CT Lung Screening: Moving the Needle Forward

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Disclosures

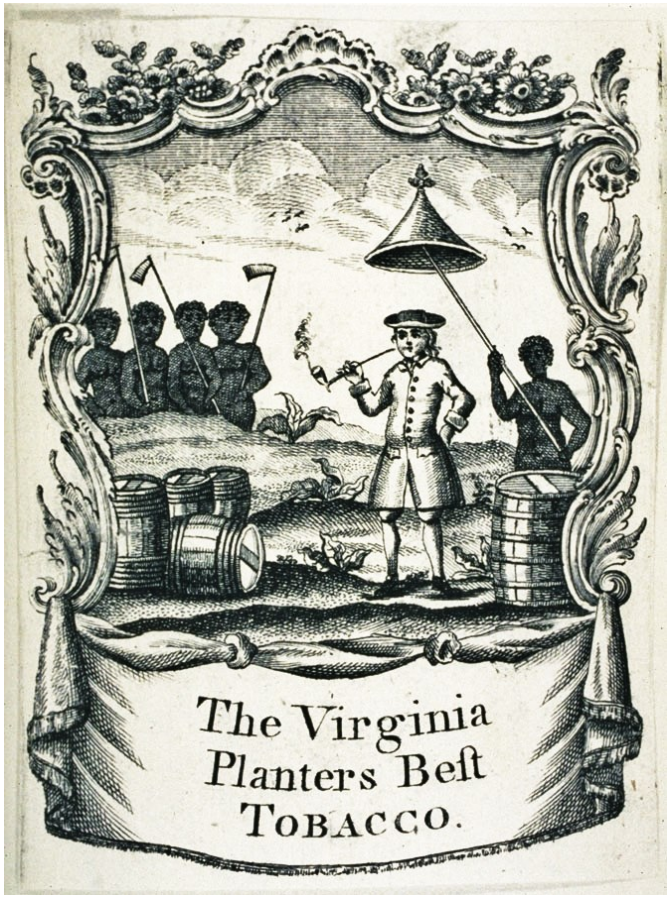
- Covidien speaking honoraria

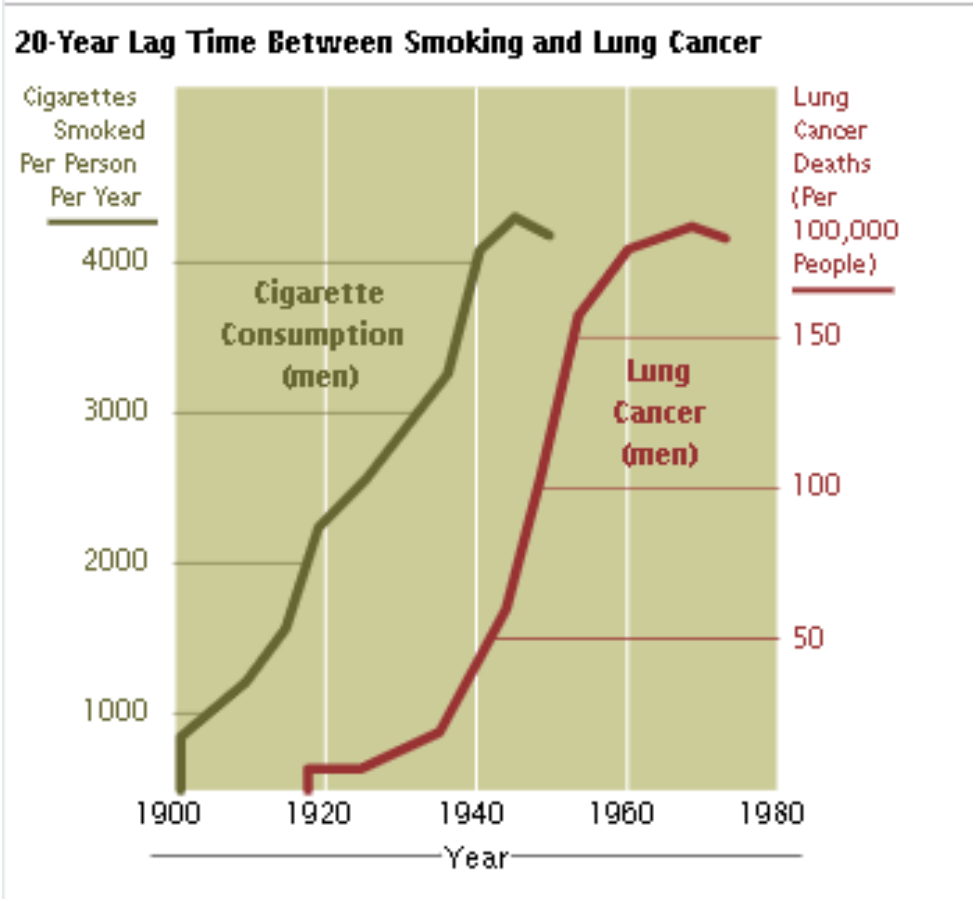
Outline

- Screening the high risk population- organizational change
- Population health
- Screening beyond USPSTF

In the beginning…

1600s Tobacco Ad





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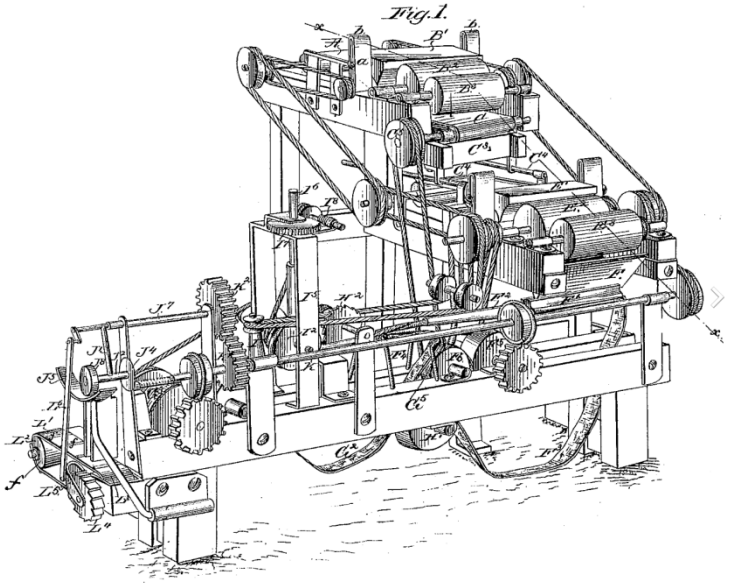
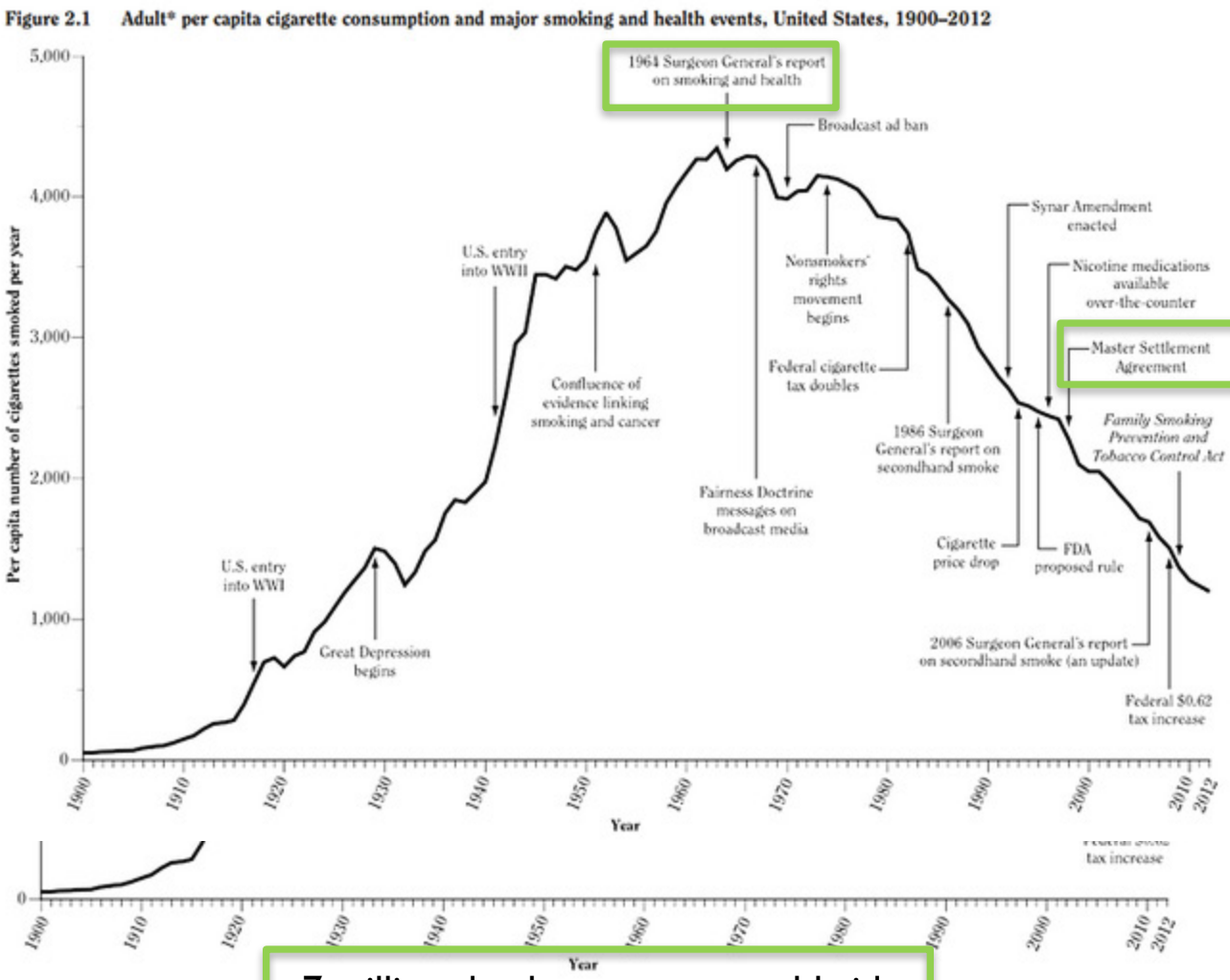
Cigarette Rolling Machine 1880

- James Albert Bonsack (age 21 years)
- Result of a contest (prize $75K) to invent machine to roll cigarettes.
- 120,000 cigs in 10 hours (200/min)
- Revolutionized industry



Rise and Fall of Smoking



$119 out of $205 billion

7 million deaths per year worldwide
179 billion in US healthcare costs
150 billion in lost US productivity

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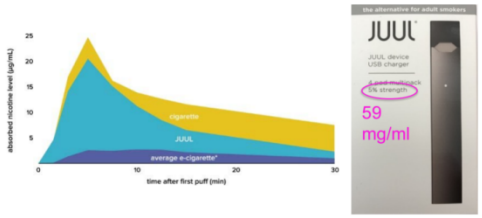
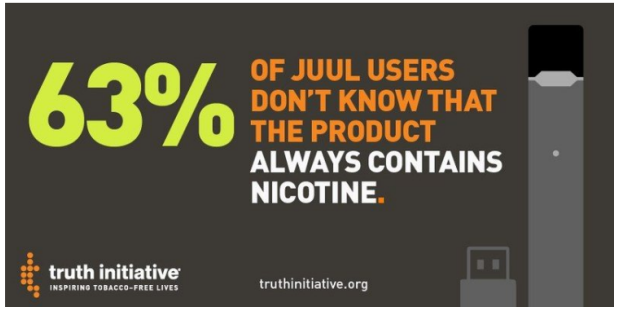
The future is… JUUL

Adam Bowen James Monsees

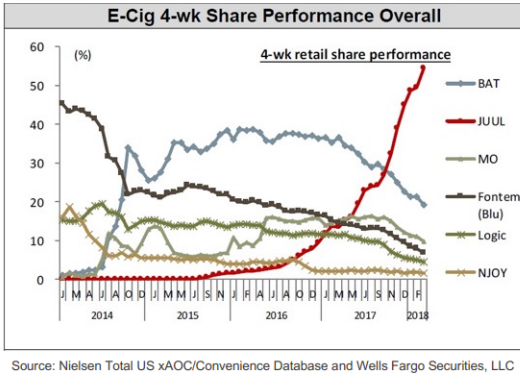
JUUL – Nicotine Delivery



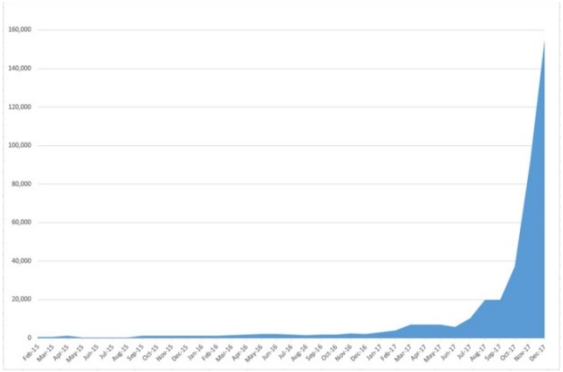


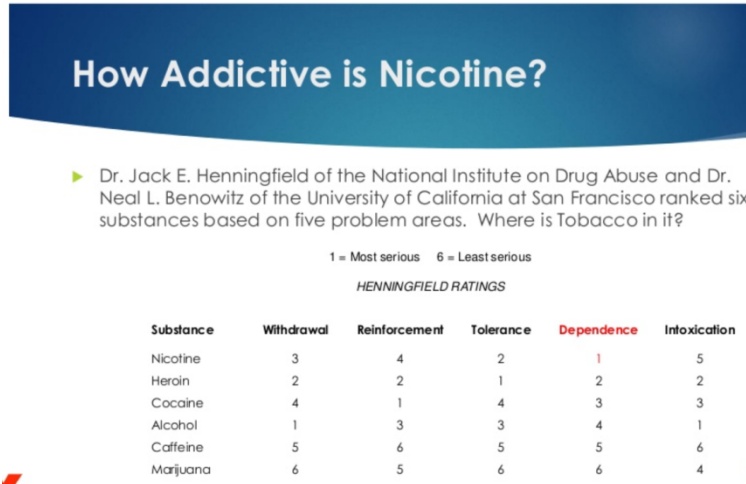
JUUL on TWITTER

> 60% mkt share



Source: Nielsen Total US xAOC/Convenience Database and Wells Fargo Securities, LLC





1 pod= 60mg Nicotine
1cig=9mg and 1mg after burning

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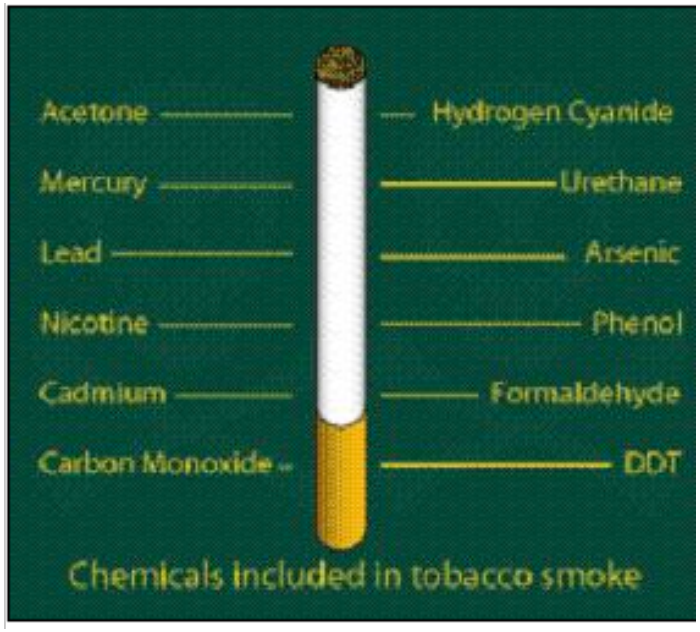
Primary Prevention

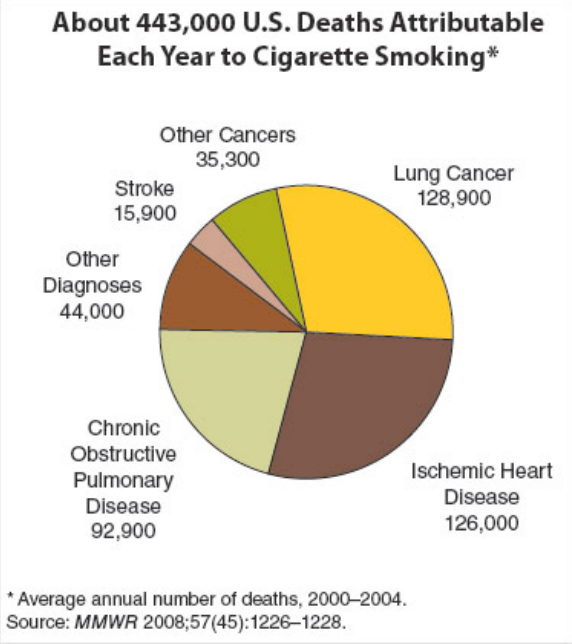
Risk Factor Modification

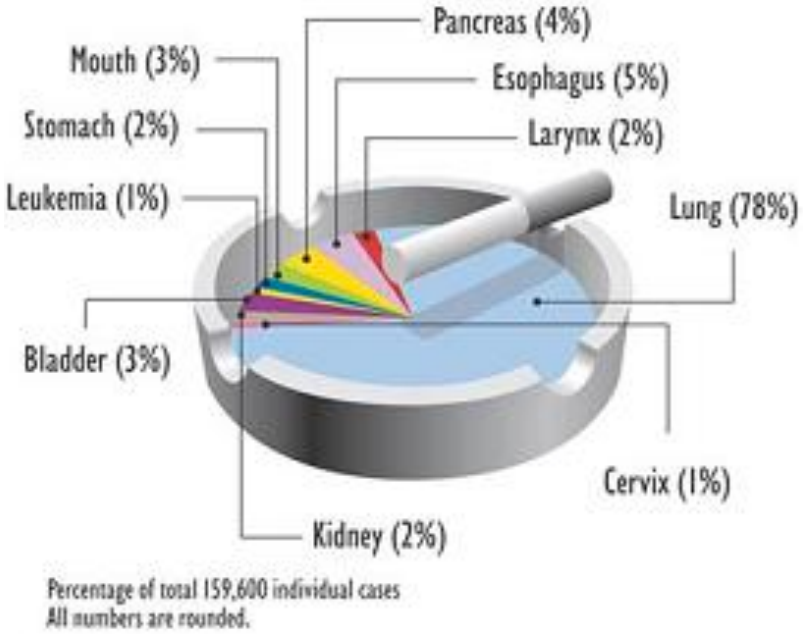
- **Tobacco Smoke (~90%)**
  - **Start age, Duration, Quantity, Type of cigarette**
  - **> 20x increased risk of lung cancer**



Primary Prevention
Smoking Cessation

- Ancillary Benefits
  - Decreases morbidity of the many other smoking related disease processes
  - ~ 1/2 of regular smokers die from smoking related disease (~30% lung cancer)



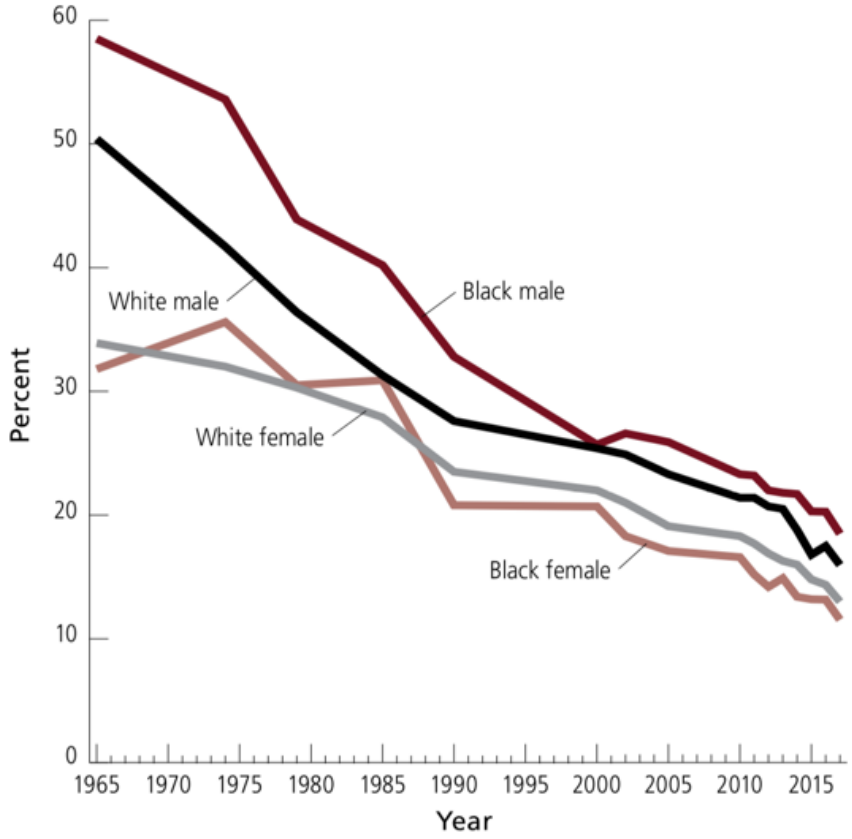


Race and Lung cancer

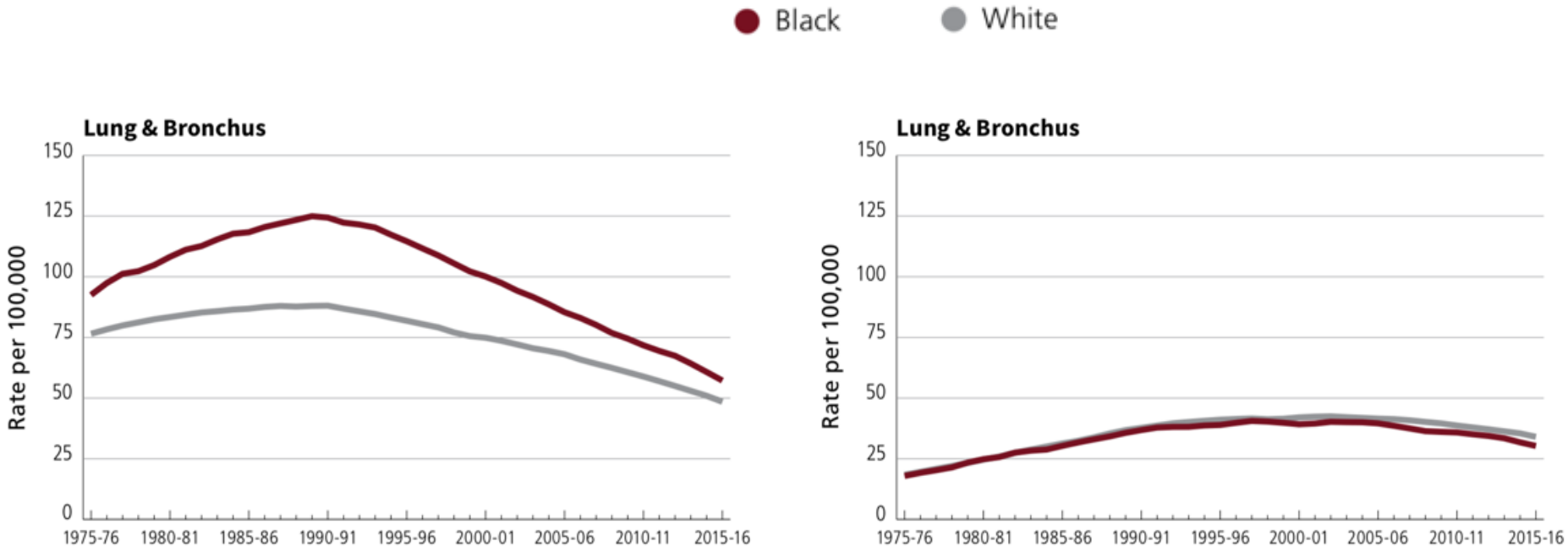
White male smokers consume 30%–40% more cigarettes than their black counterparts, but black male smokers are 34% more likely to develop lung cancer.

