



Radiological Society of Connecticut, Inc.
A CHAPTER OF THE AMERICAN COLLEGE OF RADIOLOGY

Testimony of the Radiological Society of Connecticut (RSC)

Senate Bill 862

Insurance and Real Estate Committee

February 19, 2013

Sen. Crisco, Rep. Megna and members of the committee:

The Radiological Society of Connecticut is the state chapter of the American College of Radiology, and includes membership of over 400 radiologists, radiation oncologists, and medical physicists. We strongly support S.B. 862, and we have two suggestions for modification of the provisions of the legislation. First, the language should specify that coverage would be as a preventive service, and thus not subject to co-pay or co-insurance, as are the cases with other screening tests for cancer. Second, the coverage should be consistent with the guidelines established by the American Cancer Society or the National Comprehensive Cancer Network (NCCN).

Lung cancer is the number one killer of American and Connecticut residents, killing more than the next 3 cancers combined. This is partially due to the fact that until now, there has been no effective screening test available.

Many individuals have been proponents of screening since 2001, when a consortium of academic centers called the Early Lung Cancer Action Project released data on the effectiveness of CT scanning as a screening test. At that time, a number of entities wanted to submit a bill to use tobacco settlement money for subsidy of screening for people at risk, but many responsible scientific organizations, including the RSC, wanted even more definitive data on efficacy before advocating widespread use. Just like the RSC withheld support of breast cancer screening with ultrasound, we waited for more definitive data that underwent the most rigorous scientific design and scrutiny before introducing the bill you have before you today. Now, those research studies have been done and, in fact, were terminated early because of the overwhelming evidence. In 2010, results from the landmark National Lung Screening Trial (NLST), sponsored by the National Institutes of Health, were released. The 53,000-person trial found a 20% reduction in deaths from lung cancer among current and former heavy smokers screened with low-dose helical CT. NCCN and the American Cancer Society, both highly respected scientific organizations, have now published guidelines recommending screening of high risk individuals with low-dose CT scanning. It is now time to act.

The RSC is aware of the need for fiscal responsibility and justifiable concerns about cost effectiveness, and that is what we will focus on here. Indeed, the NCCN and American Cancer Society took these into consideration in their recommendations, and these were reinforced by report from the large actuarial firm, Milliman, in 2012 and attached to this testimony. According to the Milliman analysis:

1. Had this screening program been in effect for the past 10 years, 135,000 lives would have been saved.
2. Lung cancer screening with CT costs less than other screening tests. The cost per life year saved is estimated at \$18,000, as compared with \$25,000-50,000 for other mandated screening tests.
3. The cost to commercial payers of providing the benefit will be less than \$1 per member, a small fraction of the cost of treatment of advanced lung cancer.

An analysis in the American Journal of Managed Care projected marked increases of costs of cancer care incurred by the states through the year 2020. "The number of people treated for cancer and the costs of their cancer-related medical care are projected to increase substantially for each state (average increase = 72%). Effective prevention and early detection strategies are needed to limit the growing burden of cancer."

Prevention is the key and smoking cessation is imperative.
 Study showing CT scan was better than other cessation interventions (Ostroff, 2001, <http://www.sciencedirect.com/science/article/pii/S0091743501909351>)

Connecticut takes in about \$535 million a year in state tobacco tax revenues, its share of the Tobacco Master Settlement Agreement, and tobacco cessation funding from the CDC. But the state is spending less than 1% on cessation programs. It was 50th among all states in expenditures for tobacco prevention in 2012 and 23rd in 2013, spending only 13.7% of the amount recommended by the CDC.

http://www.tobaccofreekids.org/what_we_do/state_local/tobacco_settlement/connecticut

Important data on smoking in Connecticut and its cost:

High school students who smoke - 15.9% (32,100)

Kids (under 18) who become new daily smokers each year - 4,300

Kids now under 18 and alive in Connecticut who will ultimately die prematurely from smoking - 7,600.

Adults in Connecticut who smoke - 17.1% (474,900)

Adults who die each year from their own smoking - 4,700

Annual health care costs in Connecticut directly caused by smoking - \$1.63 billion

In summary, screening high risk citizens of Connecticut for lung cancer with CT scanning:

- Is scientifically validated.
- Is recommended by guidelines of the two major, independent cancer organizations.
- Is more cost-effective than other mandated screening tests.
- Will actually save the state and other payers considerable money.
- Has been shown to be an effective tool for smoking cessation among the people receiving the test.
- Most importantly, the procedure has been shown by independent actuarial analysis that it would save approximately 13,500 lives per year.

It is time for Connecticut to become strong advocates for our citizens' health through prevention and early detection of lung cancer. We urge you to support the mandate coverage as a preventive service, according to the guidelines of the American Cancer Society or NCCN. Thank you.

Pyenson BS, Sander MS, Jiang Y, Kahn H, Mulshine JL. An actuarial analysis shows that offering lung cancer screening as an insurance benefit would save lives at relatively low cost. *Health Aff (Millwood)*. 2012;31(4).

APPENDIX

Section 1: Methods

METHODS FOR PRICING THE SCREENING RIDER

Table 1
Development of 30+ Pack-Year Smokers Aged 50-64 Years

Smoking prevalence by age in males and females	
Age range (yr.)	Smokers (%)
18-44	23.8%
45-64	21.8%
65+	9.7%

SOURCE: Centers for Disease Control and Prevention. Current smoking, early release of selected estimates based on data from the January-March 2008 National Health Interview Survey; data table for Figure 8.3. 2008; Atlanta, GA.

