 1.3

Impact of Age of Screening on Lung Cancer Outcome over 10 years

	# of scans to detect one lung cancer	Increase in new cases	Decrease in deaths
Annual Age 50-74	110	22,869	7,335
Annual Age 55-74	96	20,893	6,776
Annual Age 60-74	80	16,846	5,666
Annual Age 70-74	54	3,832	1,372
1% Risk of Lung Cancer over 3 years	87	19,846	6,461

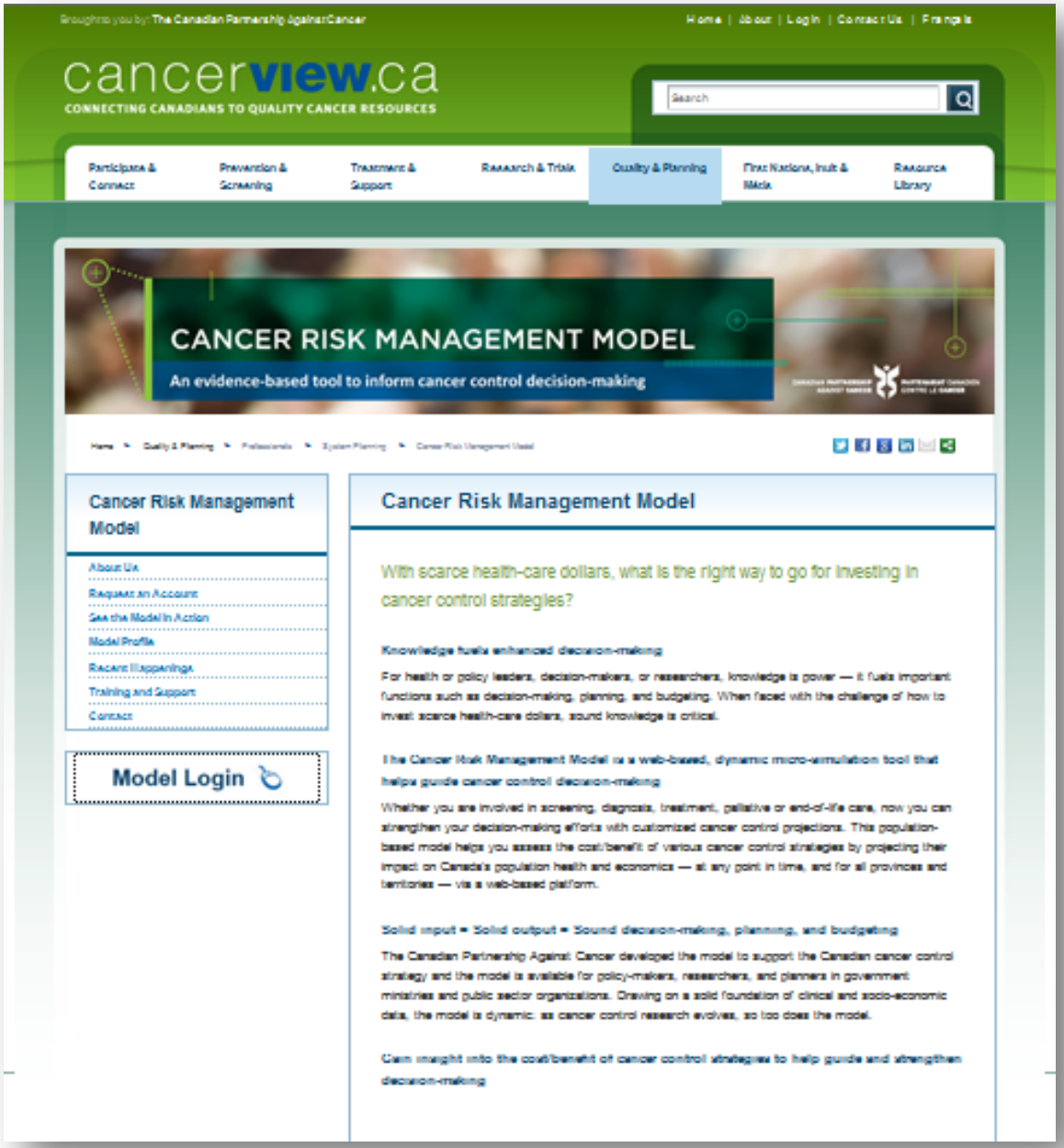
Source: CRMM version 1.3

Preliminary ICER estimates

(no screening is reference scenario)

Scenario		ICER
2.1 NLST (3 annual)	$	43,573
2.2 Annual	$	77,522
3.1 Age 50-74	$	115,208
3.2 Age 60-74	$	53,652
3.3 Age 70-74	$	38,522
4.3 35 pack-years	$	66,791
4.4 25 pack-years	$	91,143
5.0 Screen Cost Option2	$	43,654
5.1 LDCT scan cost $85	$	69,476
5.2 LDCT scan cost $300	$	89,963
6.1 Smoking cessation 15%	$	42,051
6.2 Smoking cessation 30%	$	28,335
8.1 Biennial after 3 annual	$	41,105
9.1 Three-year prob 1%	$	65,839
9.2 Three-year prob 2%	$	38,619

Source: CRMM version 1.3



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Contributors to the Lung Cancer Screening Module

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