Black women smoke less on average than white women but have similar incidence rates

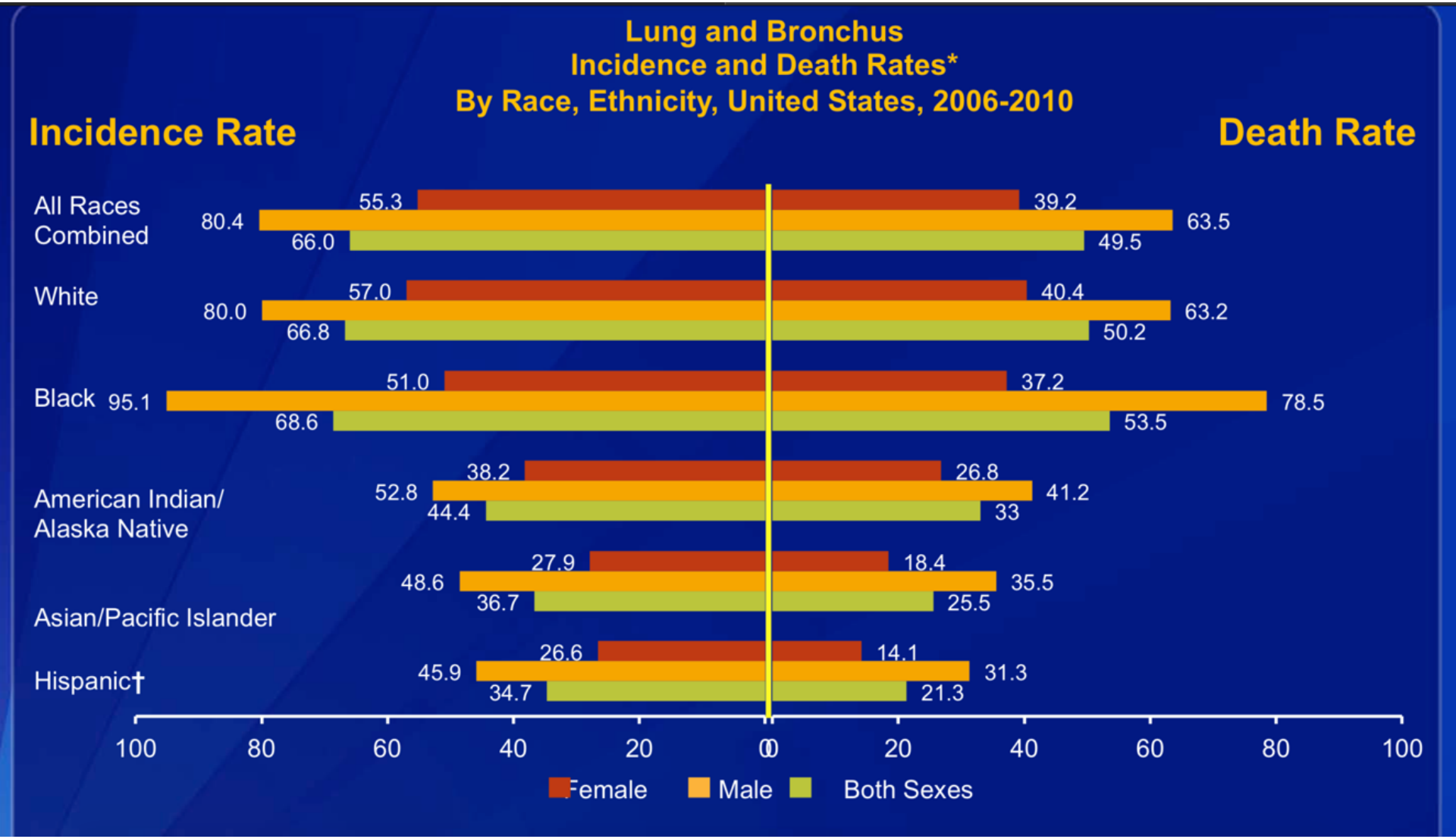
Figure 7. Adult Cigarette Smoking Prevalence (%) by Sex and Race, US, 1965-2017



Trends in Death Rates* for Selected Cancer Sites among Blacks and Whites, US, 1975-2016



African Americans have the highest incidence of and mortality from lung cancer


Lung and Bronchus
Incidence and Death Rates*
By Race, Ethnicity, United States, 2006-2010
Incidence Rate
Death Rate
All Races Combined
80.4
55.3
66.0
39.2
63.5
49.5
White
80.0
57.0
66.8
40.4
63.2
50.2
Black
95.1
51.0
68.6
37.2
78.5
53.5
American Indian/ Alaska Native
52.8
38.2
44.4
26.8
41.2
33
Asian/Pacific Islander
48.6
27.9
36.7
18.4
35.5
25.5
Hispanic†
45.9
26.6
34.7
14.1
31.3
21.3
100
80
60
40
20
0
0
20
40
60
80
100
Female
Male
Both Sexes

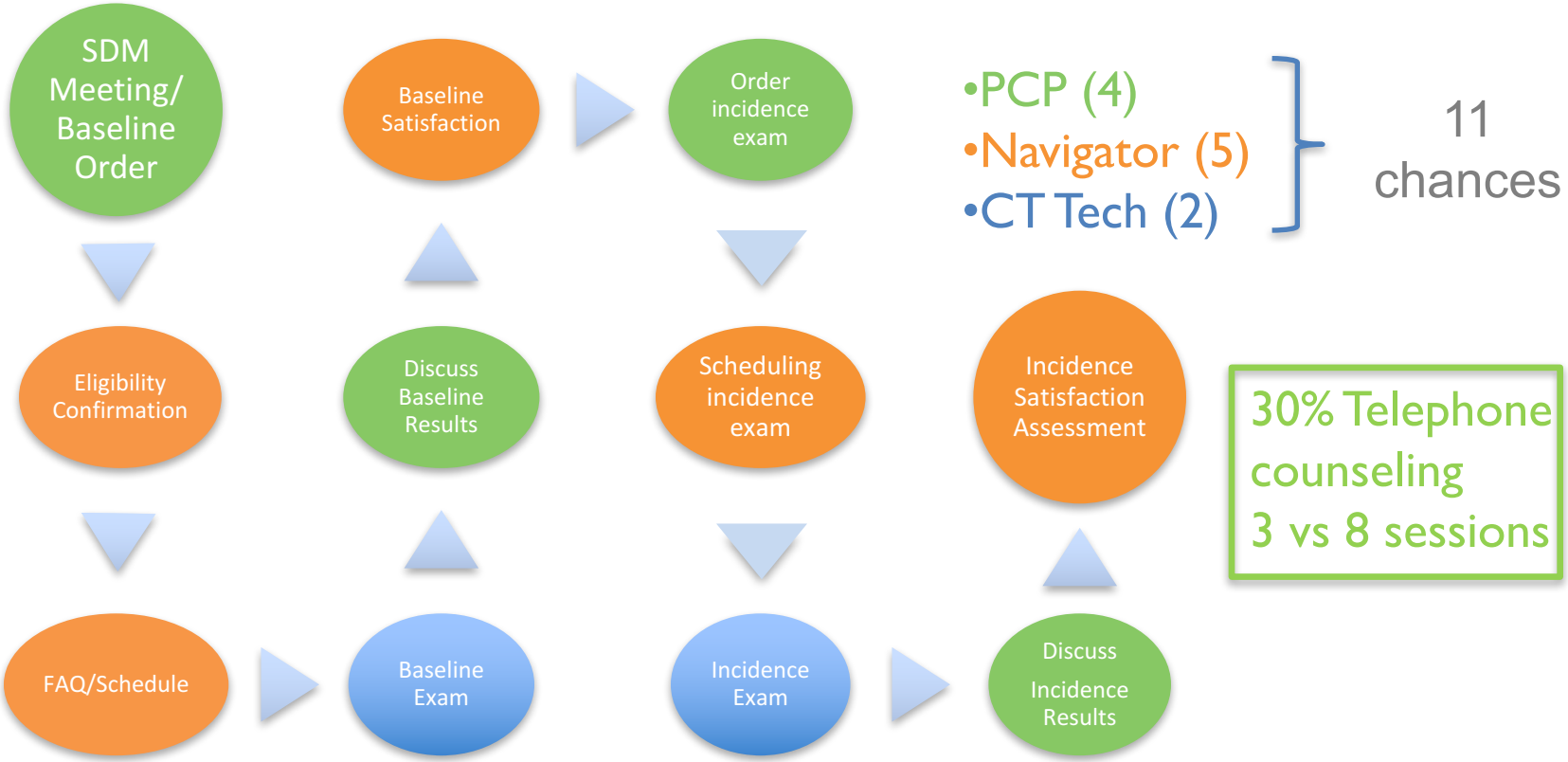
5 A's

	US Public Health Service	Provider Role
Ask	Identify tobacco use	Documented
Advise	Clear, strong, personalized	Reasons to quit
Assess	Willingness	Readiness determined
Assist	Counseling/pharmacotherapy	Strategies explained
Arrange	Schedule follow up	Purpose directed follow up

Clinical Practice Guideline Treating Tobacco Use and Dependence 2008 Update Panel,Liaisons and Staff, A clinical practice guideline for treating tobacco use and dependence 2008 update: A U.S. Public Health Service Regort. Am J Prev Med. 2008;35:158-176

Opportunities for Smoking Cessation

(Over two screening rounds)



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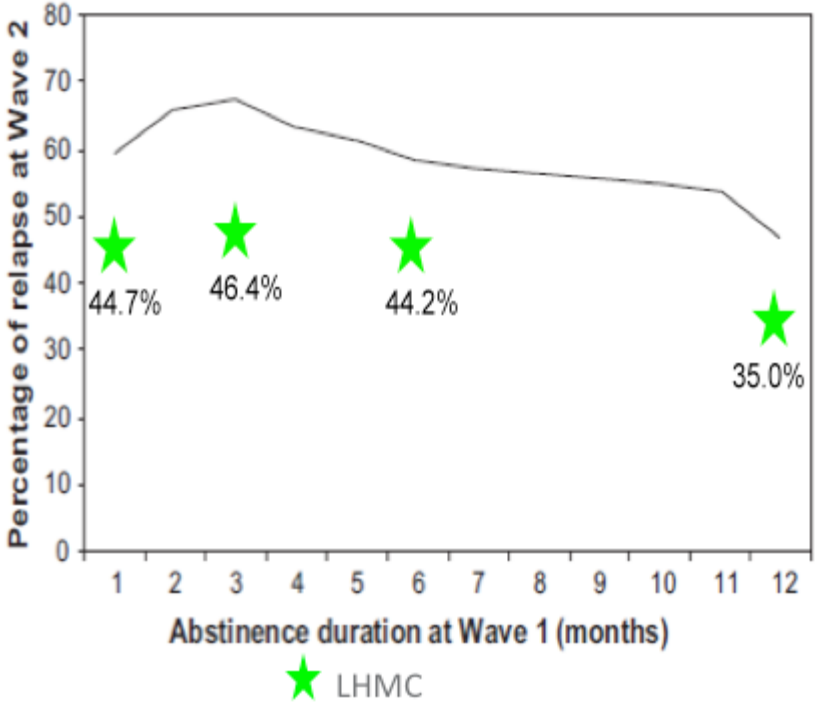
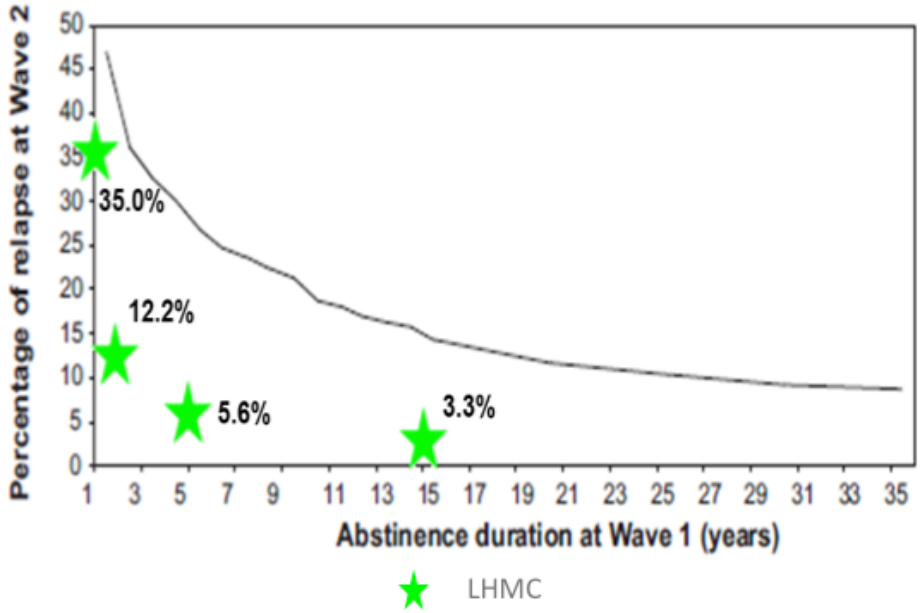
Results

Relapse Rates vs General Population

Quit < 1 year



Quit > 1 year



Garcia-Rodriguez O, Secades-Villa R, Florez-Salamance L, Okuda M, Liu S-M, Blanco C. Probability and predictors of relapse to smoking: Results of the epidemiological survey on alcohol and related conditions (NESARC). *Drug and Alcohol Dependence* 2013;132(3):479-485. http://doi.org/10.1016/j.drugalcdep.2013.03.008

NCI SMOKING CESSATION AT LUNG EXAMINATION COLLABORATION (SCALE)

LUNA	Integrated care vs quitline vs quitline plus
MATCH	CER digital cessation alone, in combo with counselor or refer to care
PLUTO	SMART design telephone vs telephone plus pharm (monthly vs quarterly contact)
CASTL	Motivational interviewing, NRT patch, NRT lozenge or message framing
LSTH Project	8 telephone sessions plus NRT vs 3 sessions plus NRT
LUNG	Gain framed intervention (Y/N) plus minus NRT
PROACT	Primary care setting: usual care vs proactive opt out cessation support with starter med pack with results letter and quitline support

Secondary Prevention
CT Lung Screening

- Most people who die from lung cancer now are FORMER SMOKERS
  - 35% of Lung Cancer Diagnosis → Current Smokers
  - 50% of Lung Cancer Diagnosis → Former Smokers
  - 15% of Lung Cancer Diagnosis → Never Smokers

- Lung Cancer 5-Year Overall Survival
  - 1975 5yrOS → 12% (current smokers ~ 35-40%)
  - Today 5yrOS → 15%' (current smokers < 20%)

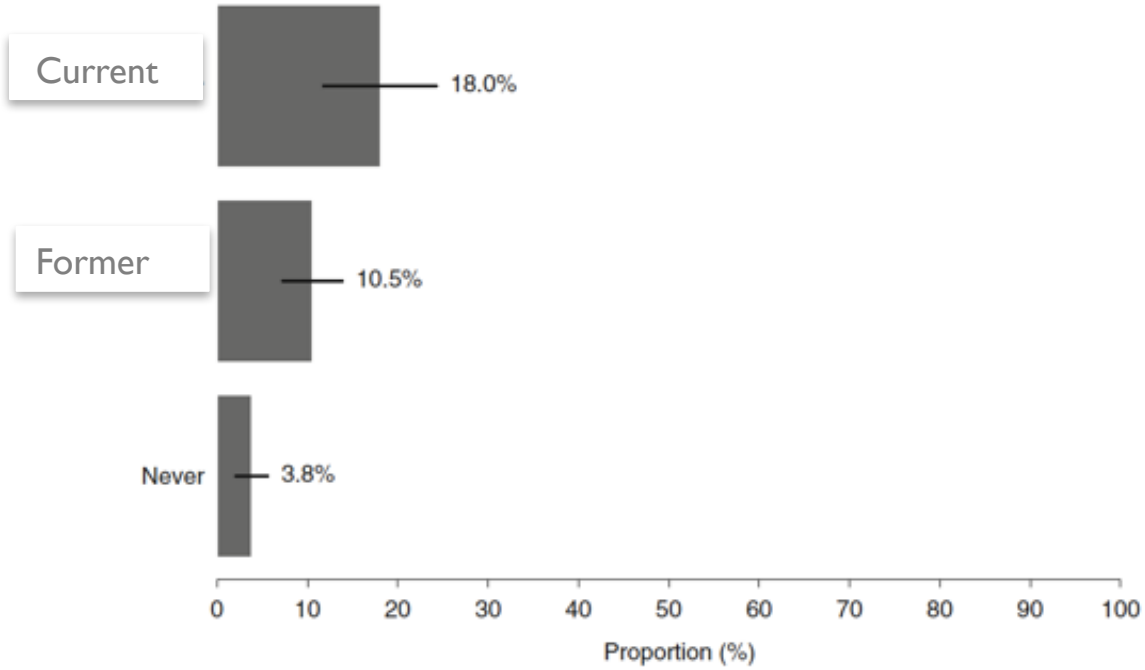
- Stagnant survival result of absent Secondary Prevention
  - FORMER SMOKERS cannot benefit from PRIMARY PREVENTION
  - Secondary Prevention = LUNG SCREENING
  - LUNG SCREENING → Find disease at early more treatable stage
  - LUNG SCREENING GOAL → Decrease mortality not incidence

Occurrence of Discussion about Lung Cancer Screening Between Patients and Healthcare Providers in the USA, 2017

Samir Soneji[1] · JaeWon Yang[2] · Nichole T. Tanner[3,4] · Gerard A. Silvestri[3]

J Canc Educ

Fig. 1 Prevalence of discussion with doctor or other healthcare professional about lung cancer screening within past year by cigarette smoking status. Source: Authors' analysis of 2017 Health Information National Trends Survey 5, Cycle 1



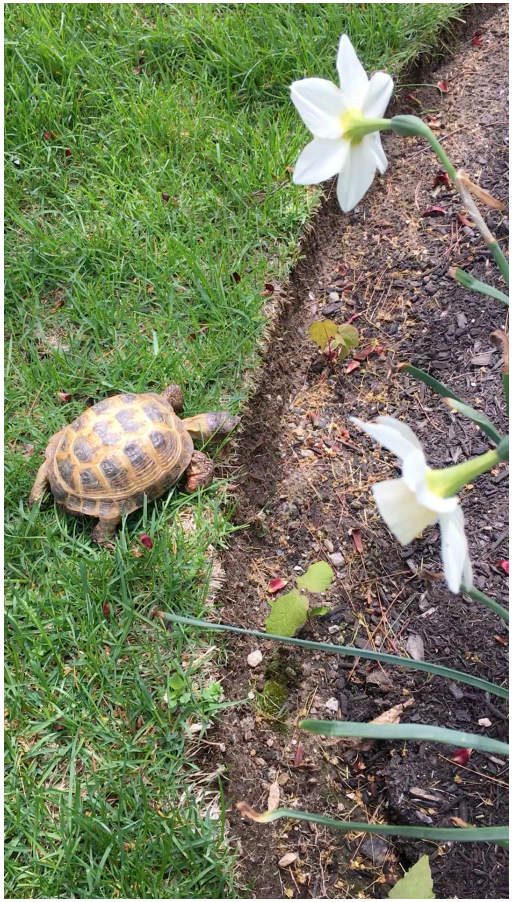

YOU STOPPED SMOKING
NOW START SCREENING
FRANK
QUIT AFTER SMOKING 22,000
PACKS OF CIGARETTES
OVER 30 YEARS
Now there's a new screening that can
catch lung cancer early and could save lives.
Talk to your doctor or learn more at
SavedByTheScan.org
Ad Council
AMERICAN LUNG ASSOCIATION.
LUNG FORCE

HEALTH NEWS ✓ Fact Checked

Why Only 2 Percent of Heavy Smokers Get Lung Cancer Screenings

Why so slow?

Reimbursement
Silos
Stigma
Misinformation
Terminology
Infrastructure
Resources
Training



Business

America's Heaviest Smokers Don't Want to Know if They Have Cancer

Screening could save 12,000 lives annually, but fewer than 2 percent of those eligible take advantage of it.

2016 data, 3 years after ACS recommendation and one year after CMS coverage

Mammography -28% in 1987, 11 years after ACS recommendation

Colonoscopy -32% in 1980, 20 years after ACS recommendation

Lung cancer screening Lahey– 65% in 2018, 6 years after NCCN recommendation 65% of eligible population screened – Changed the conversation

Kotter's Organizational Change

Figure 1. Rescue Lung, Rescue Life Implementation of Kotter Model for Organizational Change

1. Create a Sense of Urgency 2. Form a Powerful Coalition 3. Create a Vision	< PREPARE >	1. Rescue Lung, Rescue Life 2. Steering Committee 3. Hospital Mission
4. Communicate the Vision 5. Remove Obstacles	< IMPLEMENT >	4. Approval 5. CME Campaign, Demystify, LungRADS, Radiology Infrastructure
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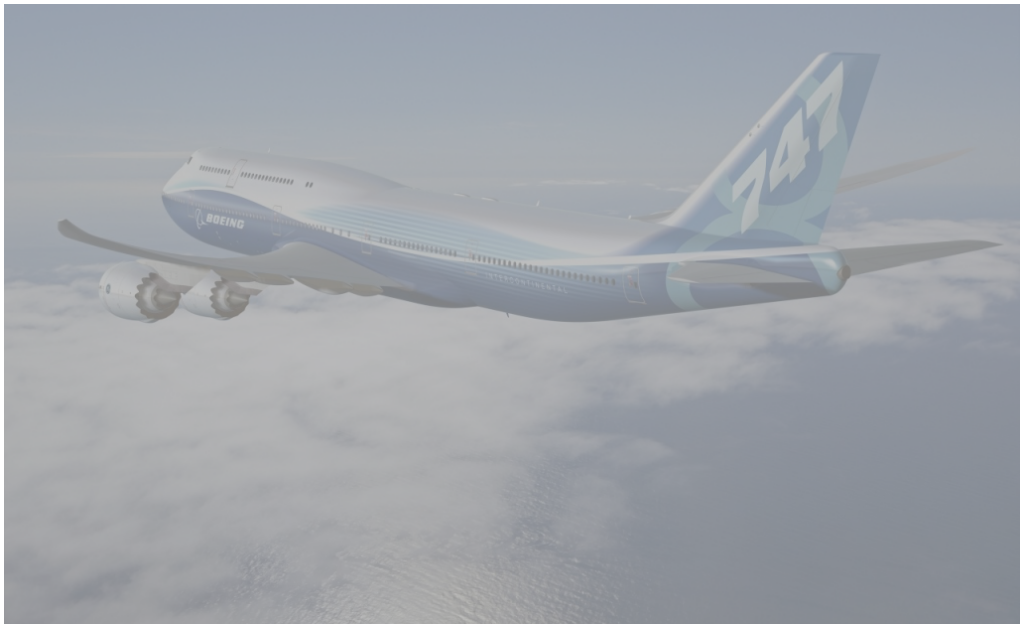
Lung Screening

Urgent Need



Lung Cancer Claims the lives of 450 People Every Day

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Access to Life-Saving Intervention

Powerful Coalition

Figure 2. Rescue Lung, Rescue Life Steering Committee Members	
CLINICAL	**ADMINISTRATION**
Radiology • Section Head Thoracic Imaging • Vice Chair Clinical Services • Vice Chair Research • Section Head Interventional Radiology • Chief Resident	**Senior** • VP Hospital-Based Clinical Services • VP Cancer Services • Associate Chief Nursing Officer
Primary Care • Chair General Internal Medicine • Resident Representative	**Radiology** • Administrative Director • Rescue Lung, Rescue Life Program Coordinator • Department Manager, CT • Department Manager, Nuclear Medicine
Pulmonary Medicine • Chair & Chief Medical Officer • Director of Interventional Pulmonology • Residency Director	**Cancer Services** • Department Manager, Radiation Oncology • Specialty Program Coordinator, Radiation Oncology • Rescue Lung, Rescue Life Program Coordinator
Oncology • Chair Radiation Oncology • Cancer Center Medical Director	**Marketing**
Thoracic Surgery	**Business Development**
Laboratory Medicine	**Philanthropy**

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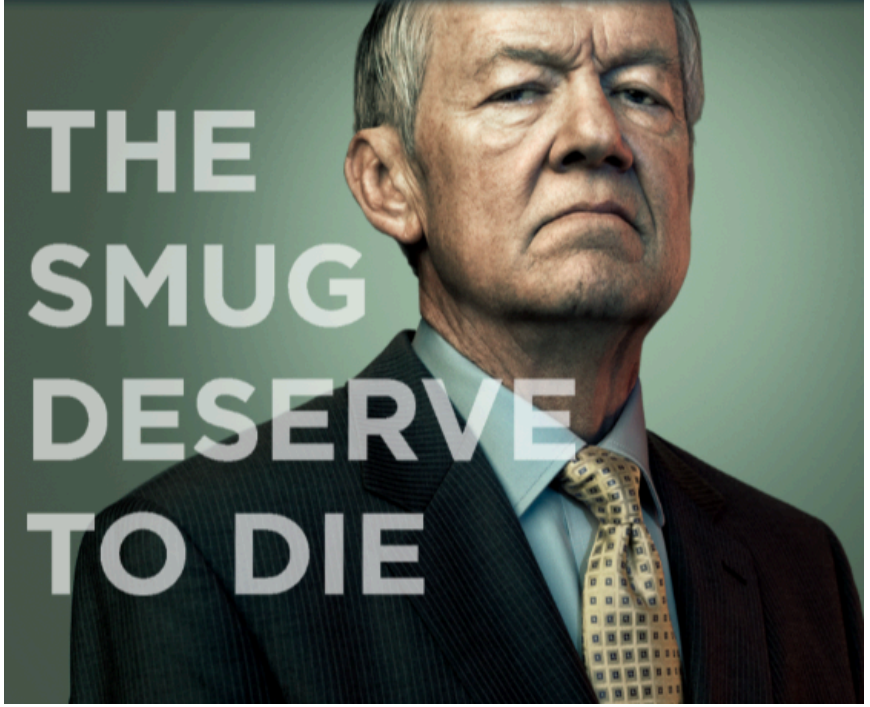
Create Vision
Rescue Lung, Rescue Life
Mission

- Save lives through the early detection of lung cancer with responsible CT lung screening
- Encourage the government to establish reimbursement for CT lung screening
- Encourage other centers of excellence in the treatment of lung cancer to offer responsible low cost CT lung screening until CMS establishes reimbursement
- Break down barriers and prejudice faced by those at risk for lung cancer
- Raise public awareness of the power of CT lung screening to save lives
- Provide a platform to explore relevant research questions

Rescue Lung Rescue Life


CAT
LOVERS
DESERVE
TO DIE


THE
SMUG
DESERVE
TO DIE


THE
TATTOOED
DESERVE
TO DIE


THE
GENETICALLY
PRIVILEGED
DESERVE
TO DIE

LUNG CANCER ALLIANCE

IF THEY HAVE LUNG CANCER. Many people believe that if you have lung cancer you did something to deserve it. It sounds absurd, but it's true. Lung cancer doesn't discriminate and neither should you. Help put an end to the stigma and the disease.