NOTES: We assumed that 30 percent of the US population aged 50 to 64 years (about 18 million of the resident US population) would be eligible for screening, which is about 50 percent higher than the currently reported percentage of smokers shown in the table above. We chose a figure for 30+ pack-years that was higher than that of current smokers because the screening program would also apply to those who quit smoking, but are eligible for screening. These ex-smokers were eligible because they had met the 30+ pack-years criteria before quitting. We note that the estimate of people eligible for the National Lung Screening Trial is lower than our assumption (i.e., 7 million 55- to 74-year olds). A smaller eligible population would improve the cost/benefit of screening—similar lives saved for less screening cost. Published figures of pack-year exposure to cigarette smoking by age are not readily available.

The 30 percent assumption was also used in the cost/benefit model, where we showed results for a 20 percent and 40 percent assumption.

Screening Protocol

The rider pricing model determines the extra monthly cost per person across the commercial insured population needed to support the International Early Lung Cancer Action Program screening protocol.¹ In keeping with insurance pricing practices for mandatory riders, the added

costs of screened individuals were spread over the entire population, including those who were not eligible.

The model follows an individual throughout the screening process in the year following screening and applies prices to the services obtained. We call the first time an individual is screened the "baseline screening." We call subsequent annual screenings "repeat screenings." Follow-up can occur during the year after either screening. Decision trees show the probability of an individual reaching any step during the year following an annual screening (different for baseline and repeat screening).^{1,2} Figure 1 shows the steps for a new screening patient during the year after the baseline screening, whereas Figure 2 shows the steps for the repeat screenings, which happen annually.

The costs for people undergoing initial versus repeat screening are slightly different. The two costs are each a weighted average of the services in each decision tree. For pricing the screening rider, we used a 25 percent/75 percent weighting for initial and repeat screening, then spread the weighted average over the entire population and divided by 12 to develop the final per member per month rider value. For the cost/benefit analysis, the vast majority of screenings would be repeat screenings, and we used the repeat screening cost.

Figure 1
Decision Tree for Baseline Screening

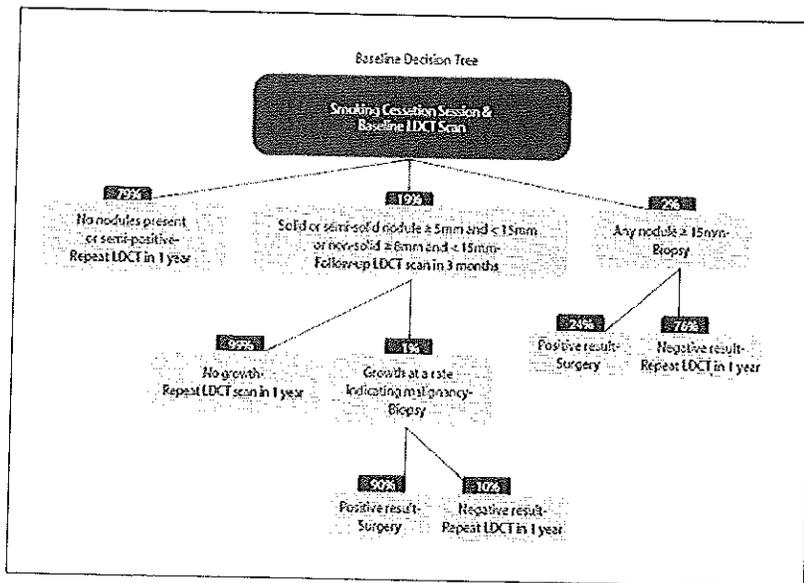
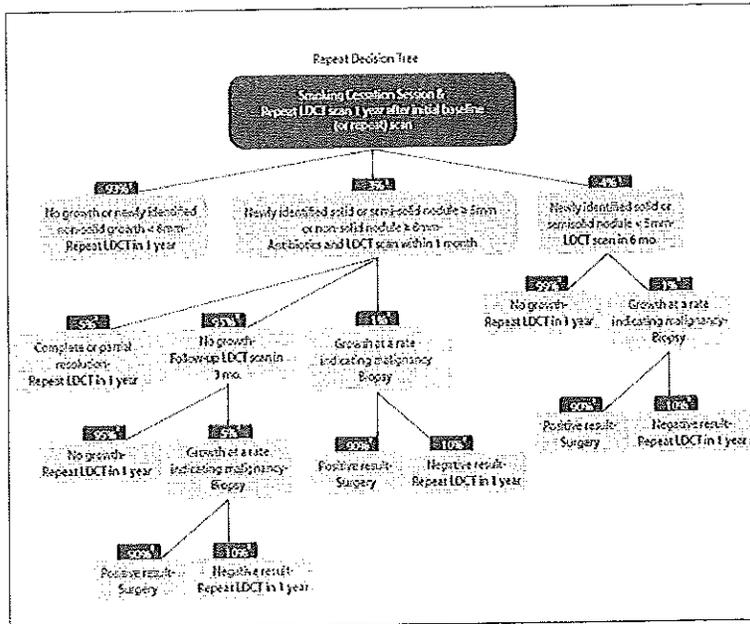


Figure 2
Decision Tree for Repeat Screenings



SOURCE: New York Early Lung Cancer Action Project Investigators. CT Screening for lung cancer: diagnoses resulting from the New York Early Lung Cancer Action Project. *Radiology*. 2007;243:239-49. Discussions with lead investigator, C. Henschke.

For the costs of follow-up biopsies to the screening, we assigned current procedural terminology codes and used a weighted average of four biopsy options, as shown in Table 2.

Table 2
Follow-up Procedures and Probabilities after Screening LDCT

Option 1 (60%)	Code
Fine needle biopsy with imaging guidance	10022
Anesthesia units	00520: 5 base units, 3 time units
Fine needle interpretation	88173
Fine needle evaluation	88172
CT- guidance—radiology	77012
Facility charge	APC: 0004
Low-level visit with primary care physician	99212
Option 2 (5%)	Code
Bronchoscopy biopsy	31628
Facility charge	31628
Low-level visit with primary care physician	99212
Option 3 (20%)	Code
VATS wedge resection	32657
VATS lobectomy	32663
Interpretation	88104, 88106, 88107, 88108
Anesthesia units	00528, 00529, 11 base units, 3 time units
Facility charge	DRG 165
Hospital visits	33231
Low-level visit with primary care physician	99212
Option 4 (15%)	Code
Thoracotomy incision	32095
Thoracotomy excision	32100, 32400, 32402, 32405
Interpretation	88104, 88106, 88107, 88108
Anesthesia units	00528, 00529, 11 base units, 3 time units
Facility charge	APC: 0069
Low-level visit with primary care physician	99212

SOURCES: (1) Henschke CI. International Early Lung Cancer Action Program: enrollment and screening protocol [Internet]. New York (NY): I-ELCAP; [cited 6 Dec 2011]. Available from: www.ielcap.org/professionals/docs/ielcap.pdf. (2) Discussions with C. Henschke. (3) Authors' assignment of codes.

NOTES: The modeled cost of antibiotics, \$25 per prescription, is higher than the cost for an all-generics regimen, which is likely. All codes are current procedural terminology codes, unless otherwise indicated. LDCT is for low-density spiral computed tomography; VATS is video-assisted thoracoscopic surgery.

Costs for Rider Services

Costs for rider pricing were based on national average Medicare reimbursements. We used the 2011 Medicare resource-based relative value scale schedule for smoking cessation counseling and for procedures in the International Early Lung Cancer Action Program protocols.³

For a 30-minute smoking cessation session, we used current procedural terminology code 99407, which has a Medicare fee of \$26.50.

For LDCT lung cancer screening, we estimated a Medicare resource-based relative value scale price, because no current procedural terminology code has been assigned to this screening. The code currently used for a computed tomography scan of the thorax is 71250, which is a diagnostic (not screening) code. We believe that large-scale lung cancer screening using LDCT would prompt the promulgation of a new current procedural terminology code, and the price would reflect the lower provider cost for screening than diagnosis, which was the case for mammography. We developed LDCT screening cost as the cost of the computed tomography scan with no contrast, reduced by the ratio of the cost of a screening bilateral mammography to a diagnostic bilateral mammography, as shown in Table 3.

Table 3

Development of a Resource-based Relative Value Scale Price for a Screening CT of the Thorax

Procedure	CPT code	2011 RBRVS national average (global)
Diagnostic Mammography, bilateral	77056	\$110.76
Screening mammography, bilateral	77057	\$81.20
Diagnostic CT of thorax, without contrast	71250	\$244.97
Estimated screening CT of thorax, without contrast ($81.20/110.76 \times 244.97=179.59$)	n/a	\$179.59

SOURCES: Except as noted, prices were based on the 2011 Medicare resource-based relative value scale. Source of the latter: Centers for Medicare and Medicaid Services. License for use of current procedural terminology, fourth edition (“CPT”) [Internet]. Washington, DC: CMS; [cited 2011 Dec 11]. Available from: <http://www.cms.gov/apps/physician-fee-schedule/search/search-criteria.aspx>.

While not a direct cost of screening in our model, we note that the installation of a new (as opposed to refurbished) spiral computed tomography scanner costs in the range of \$1 million to \$3 million.⁴

METHODOLOGY FOR COST/BENEFIT OF SCREENING

Summary

Our population consisted of the patient cohort that was newly diagnosed in 2012 and those diagnosed in prior years who have survived to 2012, assuming screening had started 15 years earlier. We then took a snapshot view in 2012 of people aged 50 to 64 years in 2012. For simplicity, we started with the projected population at each age in 2012 using US Census Bureau projections. The target population for screening was the 30 percent of 50 to 64 year-olds who were assumed to have 30+ pack-years of smoking history, and this population generated the direct cost of screening (not including treatment). To the target population, we applied lung cancer incidence and the distribution of patients in three lung cancer stages, with and without screening. The per patient cost of care by stage for each year since diagnosis was applied to those with lung cancer.