No One Deserves to Die of Lung Cancer

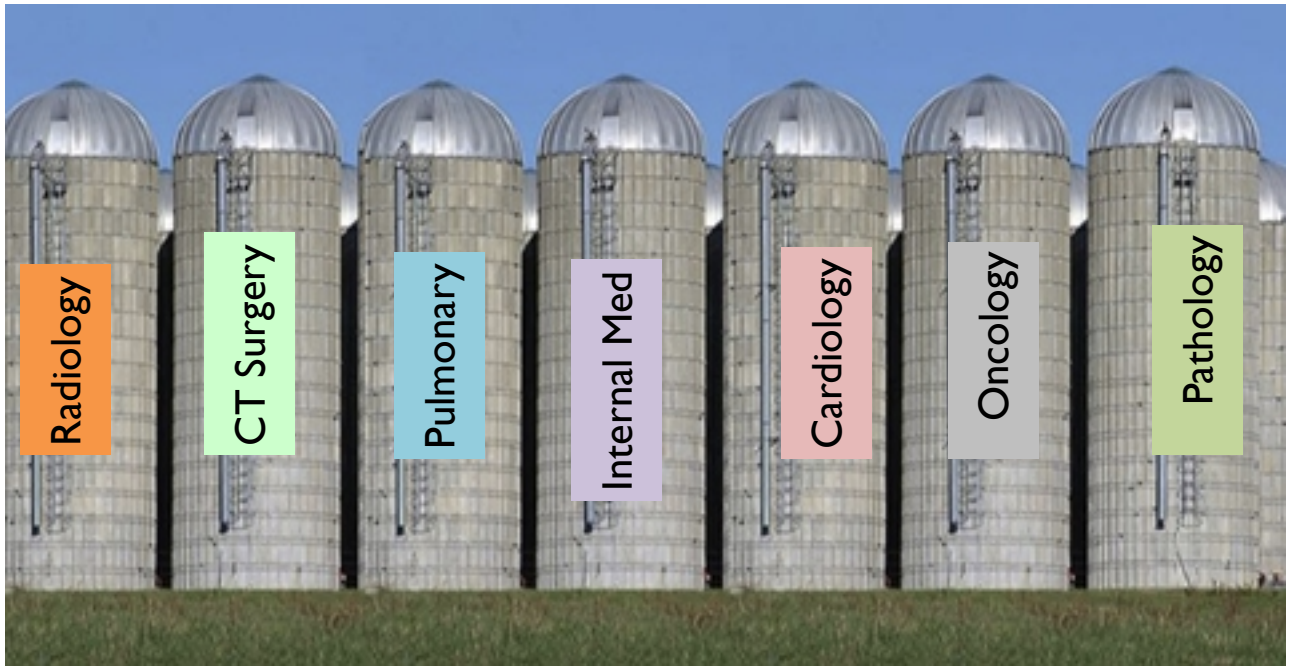
Stigma and Big Tobacco

Competition has been tough - tobacco industry, Hollywood, press

Guard against withholding of health care services or advocacy based on social history – slippery slope

Revenues and Expenses

Different Silos



Financial Analysis Year 2 (2nd Incidence)

YEAR 2 (T2 - SECOND INCIDENCE)						
	Cases	Net Payments (Pmt - Var Cost)		Totals		
Previously Negative Screens	1,351	$100		$135,056		69.1%
Previously Positive Screens	103	$100		$10,265		5.3%
New Screens	500	$100		$50,000		25.6%
Total Screens				$195,321		40.2%
Positive Screens (7.8%)	329					
True Positive (CDR) (0.8%)	17	$15,000		$256,489		39.6%
False Positives (FP)	311					
FP LDCT 6 Month	249	$120		$29,905		4.6%
FP Percutaneous Bx	1	$500		$622		0.1%
FP Bronchoscopy	4	$500		$2,178		0.3%
FP Surgical	3	$500		$1,556		0.2%
FP Chest CT	11	$200		$2,116		0.3%
FP CXR	3	$50		$156		0.0%
FP PET-CT	31	$1,000		$31,111		4.8%
Significant Incidental Findings	153	$500		$76,362		11.8%
		Total Potential Net Payments		$595,815		
		Net Adjusted for Retention and Uninsured		$485,778		
		Net Payments/Screen		$249		

Total Revenue to Radiology → $257,115

Radiologists (10,000 screens/yr)	0.1953208	$300,000		$58,596		31.2%
Program Coor				$100,000		53.2%
Tech Staff (3)				$29,298		15.6%
		Radiology Cost		$187,894		
		Total Radiology Cost/Screening		$96		

Total Cost to Radiology → $187,894

				$297,883		
				$153		

Net Gain/Loss to Radiology → GAIN ~$70,000

Lives Saved/Net Revenue

Major Assumptions
1. Net payment screening LDCT = $100
2. Definition of positive exam = Nodule > 6mm
3. Net payment diagnostic followup LDCT = $100

	US	Region
Population	300,000,000	6,500,000
High-Risk Group 1 (55-77y, 30PY, Quit < 15y)	7,000,000	151,667
High-Risk Group 2 (> 50y, >20PY, 1 Rfactor)	2,000,000	43,333
Total Qualified	9,000,000	195,000
Potential Lives Saved with 3 CT Screens	28,125	609

Net Income/Screened Patient Years 0-2	
Year 0	**$291**
Year 1	**$186**
Year 2	**$153**

INPUTS	
LDCT Screening	***$100***
Region Population	***6,500,000***
Pt Compliance	***50%***
LDCT Diagnostic	***$100***
Cancer Treatment	***$15,000***
Percutaneous Bx	***$500***
Bronchoscopy	***$500***
Surgical Bx	***$500***
Chest CT	***$200***
CXR	***$50***
PET-CT	***$1,000***
Incidentals	***$500***
Radiologist	***$300,000***
Program Coordinator	***$100,000***
Radiology Tech(3)	***$150,000***
Retention Rate	***75%***
Uninsured (55-64)	***2%***
T0 (Baseline) Cases	***1,000***
T0 (Baseline) Positive	***13.0%***
T0 (Baseline) CDR	***2.6%***
T0 (Baseline) Category S	***10.2%***
T1 (Incidence) New Cases	***500***
T1 (Incidence) Postive	***6.0%***
T1 (Incidence) CDR	***0.8%***
T1 (Incidence) Category S	***7.0%***
T2+ (Incidence) New Cases	***500***
T2+ (Incidence) Positive	**6.0%**
T2+ (Incidence) CDR	**0.2%**
T2+ (Incidence) Category S	**7.0%**

Lives Saved/Net Revenue
- 1 years and 3 years
- Mkt Share

Lung-RADS 4 Rates	
Overall	**4%**
PET	**50%**
CXR	**5%**
Chest CT	**17%**
Sugery	**5%**
Bronchoscopy	**7%**
Perc Bx	**2%**

Utilization Fraction (Assumes 50% Population Compliance)	Lives Saved and Net Income				
	1 Year			3 Years	
2% (1,950 Screenings/yr)	6	$	568,062	30	$ 1,227,746
5% (4,875 Screenings/yr)	15	$	1,420,155	76	$ 2,325,880
10% (9,750 Screenings/yr)	30	$	2,840,310	152	$ 6,138,731
20% (19,500 Screenings/yr)	61	$	5,680,621	305	$ 12,277,462

Clinical Resource Utilization

- 711 clinical CT lung screening pts.
- Followed for 12 months after screening
- Chart review
- Include all clinical activity with > 95% chance of being directly result to lung screening event
- Breakdown volume by hospital departments and Lung-RADS score

Overall Financial Events
12 Months: 711 Patients

	Cases
Original Screens	
Hospital	710
Professional	710
Total Original Screens	1,420
Subsequent Events	
Hospital	470
Professional	703
Total Subsequent Events	**1,173**
Original Screen & Subsequent Events	
Hospital	1,180
Professional	1,413
Total Original Screen & Subsequent Events	**2,593**

Hospital Events
(12 months: 711 Patients)

Attending Service	Cases
Cardiology	11
CardiothoracicSurgery	33
Community Medicine	46
Endocrinology	19
Family Medicine	2
Gastroenterology	3
General Internal Medicine	123
General Surgery	6
Gynecology	2
Hematology and Oncology	17
Nephrology	1
Neurology	1
Neurosurgery	2
Ophthalmology	2
Optometry	3
Otolaryngology	4
Pediatrics	1
PlasticSurgery	1
Pulmonary & Critical Care	168
Rheumatology	2
Transplantation	9
Urology	13
Vascular Surgery	1
Total Hospital Events	**470**

Model Projections vs Clinical Observations

Projected

Net Income/Screened Patient Years 0-10	
Year 0	$166
Year 1	$151
Year 2	$189
Year 3 -10	$200

OBSERVED

Number of Patients		711
Contribution/Patient	$	253
Estimated Contibution/Patient	$	166
Excess Contribution/Patient	$	87

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LungRADS

Figure 5. LungRADS Overall Exam Assessment: Part 1

CT LUNG SCREENING REPORTING AND DATA SYSTEM (LUNGRADS)

Lung Cancer Specific Catory (BI-RADS® Based)		NCCN-Guidelines® Based Follow-up Recommendation
Category	Assessment	
1	Negative	Routine annual LDCT screen (age < 75)
2	Benign	Routine annual LDCT screen (age < 75)
3	Probably Benign	Interval short-term diagnostic LDCT (1, 2, 3, 6, 12 months)
4	Suspicious	Pulmonary consultation and multidisciplinary clinic review
5	Known Malignancy	PCP and oncology referral

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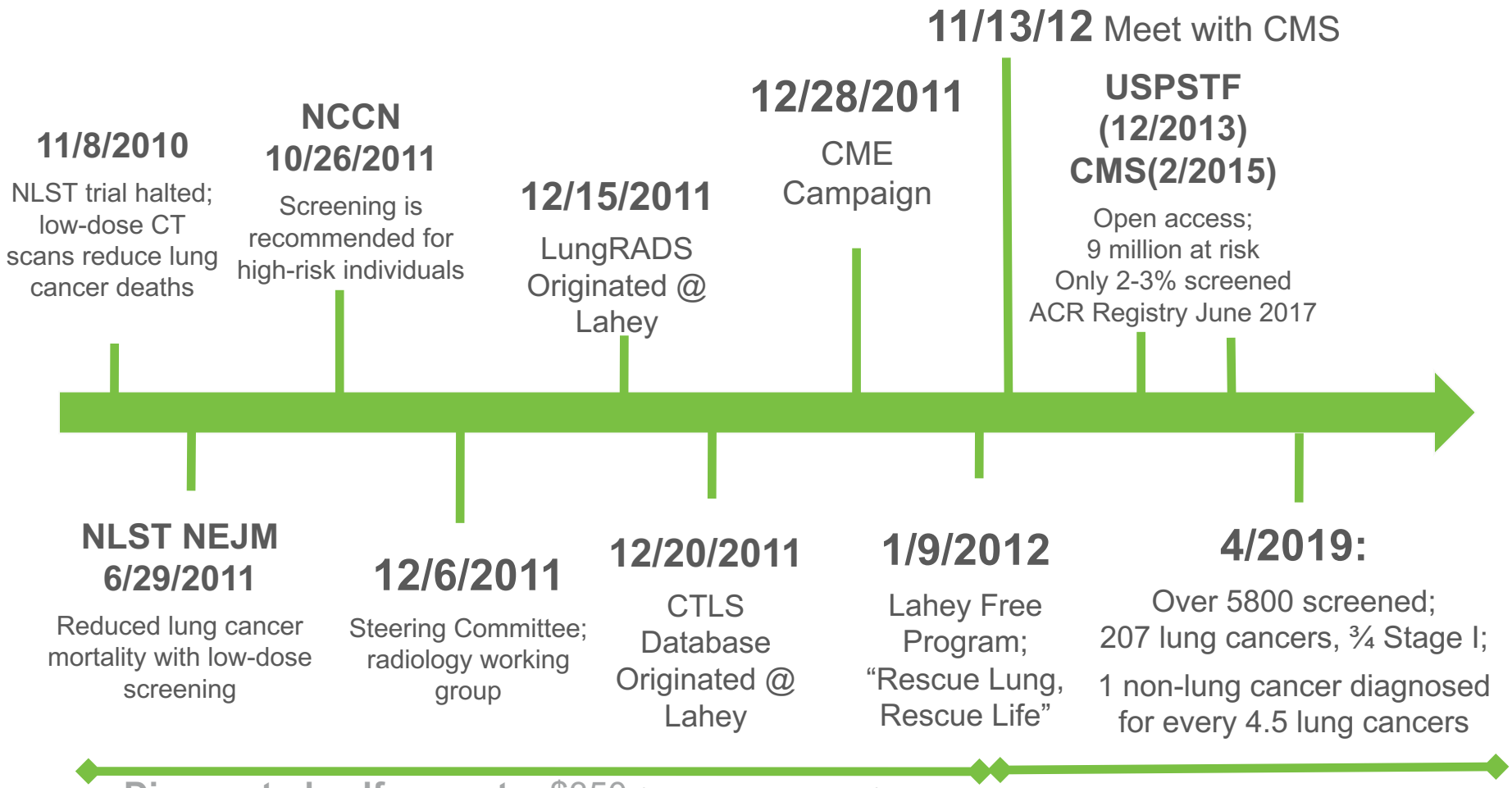
CMS Payment Drives Adoption and Access



Discounted self pay rate: $350 (4 patients screened)

Lahey Health
Cancer Institute

Lahey CLINIC

Lahey Clinic
Rescue Lung, Rescue Life
41 Mall Road
Burlington, MA 01805

P 855 282.4378
www.Lahey.org/LungScreening

A teaching hospital of Tufts University School of Medicine

November 8, 2012

The Honorable Kathleen Sebelius
Secretary
U.S. Department of Health and Human Services
200 Independence Avenue, S.W.
Washington, DC 20201

Dear Secretary Sebelius:

Lung Cancer is the number one cancer killer of men and women in the United States. In June of 2011 the National Lung Screening Trial (NLST) reported a 20 percent disease-specific mortality benefit of screening high-risk individuals with annual low dose CT (LDCT) vs. chest radiography (CXR). In fact, the mortality benefit of LDCT is arguably greater than 20 percent, as the NLST was halted early in November of 2010 out of an ethical need to inform the CXR group of the significant observed benefit of LDCT. Since the publication of the NLST, six national medical societies, including the National Comprehensive Cancer Network (NCCN), have endorsed annual LDCT lung screening for individuals at high-risk.

Nearly two years has passed since the NLST was halted but, unfortunately, the overwhelming majority of patients at high-risk for lung cancer remains unscreened. The absence of CMS reimbursement is often falsely interpreted by physicians and patients as evidence that LDCT lung screening is not recommended and/or of unproven benefit. Centers that do offer LDCT lung screening require self-payment rates ranging from $99 to $1,000. We believe these high self-pay rates, combined with a lack of medical and public education, have created significant barriers to patient access to this proven life-saving preventative care intervention. Failure to break down these barriers and open screening access to those at high-risk will result in an estimated 20,000 lives lost unnecessarily each year to this deadly disease. Furthermore, those who risk their own lives to protect others, such as members of the military and professional firefighters, disproportionately suffer the consequences of inaction as their occupational exposures, combined with social history, place many of them at high-risk to develop lung cancer.

In an urgent effort to open equitable access to LDCT screening we began offering free annual LDCT to high-risk patients at Lahey Clinic in Burlington, Mass. in January of 2012. By eliminating the self-pay barrier, and conducting an extensive local continuing medical and public education campaign, we have screened over 550 high-risk patients and found and treated 3 early stage lung cancers. Our program demonstrates that reducing financial and educational barriers to screening can improve patient access and acceptance of the life-saving potential of LDCT.

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The medical community has identified in LDCT lung screening a tool with the potential to bring about the greatest single reduction in lung cancer mortality since the War on Cancer began. The opportunity to prevent at least one in five lung cancer deaths in this high-risk population is truly extraordinary. If we can work together to establish CMS reimbursement and develop a national education campaign we have the power to save tens of thousands of U.S. lives per year. Members of the Rescue Lung, Rescue Life Steering Committee respectfully request a meeting with you to discuss this unprecedented opportunity to save lives.

Attached you will find a petition signed by a growing number of physicians and allied health professionals who support action in this time of need.

Respectfully submitted,
Andrea McKee, MD, and members of the Rescue Lung, Rescue Life Steering Committee

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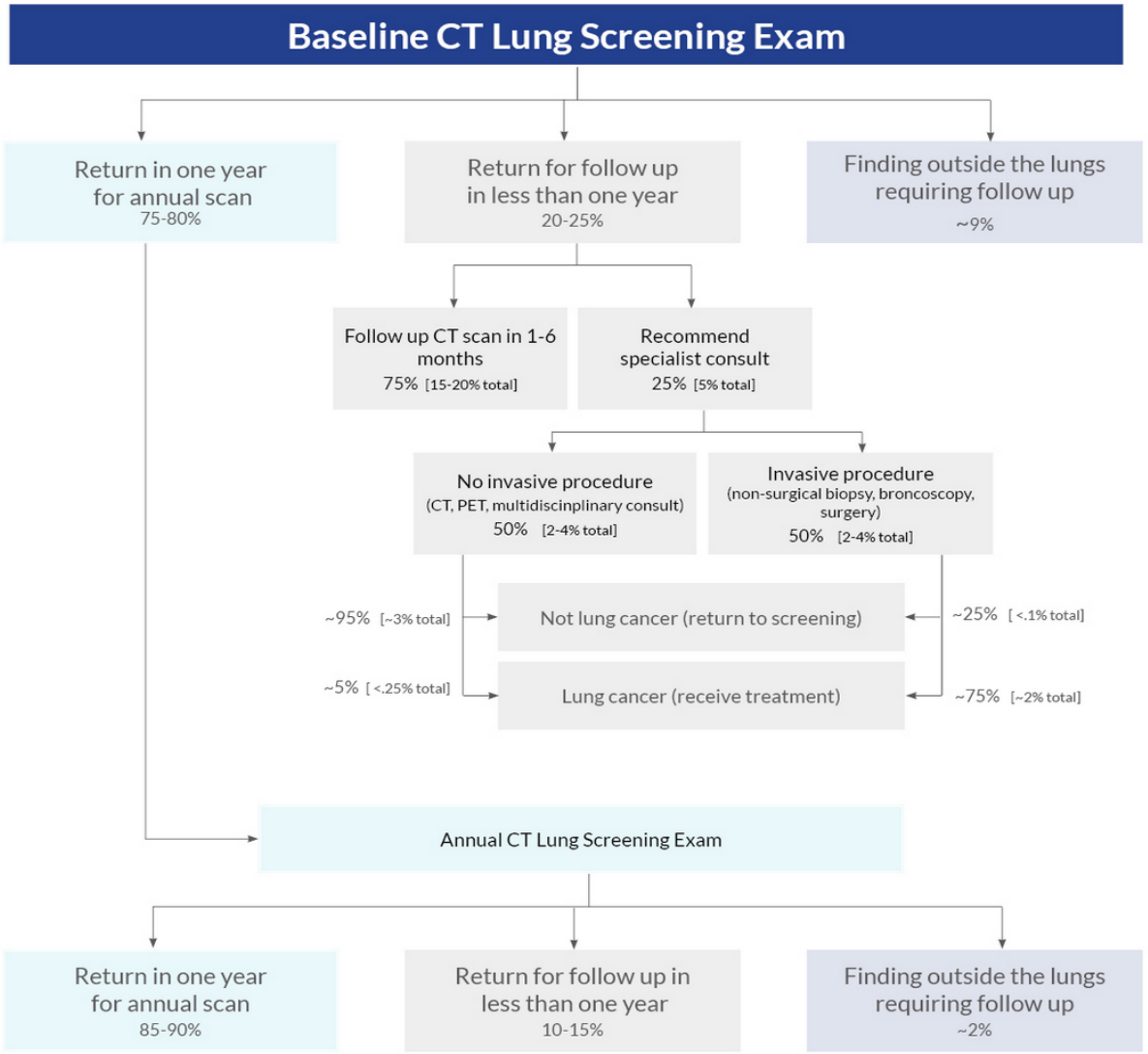
1. Request coverage
2. Demonstrate LungRADS system
3. Message relentlessness

Decision Memo for Screening for Lung Cancer with Low Dose Computed Tomography (LDCT) (CAG-00439N)

Comment:
A few commenters suggested that Medicare cover NCCN Group 2 (ages 50-54, 20-pack year smoking history, and one additional risk factor for lung cancer) under coverage with evidence development. Commenters opined that individuals in NCCN Group 2 are equivalent to individuals that would fall under NCCN Group 1. Other commenters asked for expanded coverage to those who have quit smoking more than 15 years ago.

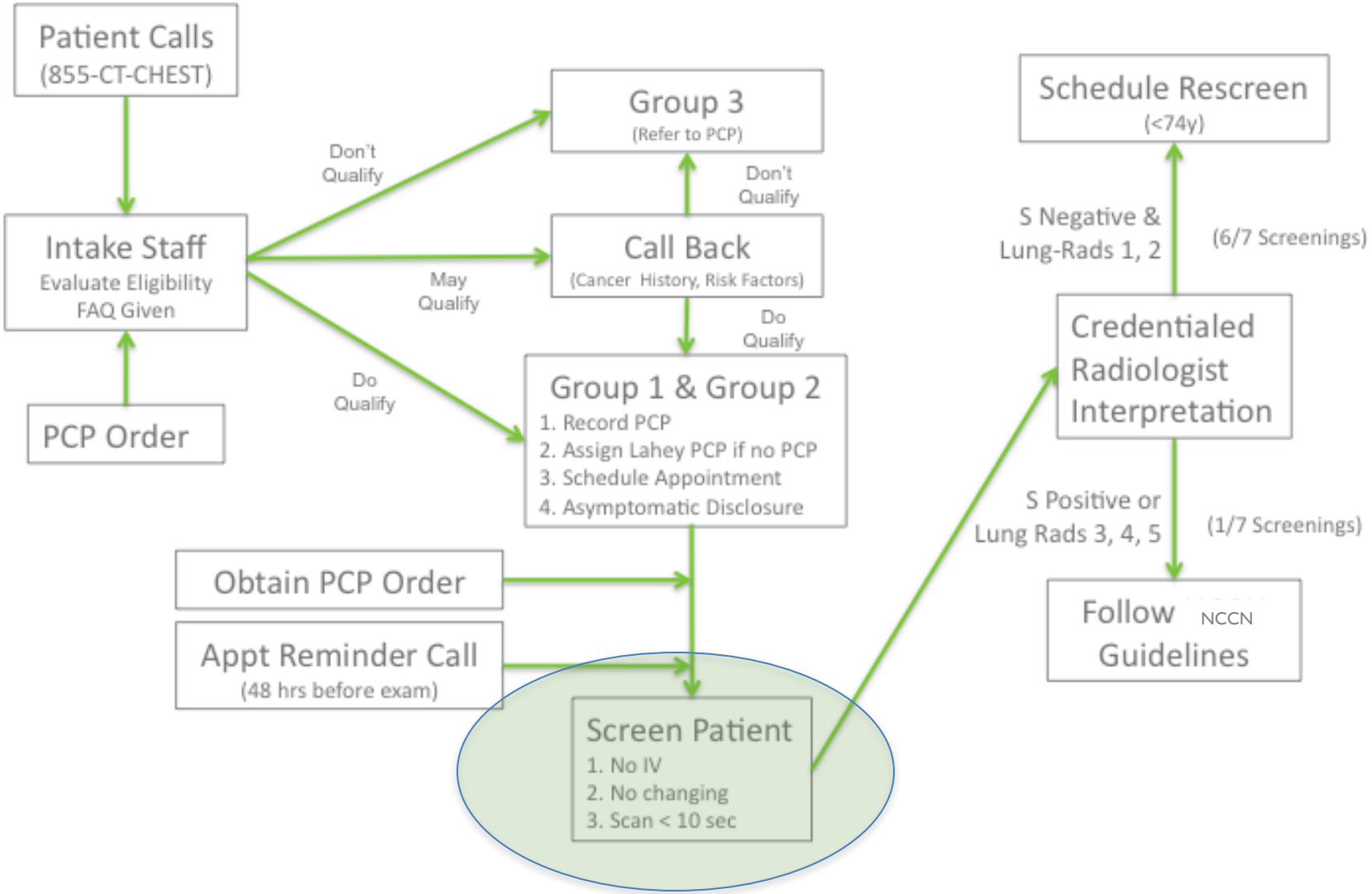
Response:
The NLST was the only trial (of several trials and observational studies over the past decade) to show benefits of lung cancer screening with LDCT. The NLST provided the evidence to determine that this service is "reasonable and necessary" and "appropriate" for Medicare beneficiaries. We did not find evidence of improvements in health outcomes in other populations, such as those suggested by the commenters (for instance, individuals that have a smoking cessation history greater than 15 years and individuals with a 20-pack year smoking history). **We will continue to closely monitor ongoing trials, which we believe will improve the evidence base, and will consider modifying coverage in the future as appropriate.**

https://www.lungcancerscreeningguide.org



Lahey Hospital & Medical Center

Screen



Lahey Hospital & Medical Center

Training Credentialed Radiologists

Radiology- Make the radiologist comfortable

- Mevis Lung Academy
- IELCAP VA PALS
- NELSON: Central Radiology Review
  - Pulmonary Recommendation for suspicious
  - European 18 month implementation plan

Systems Approach

Division of labor

- cost efficient/effective
- volume for PCP, specialist, radiology
- Triage to manage specialty volume

Breakdown by reading radiologist. NOTE: Only radiologists reading 100+ screening exams are included in analysis.

2015-2016 Baseline (T0)

RADIOLOGIST	LR0		LR1		LR2		LR3		LR4A		LR4B		LR4X		TOTAL
A	0	0.0%	6	18.8%	24	75.0%	2	6.3%	0	0.0%	0	0.0%	0	0.0%	32
B	0	0.0%	20	6.2%	260	80.0%	24	7.4%	12	3.7%	7	2.2%	2	0.6%	325
C	0	0.0%	8	19.5%	24	58.5%	4	9.8%	2	4.9%	2	4.9%	1	2.4%	41
D	0	0.0%	111	27.2%	227	55.6%	42	10.3%	16	3.9%	6	1.5%	6	1.5%	408
E	0	0.0%	16	10.5%	121	79.1%	7	4.6%	5	3.3%	4	2.6%	0	0.0%	153
TOTAL	0	0.0%	161	16.8%	656	68.4%	79	8.2%	35	3.6%	19	2.0%	9	0.9%	959

2015-2016 Annual (T1+), Table 2

RADIOLOGIST	NEGATIVE (LR 0, 1, 2)		POSITIVE (LR 3, 4A, 4B, 4X)		SUSPICIOUS (LR 4A, 4B, 4X)		DX LUNG CA (LR 5)		PPV	LR3 PPV	LR4 PPV	LR4B PPV	FALSE NEGATIVE		TOTAL	S POSITIVE	
A	124	96.1%	5	3.9%	2	1.6%	2	1.6%	40.0%	0.0%	100.0%	100.0%	0	0.0%	129	1	0.8%
B	529	92.6%	42	7.4%	25	4.4%	8	1.4%	19.0%	0.0%	32.0%	37.5%	0	0.0%	571	9	1.6%
C	86	94.5%	5	5.5%	4	4.4%	0	0.0%	0.0%	0.0%	0.0%	—	0	0.0%	91	2	2.2%
D	766	92.4%	63	7.6%	26	3.1%	8	1.0%	12.7%	0.0%	30.8%	38.5%	1	0.1%	829	28	3.4%
E	289	98.0%	6	2.0%	1	0.3%	1	0.3%	16.7%	0.0%	100.0%	—	0	0.0%	295	5	1.7%
TOTAL	1794	93.7%	121	6.3%	58	3.0%	19	1.0%	15.7%	0.0%	32.8%	40.9%	1	0.1%	1915	45	2.3%

Lung Screening Debate
Fact vs Speculation
NCCN Considerations

Proven Risks/Benefits

- At least a 20% lung cancer specific mortality benefit
- False positive rate
- False negatives
- Complications of treatment and work-up of true and false positives
- Overdiagnosis

Theoretical Risks/Benefits

- Increase/decrease pt. anxiety
- Encourage/discourage smoking
- Patients to ignore symptoms
- Costs ? Perspective
  - Patient/hospital/insurer/government/society
- Community radiologists & hospitals “bilk” the system
- Low dose radiation

Shared Decision-making and Lung Cancer Screening

Let's Get the Conversation Started

Nichole T. Tanner, MD; and Gerard A. Silvestri, MD

Screening with low-dose CT scan has been shown to reduce mortality from lung cancer in those at risk based on age and smoking history. While lung cancer screening (LCS) is recommended by the United States Preventative Services Task Force and many professional societies, it has been recognized that the decision to be screened is complex due to a close balance of risk and benefit; therefore, shared decision-making is considered an essential component of effective LCS. The Centers for Medicare and Medicaid Services provides coverage for LCS following a mandated shared-decision making (SDM) visit. Here we review the concept of SDM, facilitators and barriers, evidence and knowledge gaps, and novel considerations for SDM within LCS.