- We used US Census Bureau projections for the population size in 2012 by age and sex.⁵
- Baseline mortality data were obtained from the US Social Security Administration life table.⁶
- For each age and sex, we applied lung cancer incidence rates from the Surveillance, Epidemiology and End Results 2003-2007 report (interpolated geometrically between the five-year age ranges).
- We applied a published mortality loading factor for each stage of lung cancer⁷ to the mortality rates shown in the life table. The mortality loading factors represent the ratio of the actual number of deaths for lung cancer patients to the expected number of deaths for the standard population by age and sex.
- To calculate the number of deaths by stage, age, and sex for people, we applied the mortality rates to the population in each year. This process also provided the number of survivors from prior years still alive in 2012 for each stage by age and sex.
- Using the same mortality table with mortality loading, we calculated the life expectancy in 2012 of lung cancer patients (in actuarial notation e_x).
- We assumed that 90 percent of lung cancers were generated by people eligible for screening, which is slightly higher than the 87 percent of cancer deaths associated with smoking.⁸
- The number of lung cancers generated by the eligible population remained constant through the sensitivity tests, in which the screened population was 30 percent of the 50- to 64-year-old population in the baseline scenario, or 20 percent and 40 percent of the 50- to 64-year-old population in two alternative scenarios.
- We assumed that screening led to a diagnosis two years earlier than would otherwise have been the case. For example, the lung cancer incidence rate for a 55-year-old patient in the screened population was assumed to be that of a 57-year-old patient in the unscreened population.

- In the baseline screening scenario, we applied screening stages from the International Early Lung Cancer Action Program. Table 4 compares these stages to data derived from Surveillance, Epidemiology and End Results categorizations. The International Early Lung Cancer Action Program stages were modified in several other scenarios.

Table 4
Distribution of Patients by Stage

Stage	Derived from SEER	I-ELCAP
	Status quo scenario	With screening scenario
A	17.4	79.3
B	14.6	16.2
C	68.0	4.5

I-ELCAP is for International Early Lung Cancer Action Program; SEER is for Surveillance, Epidemiology and End Results.

SOURCES: For Derived from SEER: Eisner M. Crosstab of AJCC by SS2000, Age 50-64, in Microsoft Excel. Unpublished data; 2011; National Cancer Institute: Bethesda, MD. For I-ELCAP: New York Early Lung Cancer Action Project Investigators. CT screening for lung cancer: diagnoses resulting from the New York Early Lung Cancer Action Project. *Radiology*. 2007; 243:239-49.

For differences between the status quo and screening models, we shifted the stages of cancers from later stages to earlier stages (stage shift) and also assumed earlier detection at a younger age (lead time). The distribution of stages for screening was shifted according to International Early Lung Cancer Action Program data. We assumed a two-year lead time; in other words, the current cancer incidence for age $x+2$ was applied to age x .

To avoid counting as survivors the people who appear with cancer only because of the 2-year lead time, we set the lead time=0 in the model for the sole purpose of developing survivors--in other words, applying the current cancer incidence for age x to age x in the model, while assuming the stage shift. The lead time=0 assumption produced life-years saved figures; however, for costs, we assumed that lead time=2. Correctly accounting for lead time is important for aggregate cost, because the incidence of lung cancer increases rapidly with age. The increasing incidence means that more people aged 50 to 64 years will be diagnosed with lung cancer because of screening than without screening, and the extra costs incurred by these people should be considered in the cost/benefit calculation.

There are two components to our life-years saved calculation: life-years saved during the modeling period (15 years) and the extra life expectancy that follows the modeling period.

Costs by Cancer Stage

For the purpose of assigning costs to people with lung cancer, we used medical claims data to identify costs in people initially diagnosed with what we believed to be early or localized disease, regionally advanced cancer, or distant metastatic disease (denoted as stage A, B, and C, respectively). Because traditional lung cancer staging is not apparent in claims data, we used a system that defines stage by treatments received.

Stage A: Surgery, no chemotherapy or radiation, and no hospice, palliative care, or death during the study period.

Stage B: May have surgery, but does have chemotherapy or radiation; may or may not have hospice, palliative care, or death during the study period.

Stage C: No surgery, may have chemotherapy or radiation, and has hospice, palliative care, or death during the study period.

Our A, B, and C stages present a distribution of cases similar to the Surveillance, Epidemiology and End Results categorization of localized, regional, and distant, respectively.

The mapping shown in Table 5 illustrates the approximate relationship between traditional clinical stages and our A, B, and C stages.

Table 5

Lung Cancer Stages

Traditional clinical stages	IA, IB	IIA, IIB, IIIA	IIIB, IV
Modeled stages	A	B	C

Development of Lung Cancer Treatment Costs

We calculated the annual per patient cost of care by stage for newly diagnosed cancer patients from Thomson Reuters MarketScan 2006 to 2009. We produced figures for the first and second years since diagnosis. The treatment costs in patients in stages B and C for the first and second years after diagnosis were found to be higher than those in patients in stage A. A higher cost for later than earlier stage lung cancer has also been reported in the literature.⁹

New lung cancer patients in 2007 were identified as follows:

- No cancer diagnosis in 2006
- No hospital inpatient, emergency room, or evaluation and management claims in 2006 and having at least one inpatient visit or one emergency room visit or two evaluation and management claims for lung cancer (international classification of diseases, ninth revision [ICD-9] 162.xx) in 2006. Evaluation and management codes must be within 60 days of one another.