CHEST 2019; 155(1):21-24

NLST & NELSON: Lung cancer CT screening Mortality data

Male v Female ratio	
NLST+	41/59
NELSON	16/84

MILD = 65% Men

10 Yr LC Specific Mortality = 39%

Landmark = 58%

Percent LC Mortality Decrease			
Trial	Men	Women	50:50 M/F
NLST*	8%	27%	**18%**
NELSON**	26%	39-61%	**33 – 44%**

Pinsky et al. The National Lung Screening Trial:. *Cancer* 2013; **119**(22): 3976-83. *Aberle, et al. The National Lung Screening Trial: overview and study design. *Radiology* 2011; **258**(1): 243-53
**Effects of Volume CT Lung Cancer Screening: Mortality Results of the NELSON Randomised-Controlled Population Based Trial De Koning et al 2018

Eligibility NELSON, MILD, NLST

- NELSON
  - Age: 50-75
  - Current or quit < 10 yrs ago
  - > 10 cig/day x 30 yrs (15PY)
  - > 15 cig/day x 25 yrs (18.75 PY)

- NLST
  - Age: 55-74
  - Current or quit < 15 yrs ago
  - > 30 Pack Years (PY)

- MILD
  - Age 49-75
  - Current or quit < 10 yrs ago
  - ≥20 pack years (PY)

NELSON and MILD- Demographics

IASLC
INTERNATIONAL ASSOCIATION FOR THE STUDY OF LUNG CANCER

IASLC 19th World Conference on Lung Cancer
September 23–26, 2018 Toronto, Canada
WCLC2018.IASLC.ORG #WCLC2018

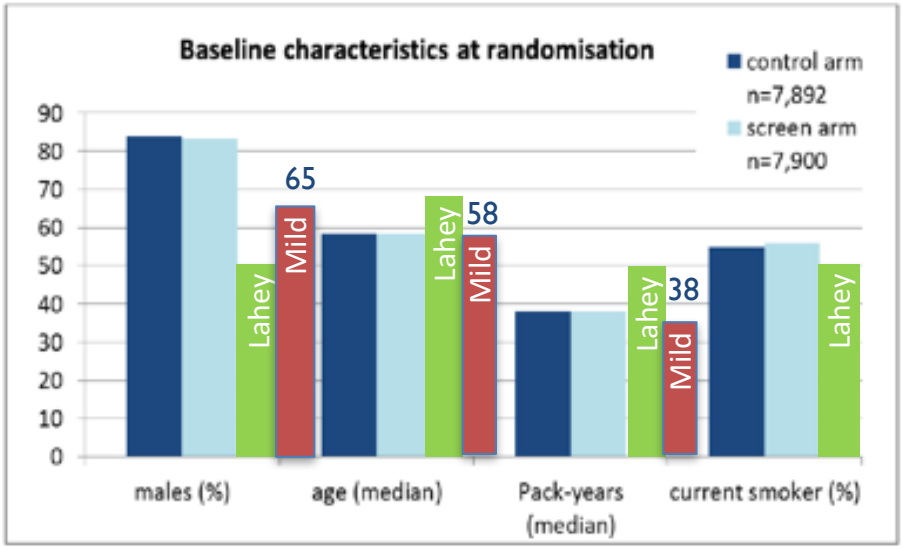


Table 2. Patient Demographics[a] — Lahey

Patient Characteristics	Total	Group 1	Group 2	*P* Value
Qualified	3,449	2,635	814	N/A
Screened	2,927	2,229 (76.1%)	698 (23.8%)	N/A
Average age, y	62.5	63.1	60.6	<.001
Male	55.6%	55.7%	55.2%	.8
Average pack-year smoking history	47.9	50.8	38.8	<.001
Current smokers	51.7%	55.8%	38.6%	<.001
Average quit years (former smokers)	9.9	6.3	18.1	<.001
Average follow-up, mo	30.4	30.2	31.3	.4

Harry J. de Koning, Erasmus MC, Public Health Rotterdam

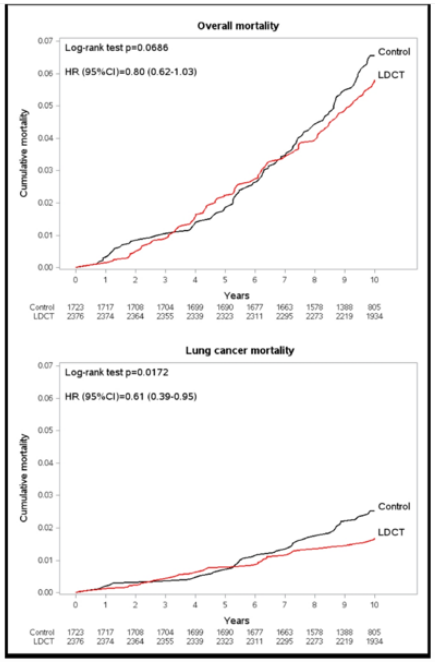
WCLC 2018

NELSON

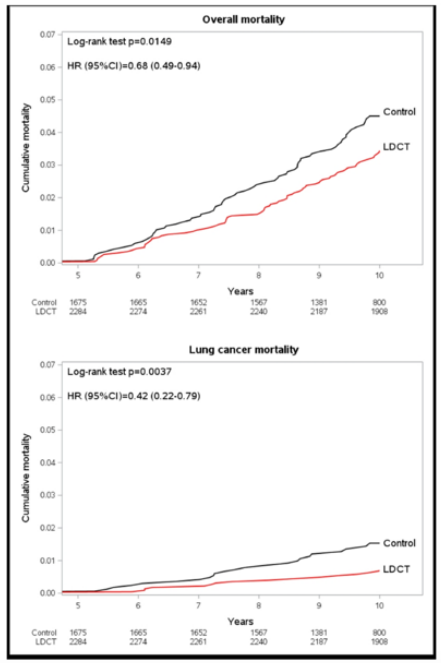
- ~16,000 randomized CT vs no screening
- 4 exams over 5.5 years evaluate at year 10
  - Baseline, year 1, year 3, year 5.5
- Volumetric imaging
- Central reading
- Pulmonary referral suspicious
- 16% women

MILD

- 4099 randomized CT vs no screening (2 to 1)
- 5 year results NS difference
- 10 year Landmark analysis to assess efficacy of long term screening



Cumulative overall mortality and lung cancer mortality, by arm over 10 years of follow-up.



Landmark analysis of cumulative overall mortality and lung cancer mortality, by arm beyond 5 years.

Lahey Hospital & Medical Center

MILD

Characteristics of the 4,099 participants in the MILD population, by study arm.

	Control arm (N = 1,723)	Intervention arm (N = 2,376)	P-values
Age (years)			
< 55	656 (38.1%)	773 (32.5%)	*0.0065*
55-59	478 (27.7%)	700 (29.5%)	
60-64	359 (20.8%)	535 (22.5%)	
65-69	174 (10.1%)	278 (11.7%)	
≥ 70	56 (3.3%)	90 (3.8%)	
Median age	57	58	
Sex			
Male	1,090 (63.3%)	1,626 (68.4%)	*0.0005*
Female	633 (36.7%)	750 (31.6%)	
Smoking Status (smokers)			
Former	177 (10.3%)	747 (31.4%)	*< 0.0001*
Current	1,546 (89.7%)	1,629 (68.6%)	
Pack-years of cigarette			
< 30	485 (28.2%)	521 (21.9%)	*< 0.0001*
≥ 30	1238 (71.9%)	1855 (78.1%)	
Median pack-years	38	39	

Significance for US Screening?

- USPSTF review underway
- Category A recommendation
- CMS Implications
  - SDM
  - Registry

Shared Decision Making

Editorials Exaggerating Radiation Harm and FPR

What is the false positive rate in modern clinical practice CTLS?

98%, 60%, 50%, 23%, 12%, 7%, 2%

Patient Anxiety – Little/No Evidence

"Permission to Smoke" – Little/No Evidence

Overdiagnosis

What is the rate of overdiagnosis in the NLST when using modern reporting and work up algorithms?

70%, 50%, 18%, 10%, 3%

Significant Incidental Findings

What is the rate of significant incidental findings in clinical CTLS practice?

70%, 40%, 10%, 6%, 4%,2%

What is the False Positive Rate?

"On a population-based level, the FP rate is traditionally defined as the probability of receiving a positive result, given an absence of the disease. In this review, the FP rate will be defined as the number of FPs as a proportion of the total number of screening examinations conducted (i.e. accounting for cases of both the presence and absence of malignant disease). The definition has been modified from the true technical definition as a result of an observed trend, whereby the FP rate is reported in the latter manner by most of the publications concerning mammographic screening." -British Journal of Radiology

What is NOT the False Positive Rate?

"In 1995, Benjamini and Hochberg introduced the concept of the False Discovery Rate (FDR) as a way to allow inference when many tests are being conducted. The FDR is the ratio of the number of false positive results to the number of total positive test results."
-Partnership for Assessment and Accreditation of Scientific Practice

	Disease or Condition	No Disease or Condition
Test Positive	A True Positive	B False Positive
Test Negative	C False Negative	D True Negative

- **False positive rate = B / (D + B)**
- **False discovery rate = B / (A + B)**

10/1000000 = **.001% = FPR**

10/11 = **90% = FDR**

False Positive Rate vs False Discovery Rate

Test	# Screened	Positive Exams	True Positive	False Negative	FPR	FDR
A	106	100	10	1	?	?
B	500	100	10	1	?	?
C	1,000	100	10	1	?	?
D	10,000	100	10	1	?	?
E	100,000	100	10	1	?	?
F	1,000,000	100	10	1	?	?

False Positive Rate vs False Discovery Rate

Test	# Screened	Positive Exams	True Positive	False Negative	FPR	FDR
A	106	100	10	1	95%	?
B	500	100	10	1	18%	?
C	1,000	100	10	1	9%	?
D	10,000	100	10	1	0.9%	?
E	100,000	100	10	1	0.09%	?
F	1,000,000	100	10	2	0.009%	?

False Positive Rate vs False Discovery Rate

Test	# Screened	Positive Exams	True Positive	False Negative	FPR	FDR
A	106	100	10	1	95%	90%
B	500	100	10	1	18%	90%
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D	10,000	100	10	1	0.9%	90%
E	100,000	100	10	1	0.09%	90%
F	1,000,000	100	10	1	0.009%	90%

False Positive Rate vs False Discovery Rate

Test	# Screened	Positive Exams	True Positive	False Negative	Sensitivity	Specificity	FPR	FDR
A	106	100	10	1	91%	5%	95%	90%
B	500	100	10	1	91%	82%	18%	90%
C	1,000	100	10	1	91%	91%	9%	90%
D	10,000	100	10	1	91%	99%	0.9%	90%
E	100,000	100	10	1	91%	~100%	0.09%	90%
F	1,000,000	100	10	1	91%	~100%	0.009%	90%

False Discovery Rate (aka: Rita Redberg's False Positive Rate) NOT HELPFUL to distinguish VERY different screening tests

False Positive Rate vs False Discovery Rate

Test	# Screened	Positive Exams	True Positive	False Negative	Sensitivity	Specificity	FPR	FDR
A	106	100	10	1	91%	5%	95%	90%
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D	10,000	100	10	1	91%	99%	0.9%	90%
E	100,000	100	10	1	91%	~100%	0.09%	90%
F	1,000,000	100	10	1	91%	~100%	0.009%	90%

~ Closest to Lung Screening

False Positive Rate vs False Discovery Rate

	False Positive Rate				False Discovery Rate			
Screening Round	NLST	NLST LR	LHMC	MG	NLST	NLST LR	LHMC	MG
T0	26.3%	12.6%	10.6%	~20%	96.2%	92.8%	83.1%	97%
T1	27.2%	5.3%	5.2%	5-10%	97.6%	90.3%	78.2%	95%
T2	15.9%	5.1%	5.0%	5-10%	94.8%	87.2%	84.6%	95%

Actual Lung Screening False Positive Rates

NLST: National Lung Screening Trial; NLST LR: Pinsky et al NLST conversion; LHMC: Lahey CTLS program; MG: Mammography (nationwide)

False Positive Rate vs False Discovery Rate

	False Positive Rate				False Discovery Rate			
Screening Round	NLST	NLST LR	LHMC	MG	NLST	NLST LR	LHMC	MG
T0	26.3%	12.6%	10.6%	~20%	96.2%	92.8%	83.1%	97%
T1	27.2%	5.3%	5.2%	5-10%	97.6%	90.3%	78.2%	95%
T2	15.9%	5.1%	5.0%	5-10%	94.8%	87.2%	84.6%	95%

Actual Lung Screening False Positive Rates

Rita Redberg's, "Lung Screening False Positive Rates"

NLST: National Lung Screening Trial; NLST LR: Pinsky et al NLST conversion; LHMC: Lahey CTLS program; MG: Mammography (nationwide)

False Positive Rate vs False Discovery Rate

	False Positive Rate				False Discovery Rate			
Screening Round	NLST	NLST LR	LHMC	MG	NLST	NLST LR	LHMC	MG
T0	26.3%	12.6%	10.6%	~20%	96.2%	92.8%	83.1%	97%
T1	27.2%	5.3%	5.2%	5-10%	97.6%	90.3%	78.2%	95%
T2	15.9%	5.1%	5.0%	5-10%	94.8%	87.2%	84.6%	95%

Actual Lung Screening False Positive Rates

Rita Redberg's, "Lung Screening False Positive Rates"

Have you ever heard of 95% false positive rates in mammography?

NLST: National Lung Screening Trial; NLST LR: Pinsky et al NLST conversion; LHMC: Lahey CTLS program; MG: Mammography (nationwide)

What **ARE** the False Positive Rates for CT Lung Screening?

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 AUGUST 4, 2011 VOL. 365 NO. 5

Reduced Lung-Cancer Mortality with Low-Dose Computed Tomographic Screening

The National Lung Screening Trial Research Team*

T0: 26.3%
T1: 27.2%
T2: 15.9%
Overall: 23.3%

Annals of Internal Medicine ORIGINAL RESEARCH

Performance of Lung-RADS in the National Lung Screening Trial

A Retrospective Assessment

Paul F. Pinsky, PhD; David S. Gierada, MD; William Black, MD; Reginald Munden, MD; Hrudaya Nath, MD; Denise Aberle, MD; and Ella Kazerooni, MD

T0: 12.6%
T1: 5.3%
T2: 5.1%
Overall: 7.8%

Original Research

JNCCN The official journal of the NCCN National Comprehensive Cancer Network®

NCCN Guidelines as a Model of Extended Criteria for Lung Cancer Screening

Brady J. McKee, MD; Shawn Regis, PhD; Andrea K. Borondy-Kitts, MS, MPH; Jeffrey A. Hashim, MD; Robert J. French Jr, MD; Christoph Wald, MD, MBA, PhD; and Andrea B. McKee, MD

T0: 10.6%
T1: 5.2%
T2: 5.0%
Overall: 7.6%

Rescuing lives from lung cancer today and tomorrow

SUPPLEMENT

Epidemiol Prev 2016 ; 40 (1): 42-50
DOI: https://doi.org/10.19191/EP16.1S1.P042.029

Screening for lung cancer in high-risk subjects: early diagnosis with spiral CT associated with risk stratification with circulating miRNAs

Lung cancer screening in high-risk subjects: early detection with LDCT and risk stratification using miRNA-based blood test

Stefano Sestini [1], Mattia Boeri [2], AlfonsoMarchianò [3], Mario Silva [4], Giuseppina Calareso [3], Carlotta Galeone [5], Gabriella Sozzi [2], Ugo Pastorino [1]

"With the results of the American study National Lung ScreeningTrial (NLST), published in 2011, for the first time a lung cancer-specific mortality reduction by 20% thanks to the use of LDCT compared to RXT, was highlighted. However, a false positive rate of 96.4% was also described with an overdiagnosis that can be up to 78.9% for bronchioalveolar lung cancer."

This is the false discovery rate

Rescuing lives from lung cancer today and tomorrow

American Journal of Respiratory and Critical Care Medicine

Home > All AJRCCM Issues > **Vol. 191, No. 1 | Jan 01, 2015**

Lung Cancer Screening

Lynn T. Tanoue [1], **Nichole T. Tanner** [2], **Michael K. Gould** [3], and **Gerard A. Silvestri** [2]

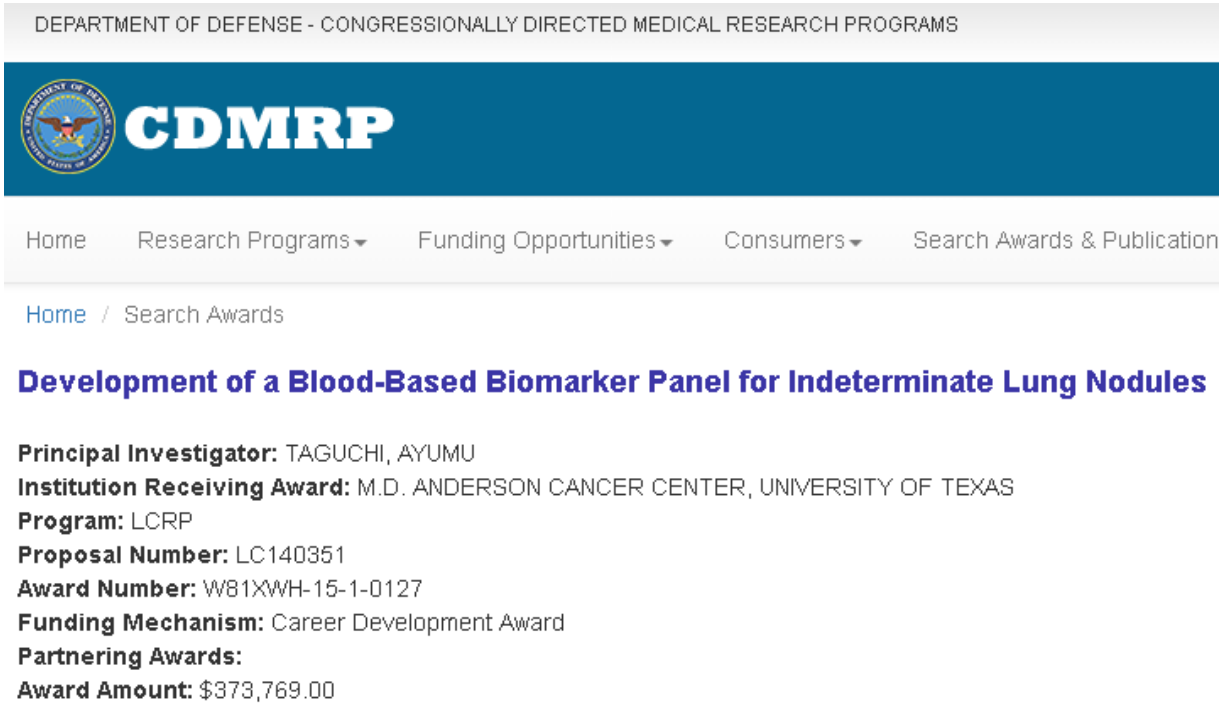
+ Author Affiliations

https://doi.org/10.1164/rccm.201410-1777CI **PubMed:** 25369325

Received: October 03, 2014 Accepted: November 02, 2014

"Overall, 39.1% of participants in the NLST LDCT group had at least one positive screening test, with a false positive rate of 96.4% across the three rounds of screening."

This is the false discovery rate



"Objective and Rationale: Lung cancer screening with low-dose CT (LDCT) has been shown to reduce mortality by 20%, although there are concerns including high false positivity, cost, and radiation exposure. Of note, the false positive rate of lung cancer screening with LDCT alone was 96.4% in the National Lung Cancer Screening Trial."

This is the false discovery rate

cancernetwork
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The Time for Low-Dose Computed Tomography Screening Is Now: A Medical Oncologist Perspective

By Benjamin P. Levy, MD and Daniel J. Becker, MD

Nov 15, 2014

"Perhaps one of the most commonly cited critiques of the NLST is the high false-positive rate (96.4%), which led to further diagnostic tests and unnecessary invasive procedures. While some have suggested that this contributes to patient anxiety and worsening quality of life (QOL), a formal analysis demonstrated no statistically significant difference in anxiety or QOL scores between participants with false-positive results and those with normal results."

This is the false discovery rate

JAMA Internal Medicine | Original Investigation

Implementation of Lung Cancer Screening in the Veterans Health Administration

Linda S. Kinsinger, MD, MPH; Charles Anderson, MD, PhD; Jane Kim, MD, MPH; Martha Larson, BSN, MS; Stephanie H. Chan, MPH; Heather A. King, PhD; Kathryn L. Rice, MD; Christopher G. Slatore, MD, MS; Nichole T. Tanner, MD, MSCR; Kathleen Pittman, BSN, MPH; Robert J. Monte, MBA; Rebecca B. McNeil, PhD; Janet M. Grubber, MSPH; Michael J. Kelley, MD; Dawn Provenzale, MD, MSc; Santanu K. Datta, PhD; Nina S. Sperber, PhD; Lottie K. Barnes, MPH; David H. Abbott, MS; Kellie J. Sims, PhD, MS; Richard L. Whitley, BS; R. Ryanne Wu, MD, MHS; George L. Jackson, PhD, MHA

Patients screened	2106 (85.9)	442 (81.0)	228 (92.3)	213 (82.9)	444 (90.8)	247 (96.9)	135 (76.3)	258 (89.0)	139 (72.8)
Patients with nodular findings on scans[c]	1257 (59.7)	340 (76.9)	70 (30.7)	181 (85.0)	248 (55.9)	153 (61.9)	63 (46.7)	112 (43.4)	90 (64.7)
Patients with nodules to be tracked[d]	1184 (56.2)	323 (73.1)	64 (28.1)	176 (82.6)	225 (50.7)	143 (57.9)	61 (45.2)	108 (41.9)	84 (60.4)
Patients with suspicious findings not confirmed to be lung cancer[e]	42 (2.0)	10 (2.3)	2 (0.9)	2 (0.9)	13 (2.9)	10 (4.0)	0	1 (0.4)	4 (2.9)
Patients with confirmed lung cancer	31 (1.5)	7 (1.6)	4 (1.8)	3 (1.4)	10 (2.3)	0	2 (1.5)	3 (1.2)	2 (1.4)

- 2106 patients screened; 1257 positive* exams; 31 confirmed lung cancers
  - False positive* rate = (1257 – 31) / 2106 = 58.2%
  - False suspicious rate = (73 – 31) / 2106 = 2%

"There was wide variation among sites in the percentage of screening test results that were positive for nodules or possible lung cancer. Overall, 1257 of the 2106 patients (59.7%) screened had a positive test result (site range, 70 of 228 [30.7%] to 181 of 213 [85.0%]) (Table 1), including 1184 patients (56.2%) who had 1 or more nodules needing to be tracked (site range, 64 of 228 [28.1%] to 176 of 213 [82.6%]). Most nodules were small (<5 cm; 710 of 1293 [54.9%]) and solid (1079 of 1293 [83.4%]) (Table 3). A total of 73 patients (3.5% of all patients screened) had findings suspicious for possible lung cancer and underwent further diagnostic evaluation. Lung cancer was confirmed for 31 of those patients (1.5%; site range, 0 of 247 to 10 of 444 [2.3%]) within the 330-day follow-up period; 20 (64.5%) of the cancers were stage I (Table 4). The mean number of days from initial LDCT scan to cancer diagnosis was 137 (range, 5-330 days). The remaining 42 patients (2.0%; site range, 0 of 135 to 10 of 247 [4.0%]) who underwent evaluation were not confirmed to have lung cancer during that time frame. The rate of false-positive test results for lung cancer was 97.5% (1226 of 1257) during the 330-day follow-up period (Table 1)."

false discovery rate

* *"Since only about one-third of nodules identified as needing to be tracked in the LCSDP were 6 mm or greater, the positive rate might decline from nearly 60% to about 20%."*

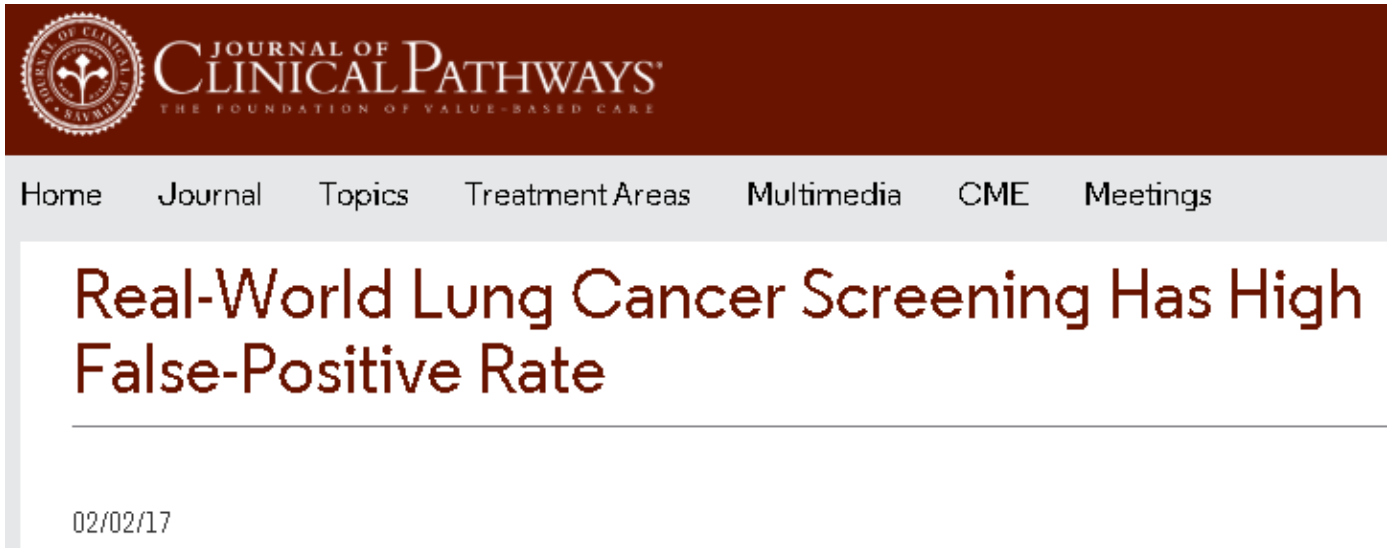
Jan 2017 JAMA Internal Medicine Article

"The rate of false-positive test results for lung cancer was 97.5% (1226 of 1257) during the 330-day follow-up period"

"The reason for the overall high rate of initially positive examination results in the VHA sites is not certain but may be owing, in part, to the older age and heavier smoking history of veterans screened."

"Since only about one-third of nodules identified as needing to be tracked in the LCSDP were 6 mm or greater, the positive rate might decline from nearly 60% to about 20%"

http://jamanetwork.com/journals/jamainternalmedicine/fullarticle/2599437



"Of the 2106 screened patients, 1257 (59.7%) had nodules, and 1184 (56.2%) required tracking. Only 42 (2.0%) patients required further evaluations that did not result in a lung cancer diagnosis, and only 31 (1.5%) were diagnosed with lung cancer within 330 days. Overall, researchers calculated a false-positive rate of 97.5%. Incidental findings such as emphysema, other pulmonary abnormalities, and coronary artery calcification were observed on the scans of 857 patients (40.7%). Wide variation in processes and patient experiences among the 8 sites was also noted."

This is the false discovery rate

NEJM Journal Watch

"A pair of studies in JAMA Internal Medicine illustrate the difficulties of implementing lung cancer screening.

In the first, eight Veterans Health Administration medical centers identified and screened patients using low-dose computed tomography (LDCT). Over 2100 patients who were eligible for screening based on smoking history and other factors completed LDCT. Overall, 60% had nodules, but just 1.5% had lung cancer diagnosed within 330 days. The researchers calculate a false-positive rate of 97.5%."

This is the false discovery rate

Aug 2018 *JAMA Internal Medicine* Shared Decision Making article

"We identified 5385 conversations involving age-eligible patients occurring between April 1, 2014, and March 1, 2018. Of these, 137 met the key word criteria. Manual review of these transcripts yielded 14 conversations about initiation of LCS."

"The 14 conversations involved 10 unique physicians (5 pulmonologists and 5 PCPs). All physicians were in office-based group or solo private practice."

1. **14 conversations, 10 physicians (0.0002% of eligible population)**
2. **Zero analysis of statistical significance**
3. **Study period starts one year before CMS-required SDM visit**

https://jamanetwork.com/journals/jamainternalmedicine/fullarticle/2696731

Aug 2018 *JAMA Internal Medicine* article

"No physician adequately explained false positives or their sequelae. No physician discussed overdiagnosis".

https://jamanetwork.com/journals/jamainternalmedicine/fullarticle/2696731

Editorial

October 2018

Failing Grade for Shared Decision Making for Lung Cancer Screening

Rita F. Redberg, MD, MSc[1,2]

» Author Affiliations | Article Information

JAMA Intern Med. 2018;178(10):1295-1296. doi:10.1001/jamainternmed.2018.3527

"Even in the highest-rated discussions, there was no mention of possible harms from the screening by the physicians, even though these harms include a 98% false-positive rate, which may lead to anxiety; additional testing including imaging or procedures, such as biopsy or lobectomy; and radiation from the LDCT with the small increased risk of cancer. Some evidence suggests that a more-rigorous and -informative SDM discussion about lung cancer screening is occurring in the Veterans Administration system."

This is the false discovery rate

SDM

2 Comments for this article COLLAPSE

August 13, 2018

Appalling

Anthony Glaser, MD, PhD | Paladina Health

Hard to believe that "Even in the highest-rated discussions, there was no mention of possible harms from the screening by the physicians, even though these harms include a 98% false-positive rate". I can understand all the time stresses and pressures primary care physicians (of which I am one) are under, but this is truly appalling. If we can't get our own house in order, why are we surprised that third-party payers require prior authorization for more and more treatments, tests, and procedures. I wonder if there have been any malpractice suits brought by the some of the 98% after they have undergone unnecessary lung biopsies. Is that what it will take to get us - or at least a few of us - to get even the barest semblance of informed consent for a 100% elective procedure?

CONFLICT OF INTEREST: None Reported

- *Baseline LDCTS were performed in 671 patients*
- *The number of patients with Lung-RADS scores of 1, 2, 3, and 4 were 306 (45.6%), 233 (34.7%), 76 (11.3%), and 56 (8.3%), respectively*
- *Therefore, a positive test with a score of 3 or 4 was obtained in 132 patients (19.7%) screened at baseline*
- *Ultimately 18 lung cancers in 16 different patients were identified, with one patient having 3 synchronous primary tumors*

➢ 671 patients screened; 132 positive exams; 16 confirmed lung cancers

➢ False positive rate = (132 – 16) / 671 = **17.3%**

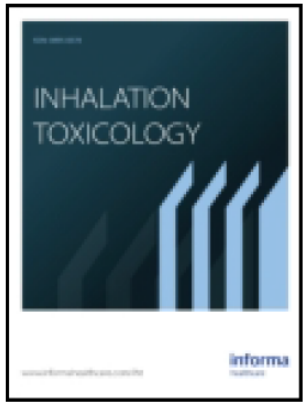
➢ False suspicious rate = (56 – 16) / 671 = **6%**

- *Overall our false-positive rate for baseline lung cancer screening among patients who completed follow up was 77.5% [95% CI 66.0-86.5%].*

false discovery rate

"Roughly one-fifth of patients in our community who met CMS criteria and underwent LDCTS had a positive test result with a false-positive rate that was lower than the National Lung Screening Trial false-positive rate of 96.4%."

This is the false discovery rate



Taylor & Francis
Taylor & Francis Group

Inhalation Toxicology

International Forum for Respiratory Research

ISSN: 0895-8378 (Print) 1091-7691 (Online) Journal homepage: http://www.tandfonline.com/loi/iiht20

Screening tests: a review with examples

L. Daniel Maxim, Ron Niebo & Mark J. Utell

Table 5. Reported false positive rates for CT scans for lung cancer.

Reported false positives as %		Remarks	Source
96.4		National Lung Screening Trial Research Team, p. 399	National Lung Screening Trial Research Team (2011)
96.1		Study also reports 90% sensitivity	Swensen et al. (2003)
95.5		106 false positives among 111 with nodules >0.5 cm	Tiitola et al. (2002)
92.9–96.0	**D**	Rates depended on nodule size, p. 260.	Swensen et al. (2005)
86.6–96.4		Rates depend upon assumed nodule size from 5.0 to 9.0 mm	Henschke et al. (2013)
94.6		Based on 14 detected cancers among 259 patients with abnormal CT scans	McWilliams et al. (2003)
94.1	**E**	From Table 2, 1773 false positives among 1883 nodules detected	Mahadevia et al. (2003)
93	**F**	Based on 8 lung cancers among 114 subjects with nodules >5 mm	Novello et al. (2005)
92.6	**G**	Based on 22 lung cancers among 298 patients with nodules	Pastorino et al. (2003)
92.1	**H**	Based on 22 cancers in 279 with suspicious nodules	Sone et al. (2001)
88.5–97	**I**	From Table 3, rate dependent upon risk	Kovalchik et al. (2013)
87.6		Based on 29 malignancies among 233 positive results	Henschke et al. (2002)
75		Percent of patients with non-calcified nodules on CT	Manos (2013)
73.4		Based on 163 benign nodules among 222 evaluated by thin section CT	Li et al. (2004)
>70		Reported value derived from Mayo clinic and ELCAP trials	Patz et al. (2004)
62.1		Based on 18 false positives among 29 subjects; for nodules >10 mm	Diedrerich et al. (2002)
43.75		Based on 36 confirmed lung cancer cases among 64 patients	Nawa et al. (2002)
21–33		Rates depend upon number of tests, p. 509. Of participants with a false-positive CT scan, 7% had an unnecessary invasive procedure and 2% had major surgery for benign disease.	Croswell et al. (2010)
19		p. 119	Gohagan et al. (2004)
7.9		p. 612. Includes multi-stage process with classification of nodules by size and calcification with follow-up.	Pedersen et al. (2009), Saghir et al. (2012)
7.9 M/5.6 F		Sensitivity reported to range between 84.6% W to 90.6% M	Toyoda et al. (2008)
1.7		Sensitivity reported at 94.6%, based on Volume CT scanning	van Klaveren et al. (2009)

D: 95.5% = 106 / 111 ≠ false positive rate

E: 94.6% = (259 – 14) / 259 ≠ false positive rate

F: 94.1% = 1773 / 1883 ≠ false positive rate

G: 93% = (114 – 8) / 114 ≠ false positive rate

H: 92.6% = (298 – 22) / 298 ≠ false positive rate

I: 92.1% = (279 – 22) / 279 ≠ false positive rate

THESE ARE ALL FALSE DISCOVERY RATES

Rescuing lives from lung cancer today and tomorrow

Is This Misrepresentation Happening for All Cancer Screening?

JAMA | US Preventive Services Task Force | EVIDENCE REPORT

Screening for Ovarian Cancer
Updated Evidence Report and Systematic Review for the US Preventive Services Task Force

Jillian T. Henderson, PhD; Elizabeth M. Webber, MS; George F. Sawaya, MD

Table 4. False-Positive and Surgical Harms Reported in Ovarian Cancer Screening Tria

Source	Quality[b]	False-Positive Screening Rate Across Entire Program, No. With False-Positive Screen/ No. Without Cancer (%)[c]
UKCTOCS, 2016[22,31,34] (CA-125 ROCA)	Good	20 340/46 067 (44.2) across 2-11 rounds of screening[e]
UKCTOCS, 2016[22,31] (TVU)	Good	NR[h]
PLCO, 2011[20,21,27]	Good	3285/34 041 (9.6) across 1-6 rounds of screening
UK Pilot, 1999[33]	Good	462/10 942 (4.2) across 1-3 rounds of screening[m]
QUEST, 2007[29]	Fair	NA

Not using false discovery rate when discussing ovarian cancer screening

Radiation Exposure

LDCT	<1 mSv	Years of annual lung screening
Mammogram	.7 mSv	
Lumbar Spine Films	2 mSv	2
Diagnostic Chest CT	10 mSv	10
Triphasic CT AB/P	25 mSv	25
Background Exposure Colorado	3 mSv/year 4.5 mSv/year	3 4.5
Occupational Exposure	50 mSv/year	50
Transatlantic Flight	.1 mSv	7 flights = 1 LDCT

10 -30 year latency period to develop secondary malignancies from RT exposure

Average age of patients in screening trials is 62

HEALTH PHYSICS SOCIETY

RADIATION RISK IN PERSPECTIVE

POSITION STATEMENT OF THE HEALTH PHYSICS SOCIETY*

Adopted: January 1996
Revised: July 2010

Contact: Brett Burk
Executive Secretary
Health Physics Society
Telephone: 703-790-1745
Fax: 703-790-2672

There is substantial and convincing scientific evidence for health risks following high-dose exposures. However, below 50–100 mSv (which includes occupational and environmental exposures), risks of health effects are either too small to be observed or are nonexistent.

quantitative estimation of health risks below an individual dose[1] of 50 millisievert (mSv) in one year or a lifetime dose of 100 mSv above that received from natural sources. Doses from natural background radiation in the United States average about 3 mSv per year. A dose of 50 mSv will be accumulated in the first 17 years of life and 0.25 Sv in a lifetime of 80 years. Estimation of health risk associated with radiation doses that are of similar magnitude as those received from natural sources should be strictly qualitative and encompass a range of hypothetical health outcomes, including the possibility of no adverse health effects at such low levels.

There is substantial and convincing scientific evidence for health risks following high-dose exposures. However, below 50–100 mSv (which includes occupational and environmental exposures), risks of health effects are either too small to be observed or are nonexistent.

TABLE 2: Published DLP to E "*k*" Conversion Coefficients[a]

Anatomic Region	DLP to E "*k*" Conversion Coefficients [mSv / (mGy × cm)]				Phantom (cm)
	Jessen et al., [11] (1999)	EC [12] (2000)	EC Appendix B [10] (2004)	EC Appendix C [13] (2004) and NRPB-W67 [14] (2005)	
Head	0.0021	0.0023	0.0023	0.0021	16
Head and neck				0.0031	16
Neck	0.0048	0.0054		0.0059	32
Chest	0.014	0.017	0.018	0.014	32
Abdomen	0.012	0.015	0.017	0.015	32
Pelvis	0.019	0.019	0.017	0.015	32
Chest, abdomen, and pelvis				0.015	32

Note—EC = European Commission, NRPB = National Radiological Protection Board.
[a] $E = k \times DLP$, where DLP = dose–length product. The phantom size is specified for the volume CT dose index measurements on which DLP is based.

Lahey CTLS exams 1/1/2016 – 12/31/2017

- DLP = 46.45 mGy-cm
- E = DLP * k
- E = 46.45 * 0.014
- **E = 0.65 mSv**

Example patient:

- Group 2
- In program for all years eligible (age 50-80; 30 years)
- **THREE** screening exams a year
- **58.5 mSv**

Radiation workers – 50mSV per year

Future Dose Reduction Opportunities

Second Generation Iterative Reconstruction

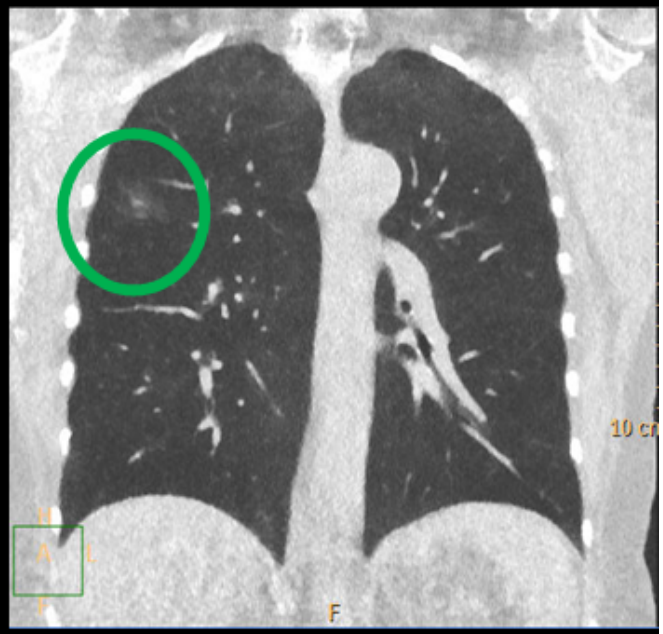
GGO

80 kVp, 10 mAs
0.014*)

DLP: 8.2 mGy x cm

Eff Dose: 0.11 mSv (k =

Chest X-Ray
0.05 mSv



Standard Reconstruction
(FBP)

Second Generation IR

= 2 CXR
Fast reconstruction time

1

Significant Incidental Findings

IASLC
INTERNATIONAL ASSOCIATION FOR THE STUDY OF LUNG CANCER

IASLC 19th World Conference on Lung Cancer
September 23–26, 2018 Toronto, Canada
WCLC2018.IASLC.ORG #WCLC2018

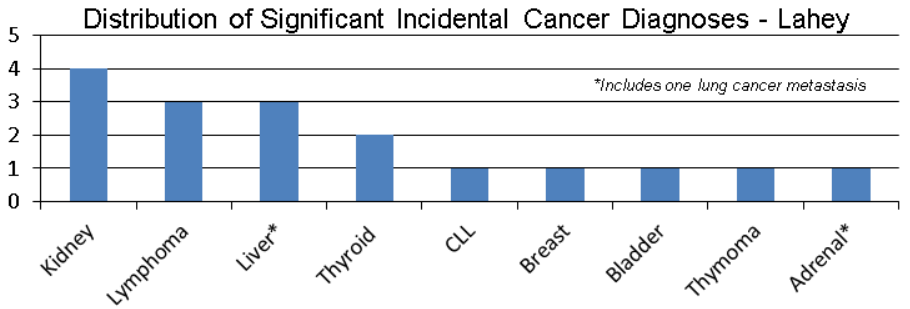
Lahey

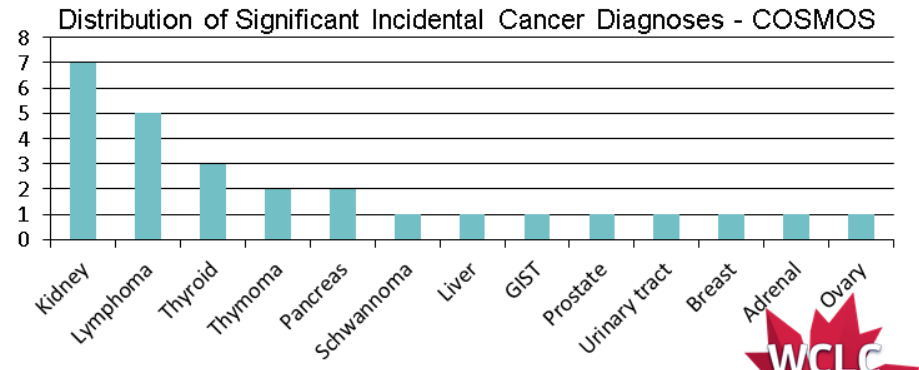
Unexpected findings which are either new or unknown and require some form of clinical or imaging investigation before the next recommended CTLS exam

COSMOS

Incidentally discovered masses or lesions included on the CT scan not referable to lung, bronchial tree, or pleura requiring further diagnostic and/or clinical examination

	Lahey	COSMOS
Patients in study	2927	5201
Study duration	5 years	5 years
Mean follow up interval	35.7 months	51.1 months
Patients with significant incidental finding(s)	9.4%	7.7%
Significant incidental CDR	6.2%	6.2%
Significant incidental cancer : lung cancer ratio	1 : 7.5	1 : 7
Significant incidental cancer rate	1 per 195 patients screened	1 per 200 patients screened





WCLC 2018

Lahey Hospital & Medical Center

Quality Metrics - Agreement on Terminology

Major discrepancies in the reporting of significant incidental findings in CT lung screening due to lack of both general and specific standard definitions

Table 2. Results of Three Rounds of Screening.*

Screening Round	Low-Dose CT			
	Total No. Screened	Positive Result	Clinically Significant Abnormality Not Suspicious for Lung Cancer	No or Minor Abnormality
			no. (% of screened)	
T0	26,309	7191 (27.3)	269 (10.2)	16,423 (62.4)
T1	24,715	6901 (27.9)	151 (6.1)	16,295 (65.9)
T2	24,102	4054 (16.8)	140 (5.8)	18,640 (77.3)

N Engl J Med 2011; 365:395-409

"The review of the scan reveals that an abnormality is present and requires further evaluation, but is not suggestive of lung malignancy. It is up to the radiologist to determine whether an abnormality is clinically significant."

Table 1. Summary Results for the Initial Ro

Characteristic	No. (%) All Sites
Patients who met all screening criteria	4246
Patients who agreed to be screened[b]	2452 (57.7)
Patients screened	2106 (85.9)
Patients with nodular findings on scans[c]	1257 (59.7)
Patients with nodules to be tracked[d]	1184 (56.2)
Patients with suspicious findings not confirmed to be lung cancer[e]	42 (2.0)
Patients with confirmed lung cancer	31 (1.5)
Patients with incidental, non-nodule findings on scans	857 (40.7)
Total LDCT scans completed[f]	2694

JAMA Intern Med. 2017;177(3):399-406

"Radiologists and coordinators were asked to record only incidental findings that would likely require follow-up or further evaluation. Overall, 857 patients (40.7%) had 1 or more incidental findings reported (site range, 89 of 444 [20.0%] to 135 of 213 [63.4%])"

Table 5

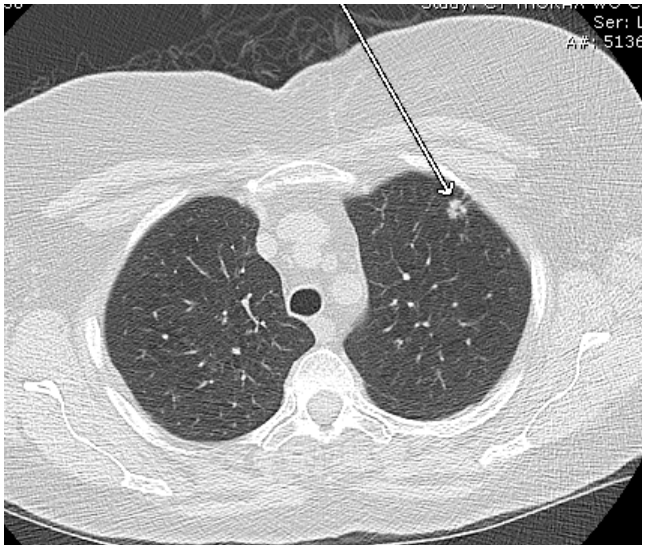
Screening Round	Significant Incidental Findings						
	Overall		Group 1		Group 2		*P* Value
T0	188	6.4%	150	6.7%	38	5.4%	.23
T1	45	2.5%	40	3.0%	5	1.2%	.03
T2	23	2.1%	20	2.4%	3	1.1%	.32
≥T3	13	1.9%	10	1.9%	3	1.9%	1
Total	269	4.1%	220	4.5%	49	3.2%	.02

J Natl Compr Canc Netw 2018;16(4):444–449

*"**Unexpected** findings which are either **new** or **unknown** and require some form of clinical or imaging investigation before the next recommended CTLS exam"*

Secondary Prevention
Preclinical Diagnosis

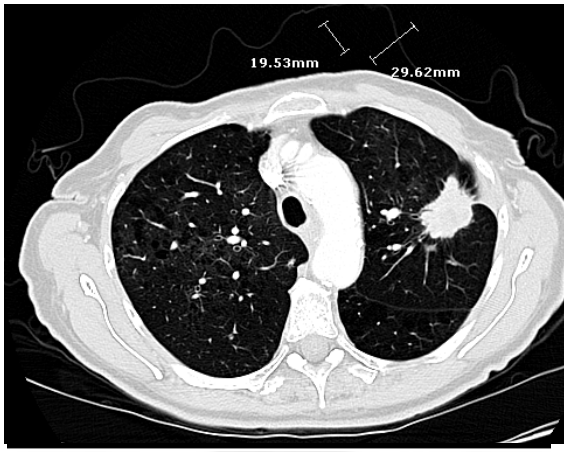
Asymptomatic

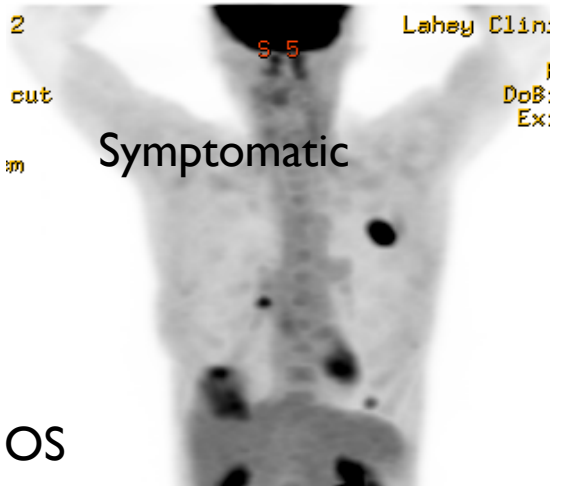


Stage I
88% 10-year OS

Screening

58% 5-year OS





Stage IV
1% 5-year OS

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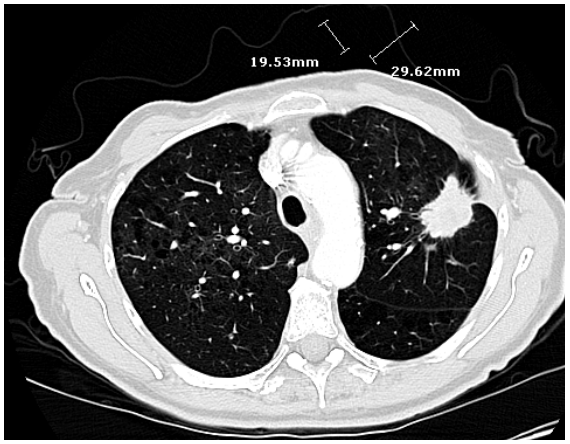
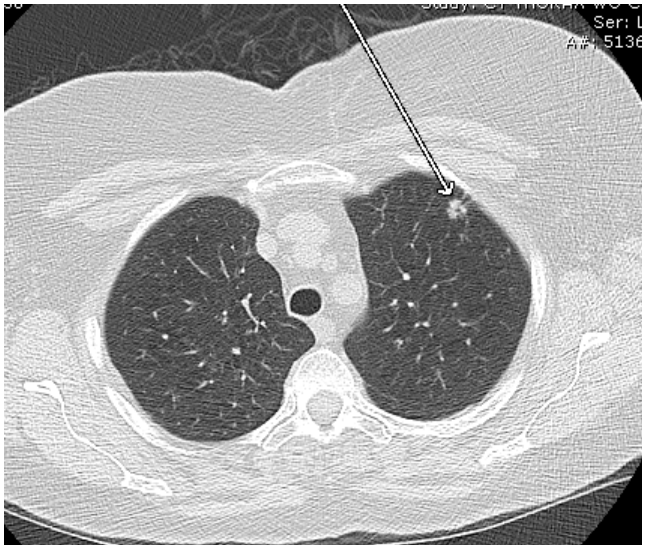
Secondary Prevention
Preclinical Diagnosis

58% 5-year OS



Asymptomatic



Stage I
88% 10-year OS

Table 2. Frequency Distribution of Lung-Cancer Diagnoses on Baseline and Annual CT Screening, According to Age and Median Pack-Years of Cigarette Smoking.

Age	Baseline Screening			Annual Screening		
	Smoking History	No. Screened	Diagnosis of Lung Cancer	Smoking History	No. Screened	Diagnosis of Lung Cancer
	median pack-yr		*no. (%)*	*median pack-yr*		*no. (%)*
40–49 yr	15	4,066	8 (<1)	20	1,324	1 (<1)
50–59 yr	28	9,948	67 (1)	30	6,678	7 (<1)
60–69 yr	38	12,184	206 (2)	40	11,879	29 (<1)
70–79 yr	38	4,840	116 (2)	40	6,692	33 (<1)
80–86 yr	30	529	13 (2)	37	883	4 (<1)
Total	30	31,567	410 (1)*	35	27,456	74 (<1)

* The number includes five participants with interim diagnoses.