Non-inpatient evaluation and management codes for lung cancer are as follows:

99201-99205, 99211-99215, 99217-99220, 99241-99245, 99304-99337, 99341-99350, 99381-99387, 99391-99397, 99401-99404, 99406-99409, 99411, 99412, 99420, 99429, 99450, 99455, 99456, 99499

Table 6

Surgery Codes Used to Identify Surgery in Lung Cancer Patients, Used for Defining Stages A, B, and C

Description	CPT
Thoracoscopy, surgical (VATS)	32657
Thoracoscopy, surgical (VATS)	32663
Removal of lung	32440
Sleeve pneumonectomy	32442
Removal of lung	32445
Partial removal of lung	32480
Bilobectomy	32482
Segmentectomy	32484
Segmentectomy	32484
Sleeve lobectomy	32486
Partial removal of lung	32500
Resection apical lung tumor	32503
Resection apical lung tum/chest	32504
Description	ICD-9 Procedure Codes
ENDOSCOPIC DESTRUC BRONC LES	32.01
OTHER DESTRUC BRONC LES	32.09
OTHER BRONCHIAL EXCISION	32.1
THORAC EXC LUNG LESION	32.20
OPEN ABLATION LUNG LES/TISS	32.23
PERCUTANEOUS ABLATION LUNG LES/TISS	32.24
THOR ABLATION LUNG LES/TISS	32.25

ABLATION LUNG TISS NEC/NOS	32.26
ENDOSCOPIC DESTRUC LUNG LES	32.28
DESTROY LOC LUNG LES NEC	32.29
THORAC SEG LUNG RESECTION	32.30
OTH SEG LUNG RESECTION NOS	32.39
LOBECTOMY OF LUNG	32.4
THORAC LOBECTOMY LUNG	32.41
LOBECTOMY OF LUNG NEC	32.49
COMPLETE PNEUMONECTOMY	32.5
THORACOSCOPIC PNEUMONECTOMY	32.50
OTHER PNEUMONECTOMY NOS	32.59
RADICAL DISSECTION THORAC STRUCT	32.6
OTHER EXCISION OF LUNG	32.9

CPT is for current procedural terminology; ICD-9 is for International Classification of Diseases, Ninth Revision.

Claims to Identify Stages

The index date was defined as the earliest date of the second evaluation and management claim, or the first emergency room or inpatient claim for lung cancer.

- Claims were incurred by the end of 2009 (for hospice/death) or within three months of the index date.
- Stages were defined as follows:
 - A = lung cancer patients in 2007 having at least one surgery and not having chemotherapy, radiation therapy, a hospice claim, or death.
 - B = lung cancer patients in 2007 having at least one surgery and chemotherapy or radiation therapy.
 - C = lung cancer patients in 2007 with no surgery claim and having a hospice claim and/or death.

Death, Used to Define Stages A, B, and C

Death, used for stage identification, was identified as an inpatient claim with the discharge status of "died" or was surmised by the end of a patient's enrollment. Because a patient's enrollment can end for reasons other than death, we did not consider the following circumstances to be an indication of death:

- Year-end plan-related changes
 - The last date of enrollment is December 31st, which is a common plan change date
 - The plan to which the patient belonged did not continue into the next year
- Imminent Medicare eligibility
 - Patients aged 64 years when last treated, as such patients would likely obtain Medicare coverage upon attaining age 65 years

Using the above criteria, we generated annual claim costs by stage, with the sample sizes shown in Table 7.

Table 7

Sample Sizes for Development of Annual Claim Costs by Stage

Stage	Number of people
A	124
B	85
C	542

SOURCE: Authors' analysis of Thomson Reuters MarketScan commercial data 2006–2009.

In the fifth and subsequent year, the cost of care per patient for stage A was based on the Milliman Medical Index,¹⁰ projected to 2012 using the Consumer Price Index medical component. We increased the Milliman Medical Index figure by 50 percent to account for the extra cost associated with smokers. The maximum allowed underwriting load under the Patient Protection and Affordable Care Act for smokers is 50 percent.¹¹ The high health risk associated with smoking may justify the 50 percent load. For example, chronic obstructive pulmonary disease and lung cancer are often comorbidities, and survivors of lung cancer may be more likely to suffer from chronic obstructive pulmonary disease. Patients with claims for chronic

obstructive pulmonary disease incur costs approximately six times those of average members with the same demographics.¹²

Stage B and C costs for year 5 were calculated as follows:

$$Cost_{Year\ 5}^{Stage\ B} = Cost_{Year\ 2}^{Stage\ B} \times Cost_{Year\ 5}^{Stage\ A} \div Cost_{Year\ 2}^{Stage\ A}$$

$$Cost_{Year\ 5}^{Stage\ C} = Cost_{Year\ 2}^{Stage\ C} \times Cost_{Year\ 5}^{Stage\ A} \div Cost_{Year\ 2}^{Stage\ A}$$

The costs for stages B and C after year 2 were not a significant factor in the model, as the very high mortality rate in such patients means that few survivors contribute to the population cost. Table 8 summarizes the costs by stage and treatment year. Costs for years 3 and 4 were estimated as the linear interpolation of costs between year 2 and year 5, separately for each stage.

Table 8

Costs of Treatment Used in Model

Treatment year	Stage A	Stage B	Stage C
Year 1	\$82,087	\$132,464	\$142,750
Year 2	\$20,159	\$42,945	\$85,956
Year 5 and later	\$11,364	\$24,209	\$48,456

Formulas for Projecting Population and Cost

Notations:

G = Male or Female

S = With or without screening

W = Lung cancer stages A, B or C

x = Age of the patient cohort

k = Duration since diagnosis

N_x^G = Size of US population with age x and gender G in 2012

$r_{x,W}^{G,S}$

= Incidence rate of people age x and gender G being diagnosed at stage W given screening S

${}_kP_{x,W}^{GS}$ =

Probability that a lung cancer patient age x with gender G diagnosed at stage W with screening S is still alive after k years

$TC_{k,W}$

= Treatment cost for a stage W lung cancer patient in the k th year of treatment

Formulas:

The model calculates in each year the number of newly diagnosed lung cancer patients in each stage by multiplying the number of people at each age and sex by the probability of being diagnosed with stage A, B, or C lung cancer.