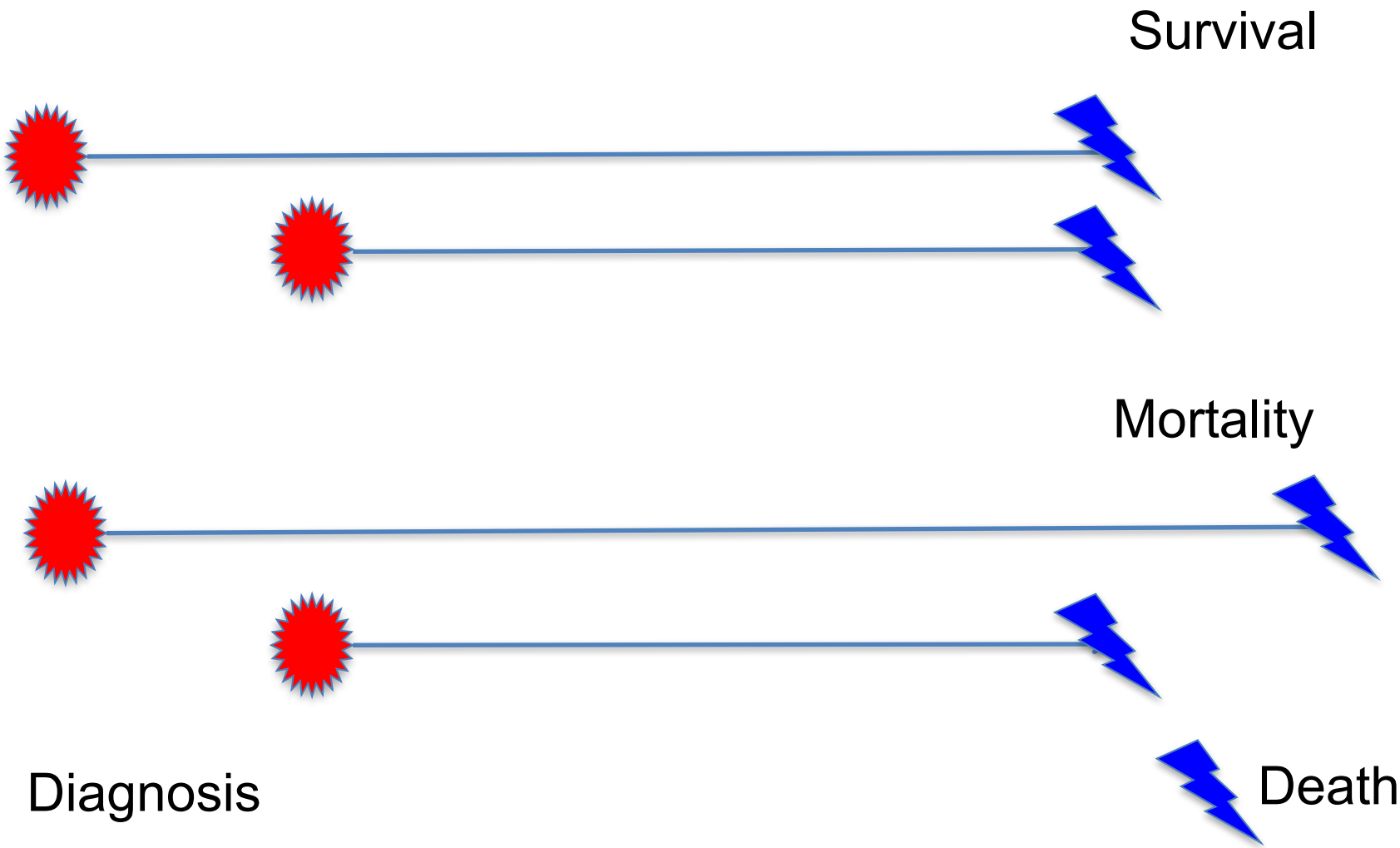
October 26, 2006
N Engl J Med 2006; 355:1763-1771
DOI: 10.1056/NEJMoa060476

Overdiagnosis, Survival, Mortality

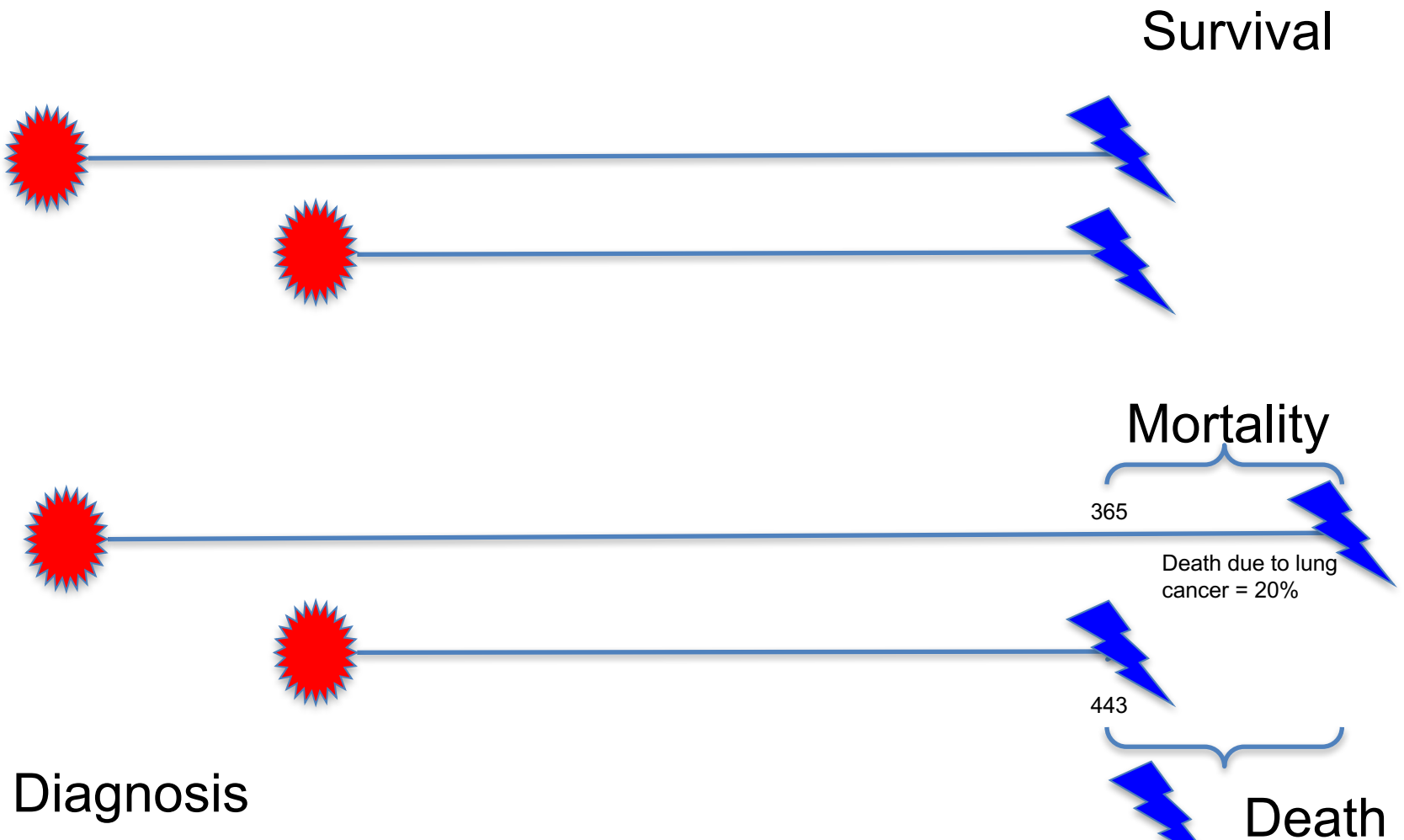
Diagnosis

Death

Overdiagnosis, Survival, Mortality

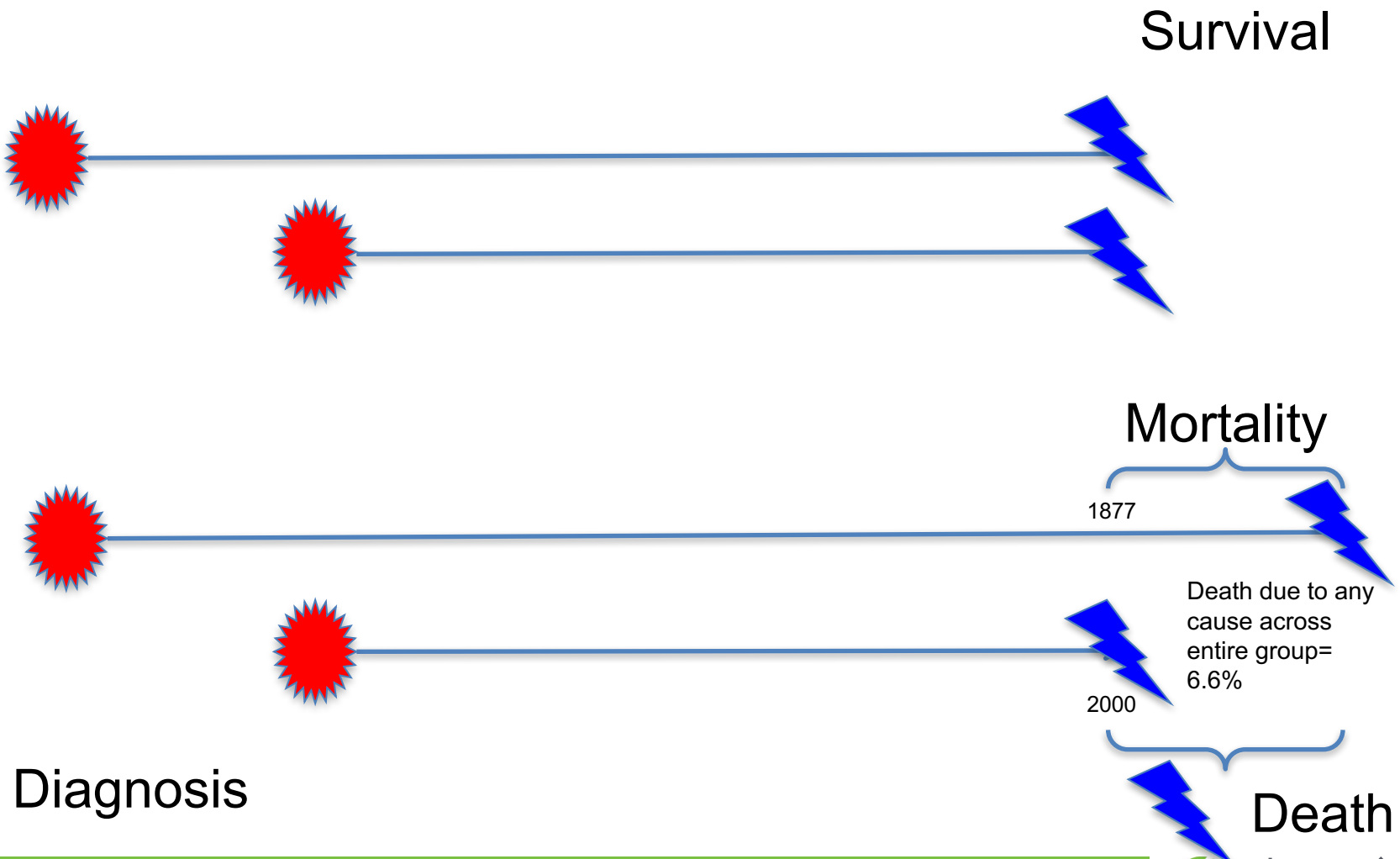


Lung Cancer Mortality



Lahey Hospital & Medical Center

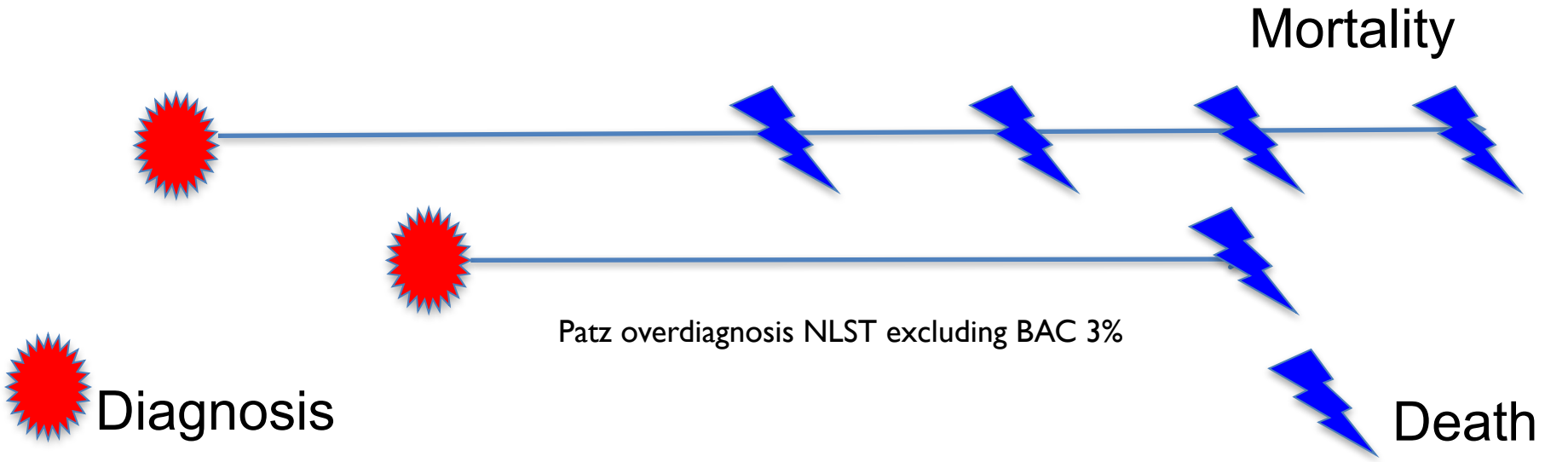
Overall Mortality



Lahey Hospital & Medical Center

Overdiagnosis

*Determine time and cause of death in those patients **diagnosed and treated** for lung cancer*



Lahey Hospital & Medical Center

Methods

Adenocarcinomas

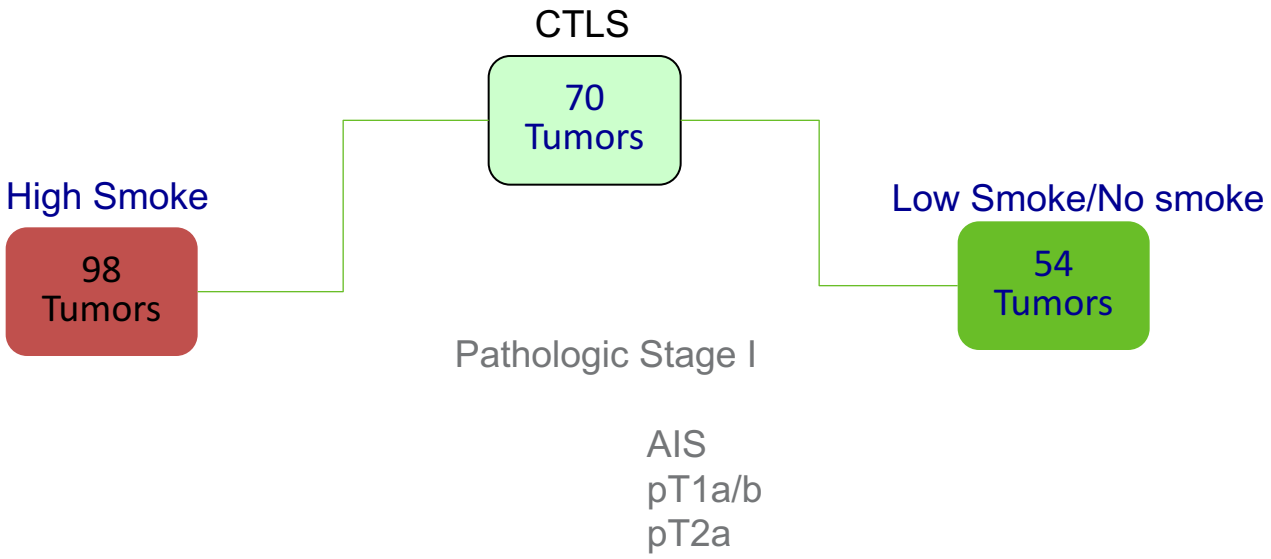


Table 1: Comparison of Clinical Features of 202 Patients with 208 Stage I Adenocarcinomas

Patients/Resections/Tumors	HS n=86/89/98	CTLS n=63/65/70	LS/NS n=53/54/54	P value
Age [median (Q1-Q3)]	68 (62-71)	66 (60-72)	67 (62-76)	0.410
Gender				0.014
Male (%)	43 (50)	31 (49)	14 (26)	
Female (%)	43 (50)	32 (51)	39 (74)	
Smoking Status				<0.001
Never smoker (%)	0	0	27 (51)	
Former smoker (%)	41 (48)	43 (68)	21 (40)	
Current smoker (%)	45 (52)	20 (32)	5 (9)	
Pack Years [median (Q1-Q3)]	41 (35-60)	40 (30-50)	10 (6-13)*	<0.001
Quit Years [median (Q1-Q3)]	10 (3-20)*	10 (6-15)*	21 (20-40)*	0.001
Laterality				0.660
Right (%)	59 (66)	46 (71)	34 (63)	
Left (%)	30 (34)	19 (29)	20 (37)	
Stage				0.095
pTis (%)	3 (3)	2 (3)	4 (7)	
IA (pT1a/b) (%)	58 (65)	45 (69)	43 (80)	
IB (pT2a) (%)	28 (32)	18 (28)	7 (13)	
Tumor Size				
Total Size [median (Q1-Q3), cm]	1.8 (1.3-2.4)	1.5 (1.1-2.3)	1.8 (1.4-2.5)	0.102
Invasive Size [median (Q1-Q3), cm]	1.5 (0.9-2.4)	1.1 (0.8-1.7)	1.0 (0.4-1.8)	0.033
Multiple Adenocarcinomas				0.356
Patients with Synchronous (%)	6 (7)	3 (5)	0	
Patients with Metachronous (%)	3 (3)	2 (3)	1 (2)	

Systematic Histologic Evaluation in 5% Increments

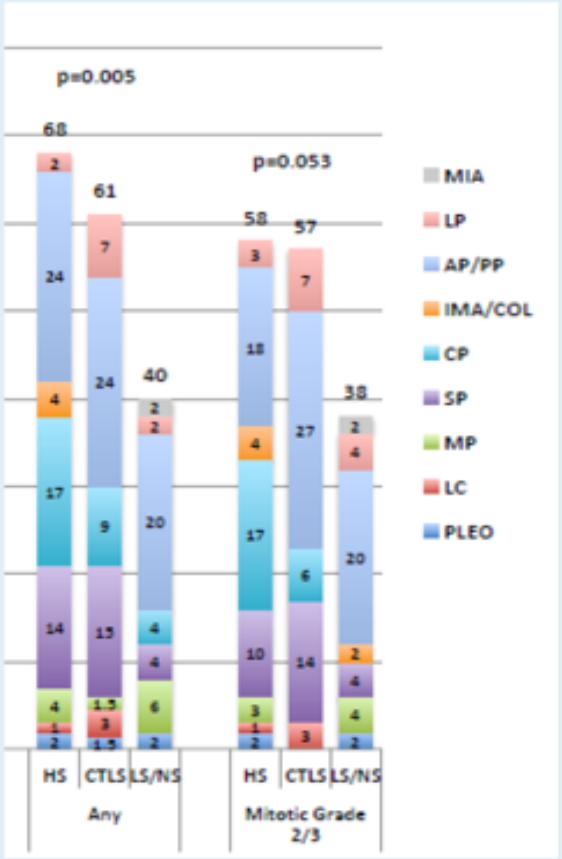
- Minimally Invasive Adenocarcinoma
- Lepidic Predominant
- Acinar Predominant
- Papillary Predominant
- Solid Predominant
- Micropapillary Predominant
- Colloid
- Invasive Mucinous
- Large Cell
- Pleomorphic Carcinoma
- Cribriform Carcinoma

Mitotic grade, Visceral Pleural, or Angiolymphatic Invasion, Air Space Invasion (STAS)

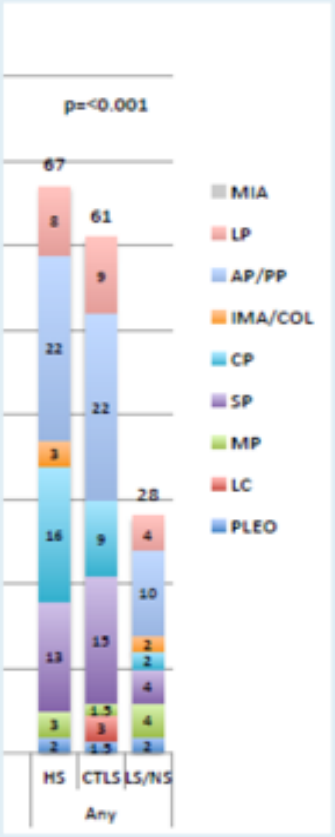
Aggressive Histologies:
>5% Micropapillary, Solid
>10%Colloid, Cribriform, Invasive Mucinous, Large Cell, Pleomorphic Carcinoma

FREQUENCY OF AGGRESSIVE HISTOLOGIC PATTERNS AND INVASIVE CHARACTERISTICS

Aggressive Histology/Mitosis



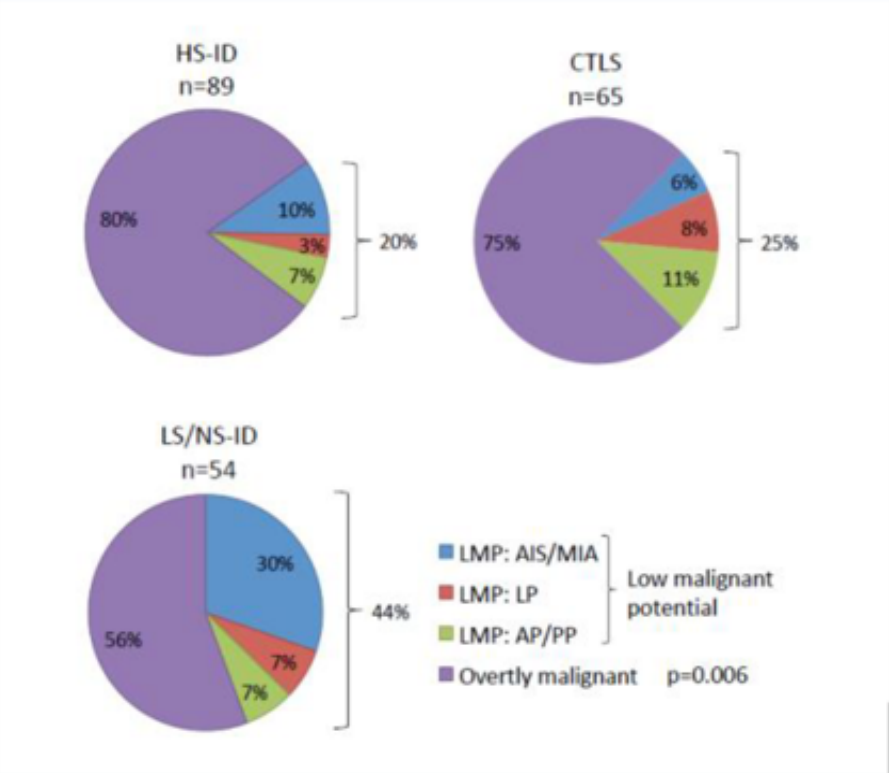
Invasion



Low smoke/No smoke – 22% ALI and 4% VPI VS CTLS 44% ALI and 22% VPI

Lahey Hospital & Medical Center

FREQUENCY OF OVERTLY MALIGNANT VS. LOW-MALIGNANT POTENTIAL (LMP) HISTOLOGIC SUBTYPES - STAGE I LUAD



Overtly malignant tumors are defined as adenocarcinomas showing any angiolymphatic, visceral pleural or air space invasion (LI, VI, VPI, STAS); mitotic grade >1; ≥5% solid or micropapillary patterns, ≥10% cribriform pattern; or invasive mucinous, colloid, large cell, or pleomorphic carcinoma.

Exome RNA sequencing

Overtly Malignant Potential 75-80% for CTLS and HS groups vs 56% for LS/NS

Pathologic Comparison of Prevalent vs. Incident CT Lung Screen Detected Cancer in NCCN High-Risk Subjects: Are They Different?

EJ Burks, JM Sands, TB Sullivan, SM Regis, BJ McKee, AB McKee, KM Rieger-Christ
Lahey Hospital & Medical Center, Burlington, MA

Rescue Lung Rescue Life

Background

CT lung cancer screening (CTLS) detects two overlapping but potentially distinct groups of tumors. Prevalent tumors, found at baseline screening, are thought to be enriched with slow-growing, potentially indolent cancers while incident tumors, found on annual repeat scans, are thought to be more uniformly fast-growing and aggressive. Pathologically, squamous cell (SCC) and small cell lung cancer (SCLC) are more commonly fast-growing and aggressive while adenocarcinomas have a greater potential for heterogeneity in their growth-rates, behavior and histology. By comparing pathologic subtypes, I-ELCAP investigators reported a higher proportion of adenocarcinoma compared to squamous cell carcinoma in prevalent than incident tumors and conversely a lower proportion of SCC and SCLCL. Based partly on these data, some worry about the risk of overdiagnosis in CTLS subjects undergoing baseline screening in which the proportion of slow-growing potentially indolent adenocarcinomas may be enriched. Current guidelines recommend screening specific high-risk subjects for which pathologic comparisons of prevalent and incident cancers have not been described.

Methods

The pathology of 155 CTLS cancers detected at Lahey Hospital & Medical Center were reviewed, including 105 detected at baseline and 50 on incident (annual) repeat screening. All individuals undergoing screening met the NCCN Guidelines Lung Cancer Screening v1.2012 high-risk criteria, were asymptomatic, had no known metastatic disease, and were free of lung cancer for at least five years. Detailed pathologic analysis was performed for 73 stage I resected adenocarcinomas, whereas histotype alone was determined for the remaining cytologically diagnosed tumors As per Lung-RADS criteria, only GGO's with or developing a solid component led to surgical intervention.

Results

Pathologic Comparison of All CTLS Cancers

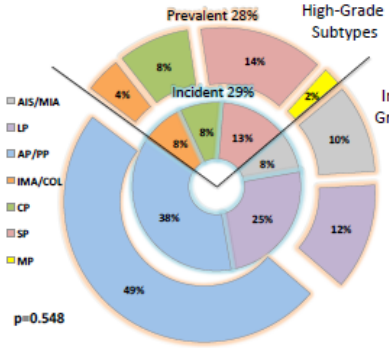
	Lahey-NCCN		
	Prevalent	Incident	P-value
Tumors	***105***	***50***	***0.004***
Adenocarcinoma	69 (66%)	30 (60%)	
SCC	28 (27%)	8 (16%)	
NSCLC Other[a]	0	4 (8%)	*
SCLC	6 (6%)	8 (16%)	*
Carcinoid	2 (2%)	0	

[a]*Large Cell, LCNEC, Pleomorphic, Myoepithelial Carcinoma.*
* NSCLC Other and SCLC remained statistically significant on post-hoc analysis.

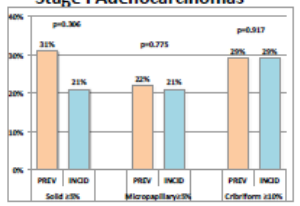
Stage Comparison CTLS NSCLC

	Lahey-NCCN		
	Prevalent	Incident	P-value
Subjects	***99***	***45***	***0.370***
Stage I	72 (73%)	38 (84%)	
Stage II	8 (8%)	3 (7%)	
Stage III	10 (10%)	3 (7%)	
Stage IV	9 (9%)	1 (2%)	

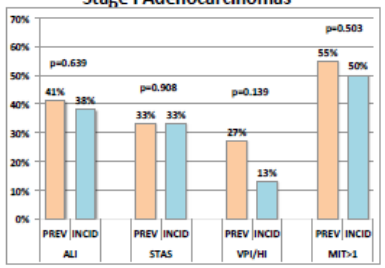
Histologic Subtype Comparison Stage I Adenocarcinomas



High Grade Component Comparison Stage I Adenocarcinomas

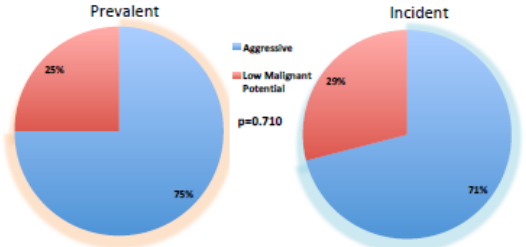


Invasive Characteristic Comparison Stage I Adenocarcinomas



ALI, angiolymphatic; STAS, spread through air spaces, VPI, visceral pleural invasion; HI, hilar invasion; MIT, mitotic grade.

Combined Aggressive Feature Comparison Stage I Adenocarcinoma



Aggressive any solid ≥5%, micropapillary ≥5%, cribriform ≥10%, angiolymphatic, STAS, visceral pleural or hilar invasion, or mitotic grade >1. Low Malignant Potential without these features.

Pathologic Comparison of Lahey-NCCN vs. I-ELCAP Cancers

	Lahey-NCCN		I-ELCAP*	
	Prevalent	Incident	Prevalent	Incident
Scans	5,352	5,821	10,056	14,678
Cancer detection rate	1.9%	0.9%	2%	0.3%
Tumors	105	50	202	48
Adeno:Squamous ratio	2.5:1	3.8:1	8:1	3.4:1
SCLC:NSCLC ratio	1:16	1:5	1:20	1:4

*Data based on historic research cohorts with variable smoke exposure, >10 packers and >40 years of age. Carter D, Vazquez M, Flieder DB., et. al. Lung Cancer 56:193-99, 2007

Conclusions

- Small cell carcinomas and uncommon aggressive NSCLC carcinomas (Pleomorphic, Large Cell, and LCNEC) are increased in incident compared to prevalent tumors, consistent with the rapid growth rates of these tumors.
- There is little pathologic variability between prevalent vs. incident stage I adenocarcinomas in NCCN high-risk subjects with the majority exhibiting aggressive histopathologic features.
- As such, the risk of overdiagnosis among baseline detected adenocarcinomas may be less than once thought.