Number of newly diagnosed lung cancer patients given screening S

$$= \sum_G \sum_W \sum_{x=50}^{64} [N_x^G \times r_{x,W}^{G,S}]$$

We calculate the number of people living with lung cancer from age 50 to 64 by multiplying the number of newly diagnosed patients at each stage and age by the probability of the patient

surviving each year up to age 65 years. This gives us, for example, surviving 65-year-olds who were diagnosed 1, 2,...15 years ago.

Number of lung cancer patients diagnosed at age x given screening S and still alive

$$= \sum_G \sum_W \sum_{x=50}^{64} \sum_{k=0}^{64-x} [N_x^G \times r_{x,W}^{G,S} \times {}_{64-x-k} P_{x,W}^{G,S}]$$

To calculate the cumulative cost of treatment, we multiplied the number of patients alive at each duration since diagnosis by the cost of treatment in the years since diagnosis.

Treatment cost for lung cancer patients diagnosed at age x given screening S and still alive

$$= \sum_G \sum_W \sum_{x=50}^{64} \sum_{k=0}^{64-x} [N_x^G \times r_{x,W}^{G,S} \times {}_{64-x-k} P_{x,W}^{G,S} \times TC_{64-x-k,W}]$$

Key Data Sources and Their Application

Thomson Reuters MarketScan claims data. This dataset contains all paid claims generated by approximately 28 million commercially insured lives. The Thomson Reuters MarketScan database represents the inpatient and outpatient healthcare service use of individuals nationwide who are covered by the benefit plans of large employers, health plans, government, and public organizations. The Thomson Reuters MarketScan database links paid claims and encounter data to detailed patient information across sites and types of providers, and over time. The annual medical database includes private sector health data from approximately 100 payers. In our study, we used Thomson Reuters MarketScan 2006-2009 and chose only patients associated with active (non-disabled) employees who were covered by comprehensive health benefits, including prescription drug benefits.

End Notes for Section 1

1. New York Early Lung Cancer Action Project Investigators. CT screening for lung cancer: diagnoses resulting from the New York Early Lung Cancer Action Project. *Radiology*. 2007;243:239-49.
2. Personal communication with C. Henschke to adapt the data to the 50- to 64-year-old screened population.
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[document-details/49-computed-tomography-ct-systems-market-worldwide-table-of-content.html](#)

5. US Census Bureau, Population Division. Table 1. Projected Population by Single Year of Age, Sex, Race, and Hispanic Origin for the United States: July 1, 2000 to July 1, 2050 [Internet]. Washington, DC and Suitland (MD): Census Bureau; [cited 2011 Dec 11]. Available from: http://www.census.gov/population/www/projections/files/nation/download/NP2008_D1.xls
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12. Fitch K, Iwasaki K, Pyenson B, Plauschinat C, Zhang J. Variation in adherence with Global Initiative for Chronic Obstructive Lung Disease (GOLD) drug therapy guidelines: a retrospective actuarial claims data analysis. *Curr Med Res Opin.* 2011;27(7):1425-9.

Section 2: Results

SUPPLEMENTAL RESULTS OF COST OF SCREENING

Per Member Per Month Lung Cancer Screening Costs and Comparisons with Other Cancer Screenings

Scenario description	Lung cancer screening rider PMPM in 2012 dollars (no cost sharing)
Baseline assumptions	\$0.76
25% increase in prices	\$0.95
25% increase in take-up rate	\$0.95
200% increase in follow-up after screening	\$0.96
Other cancer screenings	PMPM in 2006 dollars (after cost sharing)
Breast	\$2.50
Cervical	\$1.10
Colorectal	\$0.95

PMPM is for per member per month.

SOURCES: For scenario descriptions: authors' results. For other cancer screenings: Pyenson BS, Zenner P. Cancer screening: payer cost benefit thru employee benefits programs. New York (NY): Milliman; 2005 [cited 2011 Dec 12]. Available from: http://c-change.together.org/Websites/cchange/Images/Publications%20and%20Reports/Milliman_Report.pdf

NOTES: Both the lung cancer screening figures and the 2006 figures for breast, cervical, and colorectal cancer screening include all work-ups to the point of diagnosis. PMPM is per member per month.

SUPPLEMENTAL RESULTS OF COST/BENEFIT MODELING

Lung cancer patients survive to older ages with screening. The average life expectancy of lung cancer patients more than doubles with screening.¹

Table 1
Cost Per Life-Year Saved and Increased Life Expectancy from Screening in Lung Cancer Patients Aged 50-64 Years (Baseline Screening Scenario)

Cumulative life-years saved	2,297,504
Lead time adjustment	598,062
True life years saved	1,699,442
Cost per additional life-year	\$ 18,862
Life expectancy of lung cancer patients without screening	5.71 years
Life expectancy of lung cancer patients with screening	9.50 years

SOURCE: Authors' results from stage-shift model.

NOTES: Cumulative life-years saved for each age was calculated from the year a patient joined the program.

Early diagnosis through screening will significantly shift the stages of diagnosis to an earlier stage.

Table 2

Shift in Stage at Diagnosis Resulting from Screening with Lead Time Adjustment (Baseline Screening Scenario) in Patients Diagnosed in 2012

	Stage A	Stage B	Stage C	Total
Without Screening				
Number of Patients	9,505	7,998	37,130	54,633
Percent of Total	17%	15%	68%	100%
With Screening				
Number of Patients	43,324	8,851	2,458	54,633
Percent of Total	79%	16%	5%	100%

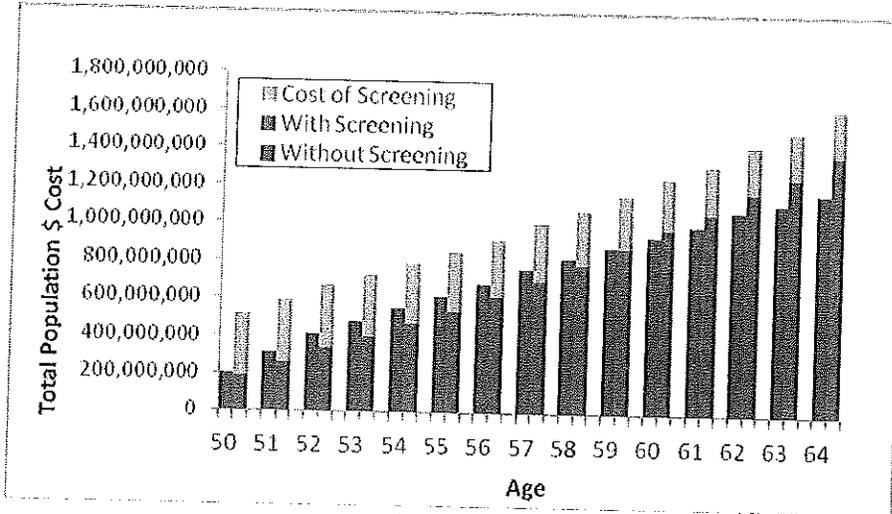
SOURCE: Authors' results from stage-shift model.

The percentages by stage for the “with screening” scenario are consistent with results reported by the International Early Lung Cancer Action Project, which reflects our use of their stage distribution.

In the status quo scenario (without screening), the cost of care across all lung cancer survivor cohorts in the eligible population was estimated at \$11.01 billion in 2012 for 50- to 64-year-olds. The corresponding cost of care figure with screening is \$11.04 billion, while the cost of screening is estimated at \$4.32 billion. Thus, the program would cost an additional \$4.35 billion in 2012. We assumed that screening would be performed annually in all eligible people. Figure 1 illustrates these figures by age in all cancer patients with and without screenings.

Figure 1

Total Costs in Cancer Patients with and without Screenings



SOURCE: Authors' results from applying costs to stage-shift model.

End Notes for Section 2

1. Authors' results compared with data in the following source: Noone AM, Howlader N, Krapcho M, Neyman N, Aminou R, Waldron W, et al. (eds). SEER Cancer Statistics Review, 1975-2008 [Internet]. Bethesda (MD): National Cancer Institute; [cited 2012 Jan 1]. Available from: http://seer.cancer.gov/csr/1975_2008/

Section 3: Discussion

DIFFERENCES BETWEEN AUTHORS' ASSUMPTIONS AND THE NATIONAL LUNG SCREENING TRIAL RESULTS

Our analysis was completed before results of the National Lung Screening Trial were published. We believe that the results of the trial are not appropriate for modeling a screening program in this decade for the following reasons:

The National Lung Screening Trial, which began accrual in 2002, used old technology, consisting of 4 slice (or 4 sensor) scanners, which means lower quality scans and potentially fewer early-stage cancers detected and more false-positive results.

By trial design, the National Lung Screening Trial was stopped when the difference in mortality between the two arms exceeded 20 percent, which means results were influenced heavily by the higher portion of late cancers detected in the first scan.

The National Lung Screening Trial, by design, had only 3 annual scans, while lung cancer has a known continuous risk profile, which again means that the stages of cancer detected were influenced heavily by the higher portion of late-stage cancers detected in the first scan.

Follow-up of suspicious nodules found by screening was left to community standards rather than optimized, which led to more invasive and less effective (efficient) follow-up.

The authors chose assumptions that are more optimistic than those of the National Lung Screening Trial in the portion of early-stage lung cancers detected, which reflect the use of current, improved imaging and screening work-up approaches that have emerged since the trial was started, rather than assumptions based on a trial design and technology that is more than ten years-old.

LUNG CANCER SCREENING FROM VALIDATION TO IMPLEMENTATION

The development and evaluation of tools to improve the early detection of lung cancer have been a critical research area for many decades.¹ In this context, a pilot study was published in 1999 that showed that screening a cohort at high-risk of developing lung cancer with LDCT detected a significant percentage of stage I lung cancers.² Although some in the clinical

research community were skeptical, these results suggested the possibility of improving clinical outcomes from lung cancer. As a result, the National Lung Screening Trial was launched in 2002. The design and implementation of this trial was influenced by the widespread use of prostate-specific antigen to screen for prostate cancer. In particular, researchers were concerned that LDCT to screen for lung cancer would become widely used, which would make it difficult to conduct a proper randomized, controlled lung cancer screening trial.