An Actuarial Analysis Shows That Offering Lung Cancer Screening As An Insurance Benefit Would Save Lives At Relatively Low Cost

- Cost per life-year saved would be below $19,000

EXHIBIT 4

Cost Of Cervical, Colorectal, Breast, And Lung Cancer Screening Per Life-Year Saved

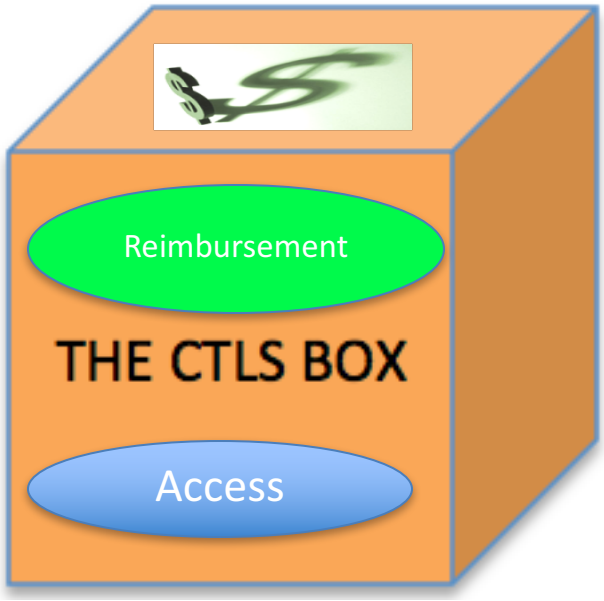
Type of cancer	Screening technique	Cost per life-year saved (dollars, year of original study)	Date of original study	Cost per life-year saved (2012 dollars)
Cervical[a]	Pap smear	33,000	2000	50,162[b]–75,181[c]
Colorectal[d]	Colonoscopy	11,900	1999	18,705[b]–28,958[c]
Breast[e]	Mammography	18,800	1997	31,309[b]–51,274[c]
Lung[f]	LDCT (baseline scenario[g])	18,862	2012	18,862
	LDCT (lowest-cost scenario[h])	11,708	2012	11,708
	LDCT (highest-cost scenario[i])	26,016	2012	26,016

Pyenson et al, Health Affairs 31, No.4 770-779: April 2012

Measure		2018			
		Your Facility (100372)		All LCSR	
		Rate	Num-Den	Rate	Num-Den
All Exams		976	976	177466	177466
Appropriateness of screening by USPSTF criteria (%)		94.16	(919 / 976)	90.69	(160946 / 177466)
Smoking cessation counselling offered (%)		100.00	(976 / 976)	78.03	(138476 / 177466)
	Smoking cessation counselling offered among current smokers (%)	100.00	(500 / 500)	85.44	(89260 / 104472)
Radiation exposure 1	Mean CTDIvol - Overall (mGy)	1.20	(NA / 976)	3.19	(NA / 177466)
	Mean CTDIvol - underweight (BMI <18.5)(mGy)	1.16	(NA / 20)	2.55	(NA / 7036)
	Mean CTDIvol - normal (BMI of 18.5–24.9)(mGy)	1.21	(NA / 191)	2.67	(NA / 42713)
	Mean CTDIvol - overweight (BMI of 25–29.9)(mGy)	1.17	(NA / 355)	2.96	(NA / 56780)
	Mean CTDIvol - obese (BMI of 30 or greater)(mGy)	1.23	(NA / 407)	3.85	(NA / 63333)
Radiation exposure 2	Mean DLP - Overall	46.05	(NA / 976)	96.19	(NA / 177466)
	Mean DLP - underweight (BMI <18.5)(mGy-cm)	45.94	(NA / 20)	77.80	(NA / 7036)
	Mean DLP - normal (BMI of 18.5–24.9)(mGy-cm)	47.71	(NA / 191)	79.96	(NA / 42713)
	Mean DLP - overweight (BMI of 25–29.9)(mGy-cm)	44.54	(NA / 355)	91.28	(NA / 56780)
	Mean DLP - obese (BMI of 30 or greater)(mGy-cm)	46.67	(NA / 407)	114.01	(NA / 63333)
Abnormal Interpretation Rate (%)	(Lung-RADS 3, 4a, 4b, 4x)	9.02	(88 / 976)	15.28	(27117 / 177466)
	Abnormal Interpretation Rate, at baseline exam (%)	18.18	(60 / 330)	17.22	(20775 / 120673)
	Abnormal Interpretation Rate, at annual exam (%)	4.35	(28 / 644)	10.52	(5821 / 55342)
Cancer Detection Rate (CDR) per 1000		0.00	(0 / 976)	2.07	(367 / 177466)
	CDR per 1000 for prevalent cancers, detected at baseline exam	0.00	(0 / 330)	2.41	(291 / 120673)
	CDR per 1000 for incident cancers, detected at annual exam	0.00	(0 / 644)	1.28	(71 / 55342)
Positive Predictive Value 1 (PPV1)(%)		0.00	(0 / 88)	1.35	(367 / 27117)
	PPV1 for lung cancers detected on percutaneous biopsies (%)		(0 / 0)	48.10	(190 / 395)
	PPV1 for lung cancers detected on bronchoscopies (%)		(0 / 0)	34.07	(92 / 270)
	PPV1 for surgically detected lung cancers (%)		(0 / 0)	59.59	(115 / 193)

What's in the Box?

Reimbursement = Access to Screening



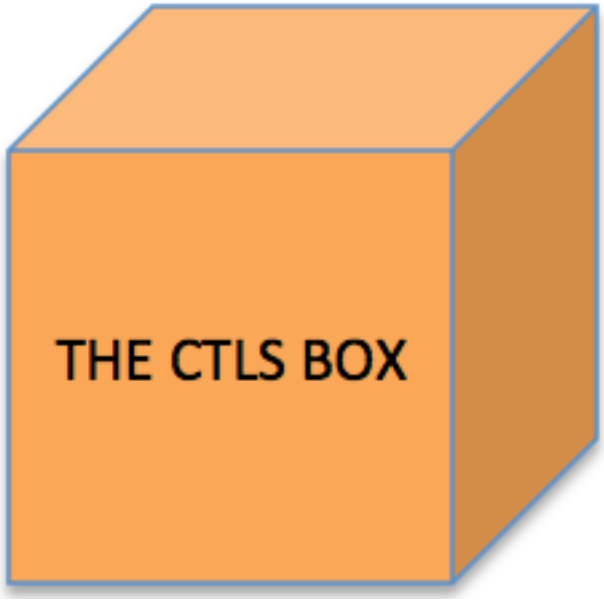
Who's in The Box?

Lung Cancer Risk Factors

NLST

✓ Age

✓ Smoking History



- Personal Cancer History
- Family History Lung Ca
- Carcinogen Exposure
- Chronic Lung Disease
- Sex
- Race
- Education
- BMI

Aberle DR, Adams AM, Berg CD, et al. Reduced lung-cancer mortality with low-dose computed tomographic screening. *The New England journal of medicine.* 2011;365(5):395-409.

NCCN Guidelines®: High-Risk Groups

Group 1 (Category 1 Recommendation)	Group 2 (Category 2A Recommendation)
55–74 years old	> 50 years old
Are currently a smoker or have quit within the past 15 years	Have smoked at least a pack of cigarettes a day for 20+ years
Have smoked at least a pack of cigarettes a day for 30+ years	Have one additional lung cancer risk factor, not to include secondhand smoke exposure

NCCN Model Based Risk

Group 1 vs Group 2

6 Year Risk of Developing Lung Cancer (*PLCOm2012 Tammemagi)*

Group 1: 65y, 30 PY, Current	**2.5%**
Group 2: 65y, 25 PY, Current, +Fam Hx	3.8%

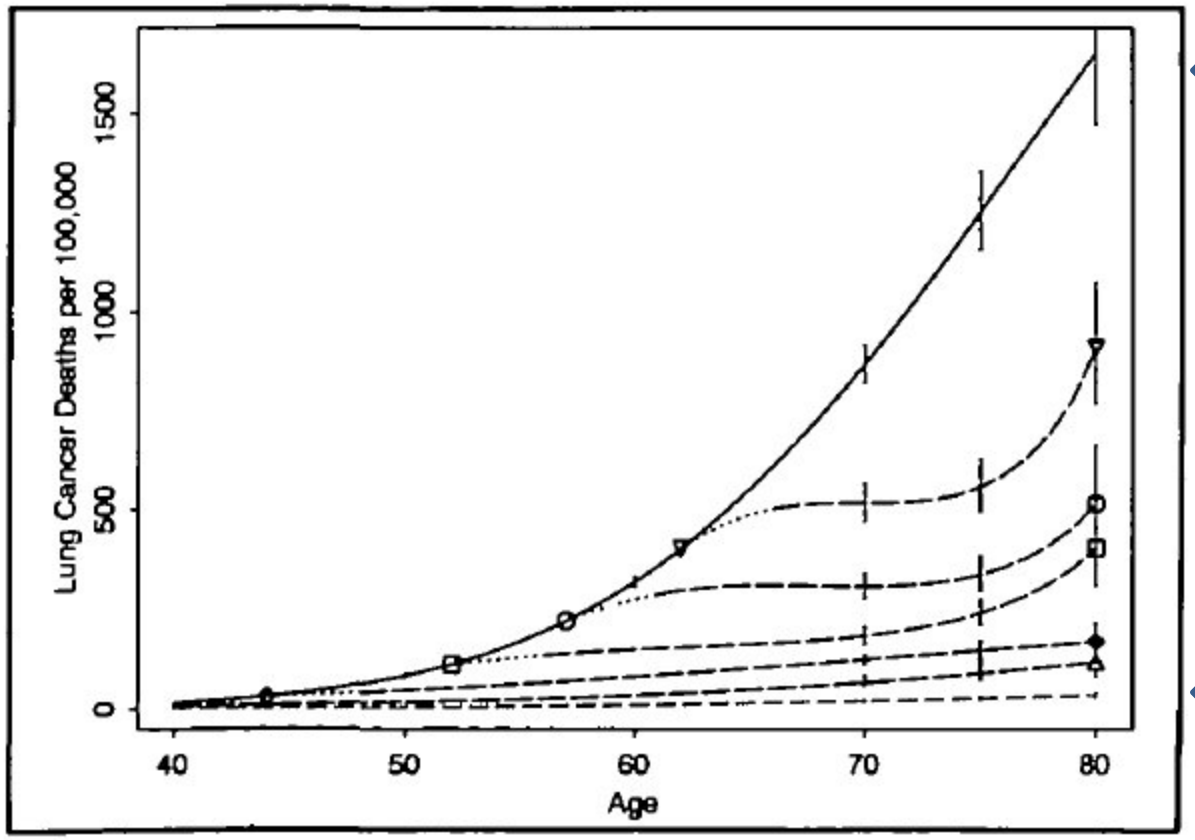
Group 1: 56y, 40PY, Current	**1.5%**
Group 2: 53y, 40PY, Current, +Fam Hx	2.1%

Group 1: 65y, 30PY, Quit x 6y	**1.6%**
Group 2: 65y, 30PY, Quit x 18y, +Fam Hx	2.0%

Tammemagi MC, et al. Selection Criteria for Lung-Cancer Screening. New England Journal of Medicine. 2013;368(8):728-36.

Available online athttp://www.brocku.ca/lung-cancer-risk-calculator

OOTB: > 30 PY & > 15 Quit Years



Current Smokers

Quit age 60-64

Quit age 55-59

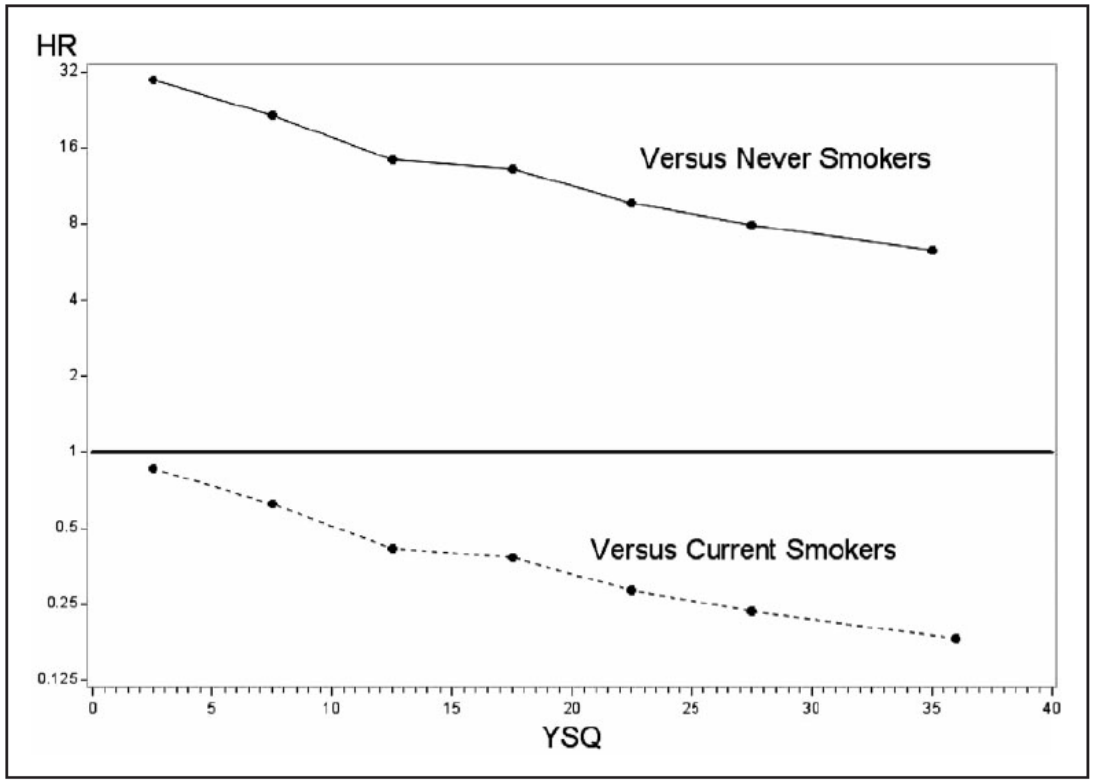
Never Smokers

(Halpern, et al. JNCI 1993;85(6)

Quitting after age 50 reduces the risk of lung cancer death compared with current smokers, but following a plateau after cessation, risk of lung cancer death rises significantly

OOTB: > 30 PY & > 15 Quit Years

PLCO



Pinsky PF, Zhu CS, Kramer BS. Lung cancer risk by years since quitting in 30+ pack year smokers. *Journal of medical screening.* 2015;22(3):151-157.

Tammemagi MC, Church TR, Hocking WG, Silvestri GA, Kvale PA, et al. (2014) Evaluation of the Lung Cancer Risks at Which to Screen Ever- and Never-Smokers: Screening Rules Applied to the PLCO and NLST Cohorts. PLoS Med 11(12): e1001764. doi:10.1371/journal.pmed.1001764

OOTB: > 30 PY & > 15 Quit Years

- Gradual decrease with years since quit
  - No dramatic drop-off after 15 years
  - Substantial elevated risk vs never smokers even at 30 years since quit.
- Cigarettes per day higher in 30PY former smokers than current smokers.
- Histology of lung cancer in Over 15 QY more similar to current than never smokers.
- "Although a 15 year limit may be reasonable, other limits may also be valid."
- Removing the 15 QY limit would increase screening qualified population by 3 million individuals

Pinsky PF, Zhu CS, Kramer BS. Lung cancer risk by years since quitting in 30+ pack year smokers. *Journal of medical screening.* 2015;22(3):151-157.

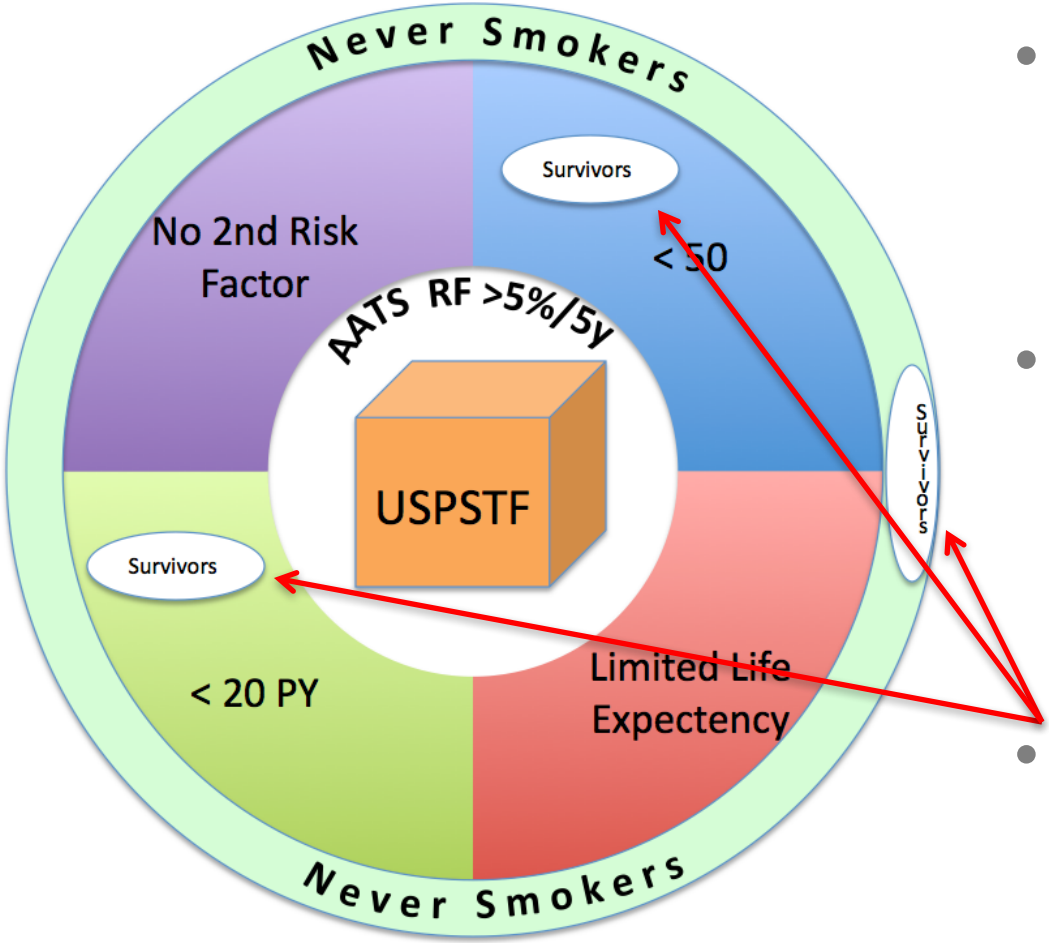
Lung Cancer Survivors

- AATS: Annual surveillance for life
  - Patient must have ability to undergo curative therapy
- Group excluded from randomized trials
- **3% risk of lung cancer diagnosis each year**
  - 13-20% develop other second primary lung tumor or other aerodigestive tumor at 6-8 years post therapy
  - Lung Cancer Study Group - incidence of 2nd Primary Lung Ca > 5 years post treatment is twice that of what is seen in first 5 years post surgery
- > 400,000 survivors in the United States

Jaklitsch MT, Jacobson FL, Austin JH, et al. The American Association for Thoracic Surgery guidelines for lung cancer screening using low-dose computed tomography scans for lung cancer survivors and other high-risk groups. *The Journal of thoracic and cardiovascular surgery.* 2012;144(1):33-38.

Out of the Box

AATS Recommendation

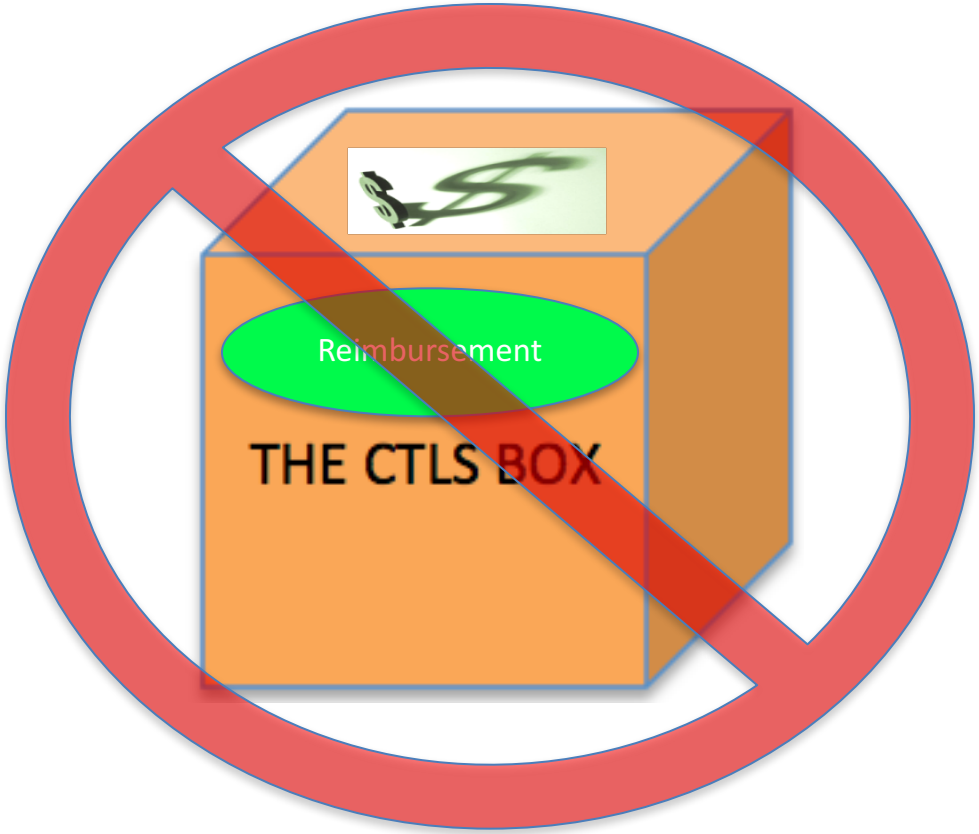


- USPSTF & no QY limit
- >50, >20 PY, >5% risk of lung cancer in 5 years.
- Lung Cancer Survivors

Jaklitsch MT, Jacobson FL, Austin JH, et al. The American Association for Thoracic Surgery guidelines for lung cancer screening using low-dose computed tomography scans for lung cancer survivors and other high-risk groups. *The Journal of thoracic and cardiovascular surgery.* 2012;144(1):33-38.

Forget the Box?

Community Benefit Screening



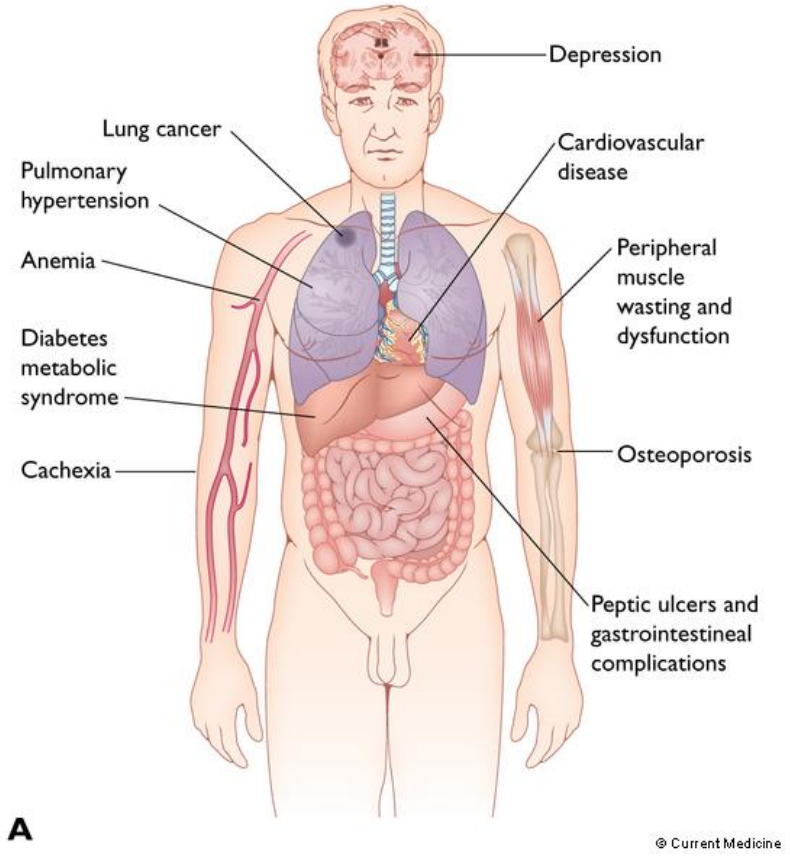
- Compliance Approval
- No reimbursement
- No advertisement
- All or nothing

Good Luck!

Population Health

- Smoking Cessation
- Coronary artery calcifications
- Emphysema/COPD
- Quantitative Imaging

Quantitative Computer Tomography Applications



Applications of Imaging

-Airway Disease

-Parenchymal Disease

-Vascular Disease

-Extra-Pulmonary

Atlas of COPD, Springer Science. 2008

Coronary Artery Calcifications

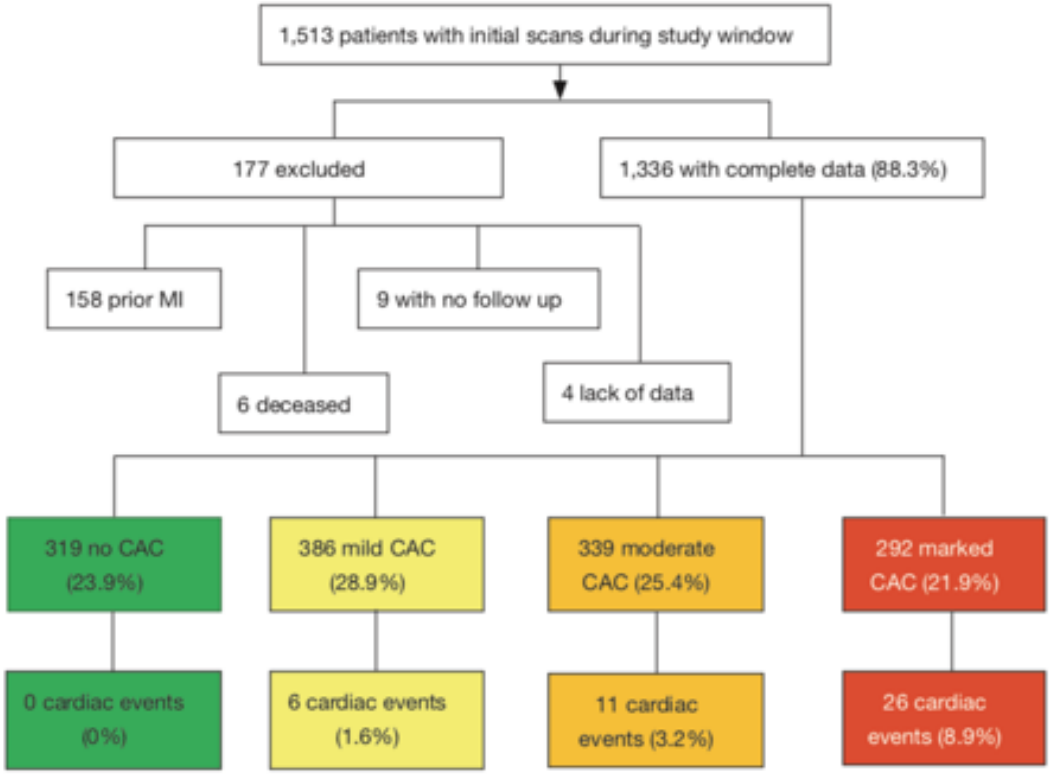


Figure 1 Study flowchart. Of the 1,336 patients with complete data, 23.9% had no CAC, 28.9% had mild CAC, 25.4% had moderate CAC and 21.9% had marked CAC. The majority of cardiac events happened in patients with moderate or marked CAC. CAC, coronary artery calcium.