Typically, a definitive randomized trial is conducted after the experimental arm of the study has been optimized, to ensure a well-defined and uniform experimental arm across study sites. Otherwise, patients in the experimental arm would receive variable, “community standard” care. In the case of lung cancer screening, that would have meant developing best practices to determine which people to screen, how to screen them, how often to screen them, and how to conduct the follow-up. The finding of Henschke and colleagues in 1999 was unexpected, and furthermore, there was no defined best practice at the time regarding how LDCT should be performed. Defining best practices for lung cancer screening would have involved a delay of many years in implementing the National Lung Screening Trial. Accordingly, the decision was made to proceed with the randomized trial without a defined, optimized screening process. The rationale was that if this new approach was as impactful as suggested, a significant mortality benefit would be evident, even with a “community standard” for the screening work-up.³ The results of the trial demonstrated a significant 20 percent mortality reduction benefit, but this was without a validated, optimized process of lung cancer screening work-up.⁴

For our analysis, we assembled the “best” practice for the implementation of lung cancer screening with LDCT from the peer-reviewed literature. LDCT technology has undergone rapid evolution in the years since the inception of the National Lung Screening Trial. In particular, the challenge of minimizing false-positive lung cancer screens has been the focus of many publications. Improved imaging resolution may allow more sensitive detection of early lung cancers, but this enhanced resolution also means that many more “suspicious” lung nodules are identified.⁵ A previous report suggested an approach to this management challenge by restricting invasive diagnostic biopsies to screening subjects who had “suspicious” screen-detected nodules that were also shown to be growing on a repeat LDCT performed after a several month interval.^{6,7} This repeat study was again performed using a “low-dose” protocol.

There have been published concerns regarding exposure to medical radiation. In the National Lung Screening Trial, the amount of radiation was minimized to 1.5 mSv per scan. The policy statement of the American Association of Physicists in Medicine is as follows: “Risks of medical imaging at effective doses below 50 mSv for single procedures or 100 mSv for multiple procedures over short time periods are too low to be detectable and may be nonexistent.”⁸

Since the time of the National Lung Screening Trial, it has been shown that the dose of radiation for a screening LDCT can be lowered even further, approaching the modest radiation dose of a conventional chest x-ray. Therefore, medical radiation in the lung cancer screening setting of mature adults does not seem to be a significant factor that should thwart the implementation of this new service.

This diagnostic work-up approach was recently validated by a report from the experimental arm of a major European lung cancer screening trial.⁹ The use of volumetric assessment of “suspicious” nodule growth is a critical filter to restrict invasive diagnostic work-up to clinically aggressive screen-detected lung cancers, and in this fashion, minimize the impact of “overdiagnosis” in the setting of computed tomography-based lung cancer screening.¹⁰

Another assumption of this actuarial modeling is that “best practice” will be integrated into all aspects of the clinical management of the screening process. An important example discussed in our analysis was the proposed use of a minimally invasive surgical technique to remove the screen-detected lung cancers. Minimally invasive video-assisted surgery for lung cancer is lower cost than open surgery; however, lung cancers detected symptomatically (not through screening) are typically larger and more advanced, and minimally invasive techniques are less likely to be suitable. This is an example where treatment innovations are just beginning to have a broader dissemination, and it underscores a favorable development that has been largely emerging after the design of the National Lung Screening Trial. With higher resolution LDCT more consistently finding earlier lung cancers, this minimally invasive surgical approach is a more favorable surgical option that was not employed in the management of many lung cancers in the trial. This is an area where incorporating current “best practice” will provide an objective basis for expecting more favorable outcomes from the surgical intervention, compared with those reported in the National Lung Screening Trial.

INFORMATION ABOUT VIDEO-ASSISTED THOROSCOPIC SURGERY

Video-assisted thoracoscopic surgery is less invasive and has a quicker recovery time, lower mortality rate, and lower cost than conventional surgery.^{11,12} Our baseline reflects recent historical data, which show that approximately 28 percent and 13 percent of stage A and B patients, respectively, received a video-assisted thoracoscopic surgery procedure. Shifting early-stage treatment to video-assisted thoracoscopic surgery would significantly reduce both cost and treatment morbidity and mortality.¹³

Table 1

VATS is Associated with a Lower Cost of Care per Lung Cancer Patient in Stage A

	Year of diagnosis	First year after diagnosis
All patients	\$82,087	\$20,159
Patients treated with VATS	\$64,619	\$17,819
Patients not treated with VATS	\$88,777	\$21,193

VATS is for video-assisted thoracoscopic surgery.

SOURCE: Authors' analysis of Thomson Reuters MarketScan data 2006-2009.

Considering the cost impact only (not the lower mortality associated with VATS), the cost per life-year saved when all stage A patients receive VATS is shown in Table 2.

Table 2

Use of VATS in Stage A Reduces the Cost per Life-Year Saved

	Current mix of VATS and non-VATS (Baseline Screening Scenario)	All stage A patients treated with VATS
Cost per life-year saved	\$ 18,862	\$ 15,177

VATS is for video-assisted thoracoscopic surgery.

SOURCE: Authors' results from stage-shift model.

CONCLUSIONS

Fortunately, the early detection tool to find the world's most lethal cancer keeps improving. Aside from the physical equipment, software tools to objectively evaluate the rate of growth are improving, specialized needles to facilitate the confirmation of the lung cancer diagnosis are emerging, and surgical interventions carry lower risks of morbidity and mortality. Many leading screening researchers have also redoubled their efforts to ensure that smoking cessation measures are always integrated with the delivery of lung cancer screening services. This approach underscores the commitment of this community to achieve maximal public health benefit with this new screening approach.¹⁴ These are promising developments that merit some consideration as we contemplate the process of national implementation of this new cancer screening service.

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