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Coronary Artery Calcifications

Table 7 Binary logistic regression model results with CAC

Independent variables	Cardiac events (n=43)		
	OR	95% CI	P
Hypertension	2.52	0.97–8.59	0.09
Hyperlipidemia	7.49	1.59–133	0.05
Pack years	1.01	1.00–1.02	0.04
CAC mild[†]	2.56	1.76–3.92	<0.001
CAC moderate	6.57	3.10–15.4	<0.001
CAC marked	16.8	5.46–60.3	<0.001

[†], CAC was run as a continuous variable in the model. The 3 CAC level OR values are shown for illustration. The OR are in relation to CAC none. CAC, coronary artery calcium; OR, odds ratio.

93.9% of the cohort had LDL measured at least once

Patients with total CAC score >400 20.0% **(111/554) goal of <70**

Patients with total CAC score >400 56.7% (314/554) goal of <100

Patients with total CAC score >400 84.8% (470/554) goal of <130

Patients with total CAC score >400 **only** 27.6% average systolic BP of last two documented readings is at goal <140

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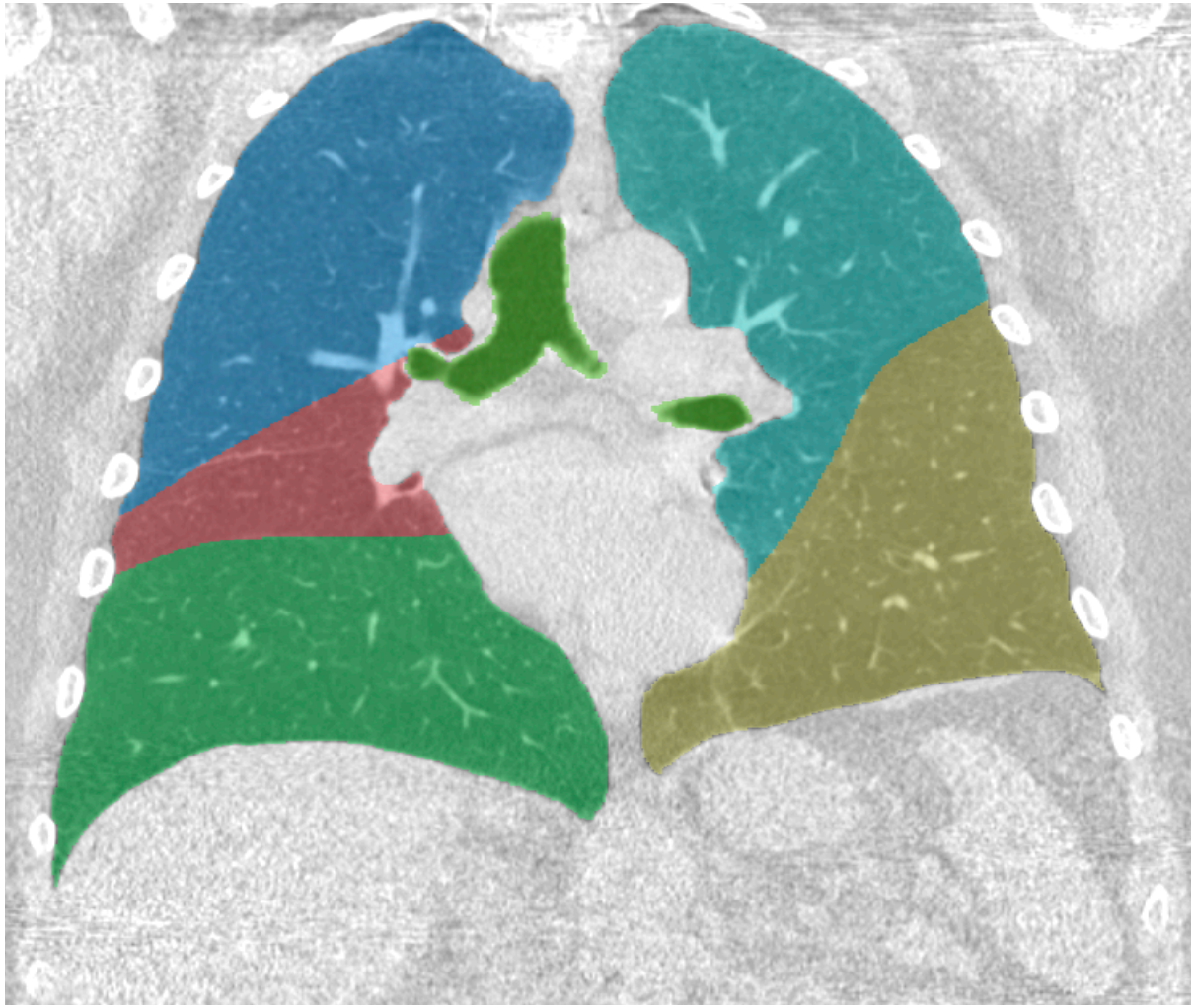
Quantification of Emphysema on Chest CT



- 30% Admission rate
- Emphysema on CT 50%
- ILA on CT 6%
- Bronchiectasis on CT 6%

Patients with Qualitative Emphysema on baseline CT

Only 32% (315/938) were ever seen by pulmonary prior to baseline CT

Patients with ILA:

Only 21.2% (22/104) were ever seen by pulmonary prior to their baseline CT

Patients with Bronchiectasis on baseline CT

Only 32% (20/62) were ever seen by pulmonary prior to their baseline CT

Broad Screening Endorsements

Risk Management

- Following *NLST* publication and the NCCN Guidelines® many additional medical societies have recommended LDCT screening (0 before the *NLST*):
  - National Comprehensive Cancer Network ***(NCCN)***
  - American Lung Association (***ALA)***
  - American Thoracic Society ***(ATS)***
  - American College of Chest Physicians ***(ACCP)***
  - American Society of Clinical Oncology ***(ASCO)***
  - American Association for Thoracic Surgery ***(AATS)***
  - American Cancer Society ***(ACS)***
  - American Association of Bronchology and Interventional Pulmonology ***(AABIP)***
  - Society of Thoracic Radiology ***(STR)***
  - Society of Thoracic Surgeons ***(STS)***
  - International Association for the Study of Lung Cancer ***(IASLC)***
  - Oncology Nursing Society ***(ONS)***
  - European Society of Thoracic Surgeons ***(ESTS)***
  - American College of Radiology ***(ACR)***
  - Cancer Care Ontario ***(CCO)***
  - ***United States Preventative Services Task Force (USPSTF)***
  - ***Centers for Medicare & Medicaid Services (CMS)***

RIGHTS AND EXPECTATIONS

THE RIGHTS OF THE PEOPLE

- You have the right to know if you are at risk for lung cancer.
- You have the right to know that well-organized low-dose CT screening has been shown to significantly reduce the possibility of dying from lung cancer.
- You have the right to clear and unbiased information on the risks and benefits of CT screening.
- You have the right to fair and equitable access to medically appropriate CT screening.
- You have the right to timely and compassionate care if you are diagnosed with lung cancer.
- You have the right to donate your scans and biological specimens to lung cancer research to help find additional life-saving cures.
- You have the right to ask screening sites if they follow the Guiding Principles for Lung Cancer Screening Excellence and provide care in a multi-disciplinary continuum.

Failure to Screen Lawsuits

Risk Management

- "…juries confronted with a plaintiff patient who develops cancer or other serious disease for which a screening test was available but not ordered by the patient's physician, tend to find that the physician's failure to order the test was negligent."

  Berlin, L. AJR December 2002 vol. 179 no. 6 1401-1405

- "Lawsuit Follows Death of Woman When Doctors Failed to Screen Her As Per Cancer Screening Guidelines"

- DC Jury Awards $5M for Failure to Screen for cancer – June 25, 2012
- "…family claimed that his Washington-based doctor, Dr. …, failed to perform the full scope of screening laid out in guidelines from national health organizations."

Kotter's Organizational Change

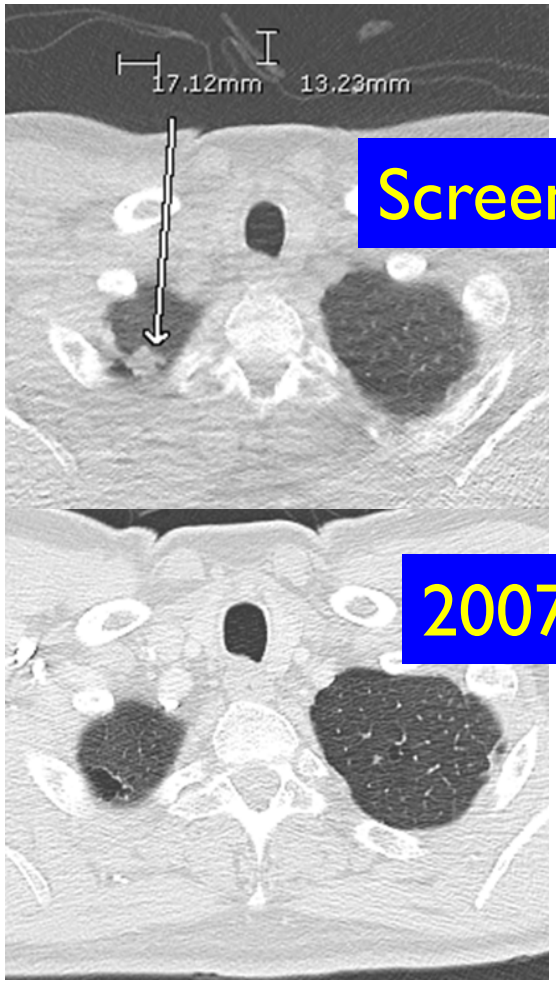
Figure 1. Rescue Lung, Rescue Life Implementation of Kotter Model for Organizational Change

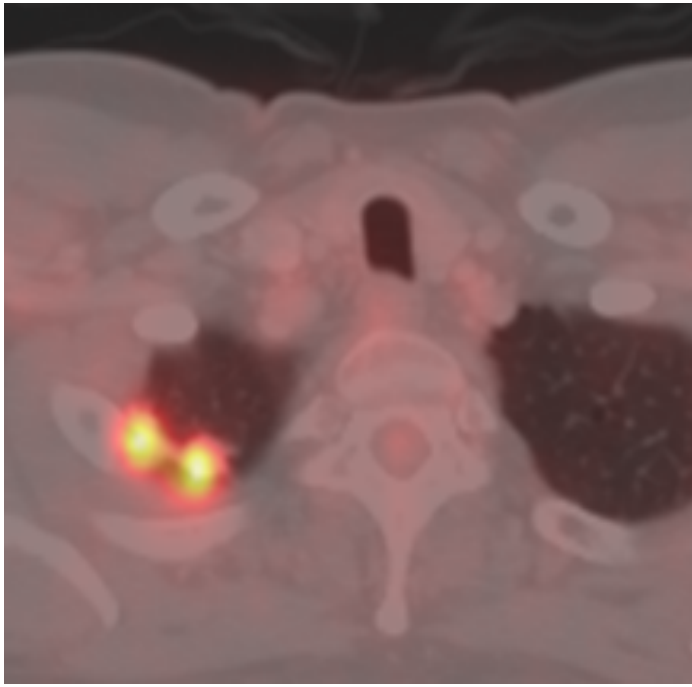
1. Create a Sense of Urgency 2. Form a Powerful Coalition 3. Create a Vision	< PREPARE >	1. Rescue Lung, Rescue Life 2. Steering Committee 3. Hospital Mission
4. Communicate the Vision 5. Remove Obstacles	< IMPLEMENT >	4. Approval 5. CME Campaign, Demystify, LungRADS, Radiology Infrastructure
6. Create Short-Term Wins 7. Build on the Change 8. Embed the Change into the Culture	< MANAGE >	6. Quality and Safety Metrics 7. Research 8. Steering Committee Governance

ACCC *Oncology Times* March/April 2014

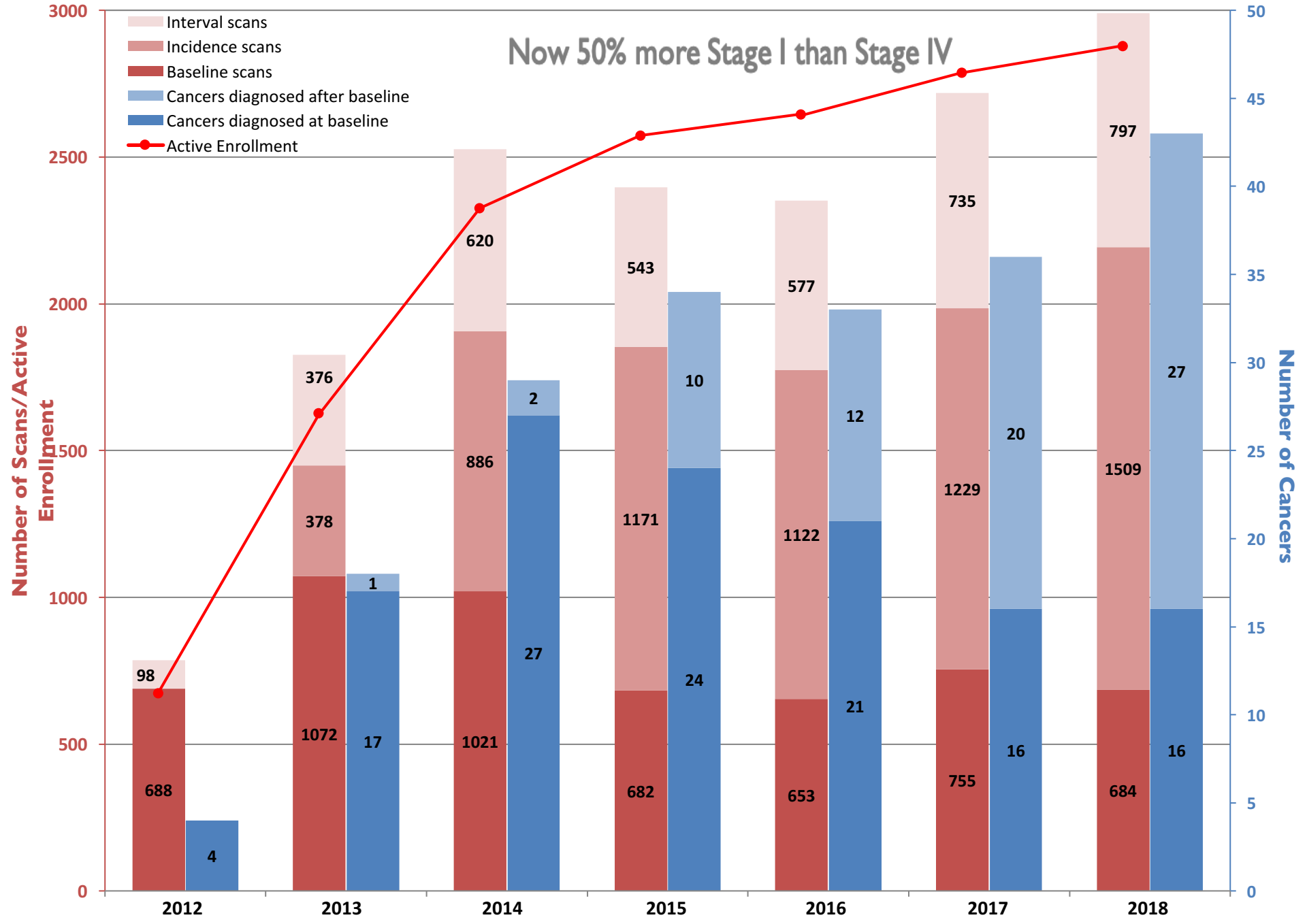
4B: Adenocarcinoma, Grade 3/4,

T1a (2cm), N0, M0 → Stage IA





CTLS Program Volume, Active Enrollment, and Cancers Diagnosed per Year



CT Lung Screening MD Summary

	# Referrals	% Referrals who qualify	% Qualified who get scanned	% Referrals who get scanned
Average Lahey MD	20	91.5%	86.2%	78.9%
Example MD	157	84.7%	83.5%	70.7%

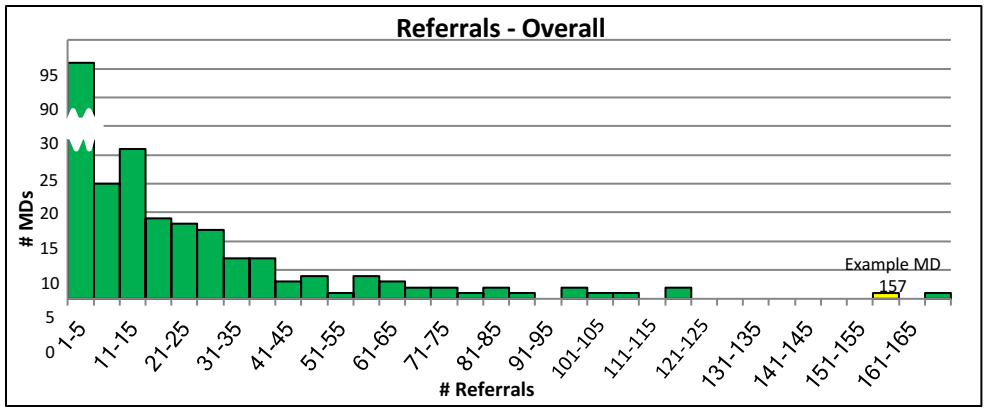
	Age	Years Quit (former smokers)	Pack years	Male	Group 1
Average Lahey patient	62.6	9.6	47.9	56.1%	78.4%
Example MD patient	61.2	12.2	45.2	64.9%	60.4%

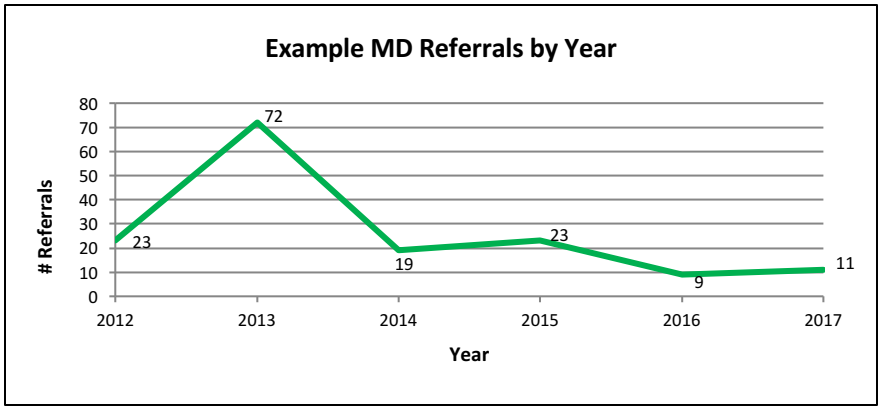
- Current smokers at baseline reporting having quit at time of most recent scan
  - ***Quit rate: 19.4%***
- Former smokers at baseline reporting smoking again at time of most recent scan
  - ***Relapse rate: 1.7%***
- Significant incidental findings (S positive) in 9% ; 0 extrapulmonary malignancies
- Two patients diagnosed with lung cancer through screening – **1.8% CDR**
  - Stage IA adenocarcinoma
  - Stage IB squamous cell carcinoma

Patients Lost to Follow Up

MRN	Status	Date Discharged
1	90 Day Letters Sent	10/11/2017
2	90 Day Letters Sent	4/6/2016
3	90 Day Letters Sent	1/12/2016
4	90 Day Letters Sent	11/10/2015
5	90 Day Letters Sent	10/22/2015
6	90 Day Letters Sent	4/23/2015
7	90 Day Letters Sent	2/6/2015
8	90 Day Letters Sent	2/2/2015
9	90 Day Letters Sent	10/29/2014
10	90 Day Letters Sent	10/24/2014
11	90 Day Letters Sent	9/8/2014
12	Qualified, Never Scanned	6/23/2017
13	Qualified, Never Scanned	3/17/2017
14	Qualified, Never Scanned	2/17/2017
15	Qualified, Never Scanned	7/16/2014
16	Qualified, Never Scanned	6/20/2014
17	Qualified, Never Scanned	2/18/2014
18	Qualified, Never Scanned	2/7/2014
19	Qualified, Never Scanned	11/20/2013
20	Qualified, Never Scanned	7/30/2013
21	Qualified, Never Scanned	6/26/2013

Group 2 patient





https://www.lungcancerscreeningguide.org

What is your rate of abnormal findings when using Lung-RADS?

EH: LR3 and LR4 combined are running around 12-15% combined. I think it is important to note that the prevalence of nodules and their sizes is going to vary by geography. There is no "right" or single or simple answer here. It might make sense to aggregate geographic areas once this data is better known.

Diagnosis by Screening Round from Lahey Medical Center, Burlington MA

24 Months of Exams with 3+ Months of Follow Up (2015-2016)

SCREEN ROUND	NEGATIVE (LR 0, 1, 2)		POSITIVE (LR 3, 4A, 4B, 4X)		SUSPICIOUS (LR 4A, 4B, 4X)		DX LUNG CA (LR 5)		PPV	LR3 PPV	LR4 PPV	LR4B PPV	FALSE NEGATIVE		TOTAL	S POSITIVE	
T0	842	85.5%	143	14.5%	63	6.4%	20	2.0%	14.0%	0.0%	31.7%	68.4%	2	0.2%	985	83	8.4%
T1	686	91.8%	61	8.2%	27	3.6%	10	1.3%	16.4%	0.0%	37.0%	50.0%	1	0.1%	747	21	2.8%
T2	613	95.5%	29	4.5%	14	2.2%	3	0.5%	10.3%	0.0%	21.4%	16.7%	0	0.0%	642	14	2.2%
T3+	545	94.5%	32	5.5%	17	2.9%	6	1.0%	18.8%	0.0%	35.3%	50.0%	0	0.0%	577	10	1.7%
TOTAL	2676	91.0%	265	9.0%	121	4.1%	39	1.3%	14.7%	0.0%	32.2%	53.7%	3	0.1%	2941	128	4.4%

NLCRT Quality Metrics Workgroup

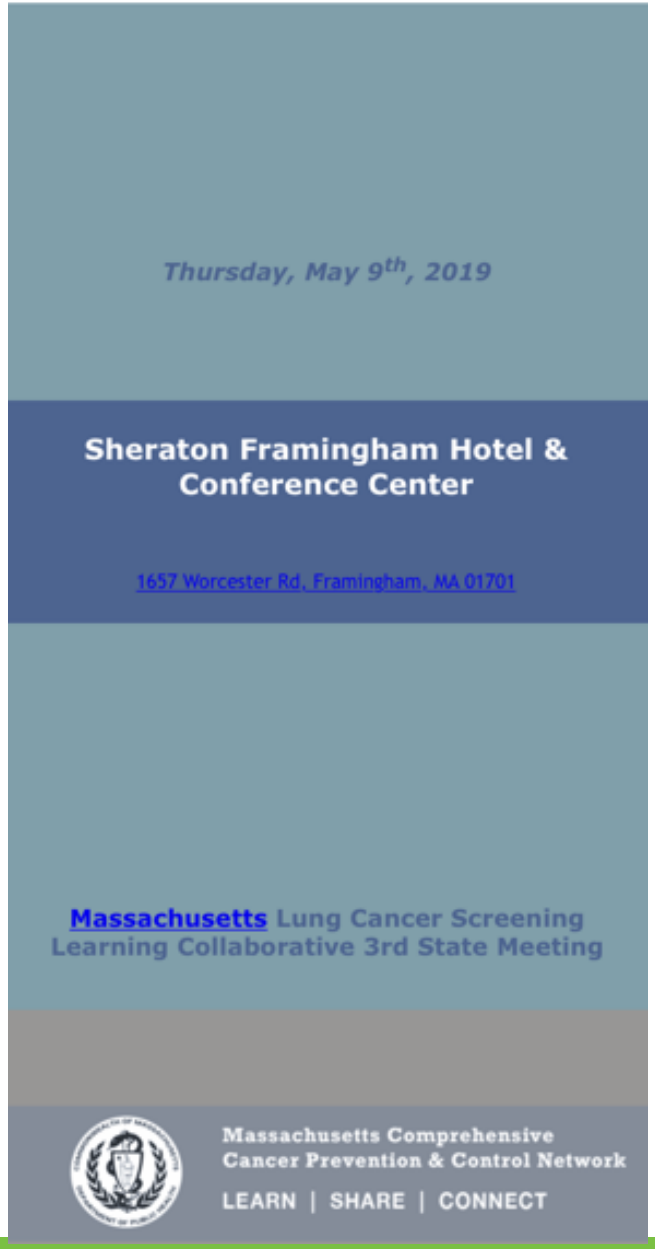
Race Breakdown in the Lung Screening Program

Race	Lung screening program	Lahey overall (FY 2014)
American Indian / Alaskan Native	0.09%	0.10%
Asian	0.65%	3.50%
Black	0.39%	1.60%
Hispanic	0.30%	1.80%
White	98.57%	86.20%
Latin American	N/A	0.20%
Other / Declined	N/A	6.50%

Future

- Act locally to change organizational culture
- Remove barriers to CTLS
  - Rescue Lung, Rescue Life Society: Rescuing lives from lung cancer today and tomorrow
- Research Opportunities
  - Smoking cessation, population health, and value based medicine
  - Molecular adjuncts
  - ACO environment
- Advocacy
  - Access for remote populations and minorities – May 17th meeting, MN
  - Expanding coverage to other risk groups
  - State based initiatives- Massachusetts State quality collaborative third in person meeting May, 9,2019
  - Public education campaigns

2019 Update - What Primary Care Providers Need to Know about Lung Cancer Screening



Lahey Hospital & Medical Center

RESCUE LUNG RESCUE LIFE SOCIETY

Saving lives at risk for lung cancer through implementing high quality CT lung screening today and pioneering early detection innovations tomorrow.

WEBSITE COMING SOON | 833-RSQ-LUNG (833-777-5864) | info@rescuelung.org

RESCUE LUNG RESCUE LIFE SOCIETY

Vision: Rescuing Lives From Lung Cancer Today and Tomorrow

Mission: Saving lives from lung cancer through implementing high quality CT lung screening today and pioneering early detection innovations tomorrow

Who We Are: We are a multidisciplinary, care-giver driven, voluntary organization providing team-based solutions to empower lung health through prevention and early detection

Values: Innovation, evidence-based practices, interdisciplinary teamwork, solution-focused, quality driven

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Thanks!

www.laheyhealth.org/lungscreening